Development of a Theoretical Model of Creative Cognition in the Elderly.

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Declaration

I hereby declare that this thesis is my own unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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Abstract

Creativity is a versatile, multifaceted and an elusive construct that encompasses multiple definitions, theories and models. The creative cognition approach conceptualises creativity as the formation of ideas that are novel and valuable. Although the importance of creativity is widely acknowledged, the cognitive basis of this phenomenon is poorly understood, especially in the elderly population. Research tends to focus on a sample that is comprised of either children or young adults, who are at their cognitive peak. This study aimed to elucidate the cognitive functions implicated in creative thinking and assess the relationship between various cognitive functions underlying creativity in the elderly. Given that various demographic factors potentially account for the type and amount of creative output generated, an additional aim of the current study was to investigate whether the demographic variables of age, multilingualism, socio-economic status (SES), level of education, and gender predicted each cognitive function identified as being implicated in the creative process. To address these two research aims, one hundred and twenty-five participants aged 65 and above were recruited and administered a battery of cognitive tests, which assessed divergent, convergent and associative thinking, as well as task-switching, inhibition and fluid intelligence. Multivariate structural equation modelling (SEM) was used to investigate the relationships between cognitive functions included in the model and group-difference analyses were used to assess whether various demographic variables predicted the individual processes implicated in creative thinking. The SEM analysis demonstrated that creativity entails the joint role of divergent and convergent thinking and that both these processes rely on associative thinking. In addition, creativity involves fluid intelligence and task-switching, but not inhibition. These findings suggest an associative basis of creativity and support the dual-process account of creative cognition, thereby recasting creativity as a higher-order cognitive function. On this basis, both associative and higher-order, executive functions should be considered when researching creativity. Finally, for the cognitive functions included in the model, statistically significant group differences were found between SES and education groups, respectively, with a higher level in both variables corresponding to better task performance. Overall, this study has significant implications in terms of informing theoretical frameworks of creative cognition which may help to elucidate the fundamental processing underlying creative thinking.

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Chapter 1: Introduction

The purpose of the following chapter is to establish the research field and provide a general overview of the topic under investigation, namely creativity. This chapter first discusses the background of the present study in order to contextualise the research, which includes a definition of creativity. The main framework of this sub-section centres around the discussion of the conceptualisations of creativity. Specifically, the three paradigms in creativity theory outlined by Glăveanu (2010), including the genius paradigm, the I-paradigm and the We-paradigm, form the basis of this section's structure. First, the genius is introduced, including assumptions and significant limitations associated with this paradigm. This paradigm places the divine or supernatural at the core of creativity and focuses only on exceptional creators, which is often at the expense of ordinary individuals and everyday forms of creativity (Glăveanu, 2010). A common criticism of this approach is that it offers an account that is unrealistic and misleading as it implies that creativity is a condition that happens to people rather than individuals actively engaging in creative acts (Paul & Kaufman, 2014). Therefore, the current research rejects the genius paradigm in favour of more contemporary conceptualisations of creativity, such as the I-paradigm.

Subsequently, this section introduces the I-paradigm of creativity, which is the conceptual framework that forms the basis of the present study. The I-paradigm relates creativity to something from within the psychology of an individual and, therefore, provides a strong foundation for analysing the mental operations underpinning creative thinking (Abraham & Windmann, 2007). This conceptualisation, therefore, implies that everyone has the potential to be creative instead of creativity being a capacity that is limited to an exceptional few (Glăveanu, 2010). A prominent manifestation of the I-paradigm is located in the cognitive sciences, which uses the functions implicated in creative thinking and the degree to which they differ among individuals as a means to study creativity (Kenett et al., 2015; Kharkhurin, 2012).

Subsequently, this section discusses three predominant cognitive theories of creativity situated in the I-paradigm, which include the associative theory, the executive control theory and dual-process theory. Briefly, the associative theory conceptualises creativity as the process of generating associative elements in semantic memory into novel and unique combinations (Benedek et al., 2012b). Creativity in the context of the associative theory is a bottom-up and automatic process that operates independently of conscious control (Colzato et al., 2013). This view implies that creativity is synonymous with divergent thinking, which Guilford (1956) identified as a component of creativity. Divergent thinking refers to an intuitive and reflective process that involves the ability to generate multiple discrete and unusual candidate ideas (Webb et al., 2017). While this mode of thinking enables flexible creative processing, thereby producing more unconventional possibilities, on its own it may result in unrealistic or inappropriate ideas due to information not being evaluated or refined (Runco & Jaeger, 2012).

This conceptualisation is, thus, criticised for oversimplifying and obscuring important aspects of the creative process, such as higher-order cognitive processes. As a consequence, research considers a contemporary theory, namely the executive control approach, which maintains that creativity is a top-down process that relies on the ability to control both attention and cognition (Beaty et al., 2014b). In doing so, this theory conceptualises creativity solely in terms of another component of creativity identified by Guilford (1956), namely convergent thinking. This component of creativity is characterised as critical and evaluative and involves the ability to select and refine various promising possibilities into a single, best fit idea (Cropley, 2006). While this mode of thinking enables conventional and literal processing, thereby ensuring that relevance and appropriateness criteria of creativity are met, on its own, it lacks the flexibility and spontaneity required to satisfy the novel criteria of creativity (Zabelina & Robinson, 2010).

Therefore, the present study considers a final theory of creative cognition that consolidates associative and executive control theories of creativity, namely the dual-process theory. In general, this theory maintains that creativity relies on both Type-1 thinking (automatic, fast) and Type-2 thinking (systematic and deliberative). The dual-process theory forms the basis of the hypothesised theoretical model developed in the current study as this theory accounts for the joint role of bottom-up, automatic process and top-down, controlled processes that are required to generate ideas that meet both the novel and usefulness criteria of creativity (Sowden et al., 2015).

This section then introduces the two dual-process theories discussed in the literature review, including the Geneplore model and the dual-pathway model. The Geneplore model maintains that creativity consists of a generation stage and an exploration stage (Finke et al., 1992). In contrast, the dual-pathway model posits that there are two pathways to creative performance, including the flexibility pathway and the persistence pathway (Nijstad et al., 2010). While these models both acknowledge the joint role of divergent thinking and convergent thinking in the creative process, they each make different predictions regarding the extent to which these modes of thinking operate in series or parallel. Specifically, the Geneplore model suggests divergent and convergent thinking are entirely independent processes that operate serially, whereas the dual-pathway model suggests these aspects of creativity function more in unison (Sowden et al., 2015).

Nevertheless, dual-process theories of creativity typically agree on the notion that creativity entails both a divergent thinking stage, which predominates during the formation of ideas, and a convergent thinking stage, which predominates in the exploration, evaluation and refinement of an idea (Kharkhurin, 2012). In particular, the initial, divergent thinking phase involves automatically developing associative links between conceptual representations, which results in novel and unusual candidate idea. The subsequent convergent thinking phase then evaluates and expands on these candidate ideas, which produces relevant and useful creative products (Cropley, 2006). This idea demonstrates that creativity relies on both divergent and convergent thinking and are, therefore, the first two functions identified in the current study as underlying creativity.

Additionally, given that the theories mentioned above generally all agree that creativity draws on additional cognitive functions to divergent and convergent thinking, such as associative thinking, task-switching, inhibition and fluid intelligence, these additional functions are discussed in some detail. In particular, since divergent and convergent thinking presumably rely on associative processes (Lee & Therriault, 2013), the current study identifies associative thinking as a function that underlies creativity. Moreover, since dual-process theories assume that executive functions facilitate the exploration of creative ideas, the role of task-switching, inhibition and fluid intelligence are discussed. Specifically, task-switching possibly facilitates the shifting from one processing mode to the other or the switching between conceptual features (Sowden et al., 2015). Furthermore, the ability to inhibit strong competing responses or previously relevant tasks and redundant creative strategies accompanies this flexible cognitive switching (Gilhooly et al., 2007). Lastly, the current research considers the role of fluid intelligence in the creative process as this function possibly facilitates the appropriate allocation of the executive functions mentioned above (van der Meer et al., 2010).

Although the I-paradigm, and in particular the creative cognitive approach, has helped enrich our understanding of the creative process and elucidate the cognitive functions underlying creativity, there are two significant research gaps that the present study ultimately aimed to address. Firstly, creativity research tends to investigate the role of individual processes in isolation and, as a consequence, how multiple cognitive functions interact with each other, which together influence creative performance, is overlooked (Reiter-Palmon, 2014). This approach is surprising given that cognitive theories generally agree that creativity comprises of multiple cognitive functions (Kharkhurin, 2012). The first phase of this research addressed this gap by using multivariate analysis to investigate the potential role that multiple cognitive functions may play in the creative process. In particular, structural equation modelling (SEM) was used to investigate the relationships between components of creativity, namely divergent, convergent and associative thinking, as well as executive function, including task-switching, inhibition and fluid intelligence.

Secondly, theorists often criticise the creative cognitive approach for encouraging methodological reductionism by focusing only on internal processes, including cognition and personality, to the exclusion of other, external factors, such as contextual and environmental factors (Glăveanu, 2010). The second phase of this research addressed this gap by investigating whether various demographic variables, including age, multilingualism, SES, level of education and gender, predicted the individual cognitive processes included in the theoretical model developed in the first phase of the study. In order to address the second identified research gap (i.e., the failure to acknowledge the role of contextual factors), this section introduces Glăveanu's (2010) We-paradigm. In brief, the We-paradigm builds on the I-paradigm's assumption that creative ability is universal but grounds this ability within social interaction rather than isolated individuals (Glăveanu, 2010). These factors are essential to take into consideration, especially in the South African context as the population is highly complex and heterogeneous compared to many others (Howell, 2019). Therefore, this study is located in mainly the I-paradigm and, to an extent, the We-paradigm, whereas the genius paradigm is considered irrelevant.

After familiarising the reader with the background, the next section introduces the study's aims and objectives. This section indicates what this study sets out to accomplish, and the steps taken to achieve this. The researcher developed the aims of this study with the intent to address two main research gaps. These included: (1.) a lack of research that investigates how multiple cognitive processes (i.e., divergent thinking, convergent thinking, associative thinking, task-switching, inhibition and fluid intelligence) interact with each other that together may influence creativity, and (2.) the lack of focus on the role contextual factors may play in the creative process.

The present research, therefore, had two main aims. The first aim was to contribute to existing cognitive theory, by elucidating the cognitive functions implicated in creative thinking, and to investigate the relationship between various cognitive functions underlying creativity. A review of the existing literature helped formulate a hypothesised theoretical model that was, subsequently, tested and validated using SEM. The second aim was to investigate whether various demographic variables, namely age, multilingualism, socio-economic status (SES), education, and gender, predicted the individual cognitive functions identified as underlying the creative process. This phase of the research involved evaluating whether there were differences in cognitive test performance across the demographic sub-groups. The introduction concludes by describing the thesis structure, which provides an overview of each chapter to help guide the reader through the thesis.

1.1. Background

There are few characteristics that define and shape the human experience as profoundly and pervasively as creativity (Batey, 2012). It is not only a crucial operator that drives progress in widespread human endeavours, such as art, science, and technology but is also a vehicle of self-expression that constitutes a crucial component of the human condition. Arguably, one of the most fundamental issues for any study of creativity is how this construct is defined and conceptualised (Paul & Kaufman, 2014). There is a consensus that a product needs to meet two criteria in order for it to be considered genuinely creative (Cropley, 2011). While it is essential for a product to be *new*, this criterion alone does not necessarily constitute creativity, as novelty can also be nonsensical and, therefore, worthless (Paul & Kaufman, 2014). Hence, the creativity of a product is also contingent on its usefulness. Creative products must, therefore, be novel and original as well as deemed to be effective, useful or of some value (Runco & Jaeger, 2012; Zmigrod et al., 2015).

Given the importance of creativity, this construct has not always received full attention in research. The lack of research, particularly in the field of psychology, is often attributed to traditional assumptions regarding its source, which continues to shape much of the contemporary thinking about creativity. In particular, the notion of a supernatural or a divine origin of creative inspiration forms the basis of traditional conceptualisations (Weisberg, 2010). Glăveanu (2010) refers to this conceptualisation as the genius paradigm, which defines creative individuals in terms of two main characteristics: exclusivity and disconnection. Creativity in this context is exclusivist as only a select group of gifted individuals are viewed as capable of being creative and, as a prerequisite, are distinguished from the general person due to their abilities. Additionally, this paradigm implies that creative individuals produce output *ex nihilo*, that is, generating creative products out of nothing (Glăveanu, 2010). However, an important issue associated with the ex nihilo perspective is that it gives the impression of passivity, whereby creativity is a condition that happens to or within people rather than individuals actively engaging in creative acts. Creativity within this framework occurs spontaneously, with ideas merely appearing without a basis for reflection, intelligence, or control. This assumption suggests that the creative process merely entails the apparition of ideas, which implies that this process concludes as soon as alternative ideas are presented for consideration and consciously explored further or rejected for another (Paul & Kaufman, 2014). Due to these shortcomings, the genius paradigm began to shift focus away from the divine and supernatural origin of creativity to conceptualisations that provided a solid basis, such as human biology (Glăveanu, 2010).

A modern manifestation of the genius paradigm is provided by Francis Galton who, through his theory of the "Hereditary Genius", introduced the first scientific study of the creative genius (Simonton, 2003). His theory assumes that when all conditions are equal in the competition between nature and nurture, the former will prove to be the stronger of the two and, therefore, prevail (Galton, 1874). This paradigm refers to creative achievement strictly in terms of eminence, whereby the only products that are worthy of being deemed as creative are those that introduce reputable novelties, establish new schools of thought or constitute significant breakthroughs in a particular field (Glăveanu, 2010; Runco, 2014a). This idea represents not only the main attraction but also the principle limitation of the genius paradigm. Although celebrating distinguished creative achievement makes creativity a desirable human capacity, the limitation of doing so is that everyday forms of creativity and common creative experiences are overlooked, providing an elitist and essentialist account of creativity (Glăveanu, 2010).

Therefore, the field of creativity has experienced a paradigmatic shift, with modern conceptualisations replacing the notion of the creative genius with the "normal" individual. Glăveanu (2010) referred to this conceptualisation as the I-paradigm, with the *I* being representative of the individual. This approach assumes that everyone is capable of being creative, rather than it being an ability restricted to the genius and attributed to some form of divine intervention, biology or unique psychological features. Whereas the genius paradigm was deeply rooted in pre-psychological thought, the emergence of the I-paradigm is attributed mainly to psychologists' increasing interest in the field of creativity. The driving force behind this paradigm was Joy Guilford, whose address at the American Psychological Association, which called for an increase in research on the topic, resulted in a definite surge of interest in exploring the link between the creative abilities of individuals and their attributes, i.e., personality, intelligence.

One of the most prominent manifestations of the I-paradigm, with its basis located in the cognitive sciences, is the field of creative cognition (Glăveanu, 2010). Kozbelt et al.

(2010) identify two main features of creativity that the cognitive approaches emphasise, including both process and person aspects. Firstly, the goal of process-oriented theories of creativity is to investigate and explain the nature of the mental mechanisms engaged during creative thinking. Secondly, by focusing on the person (personality) aspect, cognitive theories of creativity aim to investigate individual differences in such mechanisms (Kozbelt et al., 2010). Therefore, cognitive approaches to creativity explore the various cognitive processes implicated in creative thinking, as well as the degree to which they differ among individuals, to effectively study this elusive construct (Kenett et al., 2015; Kharkhurin, 2012).

Cognitive theories of creative thinking are relatively varied, each of which focuses on different aspects of creativity. While certain theories focus on universal capacities (i.e., intelligence, memory, attention), others focus on individual difference, such as functions evaluated by measures of divergent thinking. Moreover, different theories take opposing stances regarding whether creativity predominantly draws on implicit, unconscious processes or rather relies on conscious operations (Kozbelt et al., 2010). For example, Mednick's (1962) well established associative theory maintains that associative processes form the basis of creative thinking and, therefore, conceptualises creativity as a bottom-up, automatic process that occurs unconsciously and operates independently of conscious control (Colzato et al., 2013). In contrast, the executive control theory emphasises the role of top-down, executive control during the creative process (Benedek et al., 2017). However, a recent account that consolidates these opposing approaches is the dual-process theory of creativity.

Dual-process theories characterise cognition as comprising of two systems, including System-1 and System 2 (Kahneman, 2011). Briefly, System-1 is characterised as rapid, associative, automatic and affective-based, which corresponds to individuals' intuitions and instincts. These processes are trained, habitual and, therefore, difficult to change. In contrast, System-2 processes are characterised as slow, controlled, and volatile and are subject to deliberative judgments. However, a criticism of this dual-system distinction is that it implies that the two types of processes are situated in, and restricted to, two distinct cognitive or neurological systems (Evans & Stanovich, 2013). Consequently, the terms *Type-1* and *Type-2* processing replace the terms mentioned above as they account for the possibility that multiple cognitive functions or neural systems underlie them. Type-1 processes are defined as autonomous, initiate and terminate when relevant stimulating situations are present and do not rely on working memory. In contrast, Type-2 processes are defined as controlled and rely on working memory.

Dual-process theories differ in terms of the assumptions they have regarding how both Type-1 and Type-2 processes interact (Glöckner & Witteman, 2010). For example, pre-emptive dual-process models assume that one type of processing is first selected before the actual processing begins. In contrast, parallel-competitive dual-process models assume that both types of processing compete throughout the task. Lastly, the default-interventionist dual-process models maintain that while Type-1 processing is the default style of thinking, Type-2 processing intervenes if Type-1 processing cannot provide a solution (Evans, 2007).

An influential dual-process model that overlaps considerably with the default-interventionist framework is Norman and Shallice's (1986) representative model of executive control. This model specifies how cognition and behaviour schemas are either activated or inhibited for routine and non-routine tasks or situations. The model comprises two main mechanisms that facilitate the selection of schemas: the contention scheduling system (CSS) and the supervisory attentional system (SAS). The CSS facilitates the implementation of appropriate schema for routine, habitual circumstance, which inhibits irrelevant schemas that compete for the control of cognitive resources. In novel and non-routine situations, the SAS supervises and controls the CSS by activating schemas to ensure they are appropriate to the situation.

Applied to creative cognition, the Norman and Shallice (1986) model suggests that the CSS facilitates the automatic activation of content that produces ideas that are novel and unconventional (Type-1 process). However, if this activation results in salient conceptual knowledge or unrealistic ideas that are inappropriate for the creative task, the SAS (Type-2 process) is required to alter contention scheduling in order to activate additional content or inhibit irrelevant information. This conceptualisation resembles the assumptions made in the default-interventionist framework (Evans & Stanovich, 2013). Two predominant dual-process models that focus on creativity and cohere with the conceptualisation of cognition described above include the Geneplore model (Finke et al., 1992) and the dual-pathway model (Nijstad et al., 2010).

The Geneplore model characterises the generation of creative ideas that are both novel and useful as resulting from the interaction of generative and explorative processes. Specifically, the generative process develops candidate ideas that vary in the degree of their creative potential, which is subsequently evaluated and elaborated on through the explorative process (Finke et al., 1992). Similarly, the dual-pathway model maintains that there are two pathways that lead to creative potential, including the flexibility pathway and the persistence pathway. The flexibility pathway involves generating creative products by surveying multiple conceptual categories, establishing new links between distantly related concepts and flexibly switching between conceptual categories. In contrast, the persistence pathway entails effortfully producing creative output by systematically exploring fewer conceptual categories at greater depth and evaluating the viability of creative products (Nijstad et al., 2010).

Although these two dual-process models of creativity agree on the assumption that creativity relies on the joint role of bottom-up, associative processes and top-down, controlled processes, each of these models make different predictions regarding how the thinking processes interact. In particular, the Geneplore model assumes that these two processes operate in series, thereby implying that one mode of thinking needs to conclude before the other is engaged. In contrast, while the dual-pathway model does not necessarily assume that the two creative processing modes function in parallel, it suggests that Type-1 and Type-2 processes involved in creativity are integrated to a greater extent than described in the Geneplore model (Sowden et al., 2015).

Although the different creative cognitive theories discussed above, including the associative, executive control and dual-process theories, make different assumptions regarding the processes underlying creativity, they generally converge on the notion that no single cognitive function serves as the exclusive creative process. Instead, creative thinking involves unique combinations and unusual patterns of the same cognitive processes that engage during non-creative endeavours (Kharkhurin, 2012). In other words, creativity in the context of cognitive science is the process of generating extraordinary products using ordinary cognitive operations that combine in unusual or uncommon ways (Dasgupta, 2019). This idea suggests that, although creativity is a construct that is both theoretically and empirically difficult to study, the multitude of cognitive functions implicated in creative processing can be used to effectively research this construct (Kenett et al., 2015; Kharkhurin, 2012).

For example, Guilford (1967) identified and distinguished two main components of creativity, namely divergent and convergent thinking. Divergent thinking refers to an ideational, bottom-up thought process that occurs when concepts and associations disperse in varied directions (Kharkhurin, 2012; Webb et al., 2017). In contrast, convergent thinking refers to an analytical, top-down style of thinking that extracts a single, best fit or correct solution (Cropley, 2006; Kharkhurin, 2012; Webb et al., 2017). A relatively recent theory argues that creativity entails biphasic processing, namely the joint operation of divergent and convergent thinking (Lee & Therriault, 2013). The initial phase involves unregulated associative links generating automatically and unconsciously, which results in novel output. Following this stage is the phase that involves the exploration, evaluation and criticism of the generated associative links, which identifies relevant and useful aspects of the initial output (Cropley, 2006). This joint role is highly reminiscent of the dual-process theory of creativity, whereby divergent and convergent thinking map onto the generative, Type-1 processing and explorative, Type-2 processing phases respectively (Sowden et al., 2015).

Moreover, these two phases of the creative process relate in respect of their reliance on semantic networks (Kenett, 2018a) and differ from each other in terms of the extent of the involvement of executive functions (Colzato et al., 2013). Specifically, while the associative networks of semantic memory are possibly the foundation of both divergent and convergent thinking, executive functions, which are assumed to then operate on these semantic networks to facilitate more efficient search processes and conceptual combinations (Dane, 2010), engage to a higher degree in convergent thinking than divergent thinking (Colzato et al., 2013).

This notion suggests that both associative processes and executive functions constitute the underpinnings of creative thinking, which is a notion that has been supported by prior research. Specifically, research has found creative cognition to entail associative thinking (Benedek et al., 2012b; Lee & Therriault, 2013; Mednick, 1962), as well as executive functions, including task-switching (Pan & Yu, 2018), inhibition (Beaty et al., 2014b; Benedek et al., 2012a; Vartanian, 2009) and fluid intelligence (Cho et al., 2010; Jauk et al., 2013; Nusbaum & Silvia, 2011). Contemporary creativity research is beginning to elucidate the cognitive mechanisms underlying the creative process as well as to re-examine both the relationship between associative and higher-order aspect of creativity.

Taken together, the I-paradigm, and specifically, the creative cognitive approach, has made progress in the field of creativity research. By enriching our understanding of the mental processes underlying creative thinking, the cognitive approach has made significant advances in the development of theoretical models of creativity. This paradigm has also proved beneficial for research methodology. Psychometric approaches to studying creativity have developed and expanded, with the majority of creativity tests generated to assess divergent thinking and problem-solving, which were validated and administered to ordinary individuals (Runco, 2004). Nevertheless, the cognitive approach to creativity is not without its limitations, which the next section discusses further.

Despite the notable advantages associated with the I-paradigm, there are two crucial areas where there is lack of knowledge and understanding, making progress towards developing a unified theory of creative cognition problematic. Firstly, in terms of theory development, existing research tends to investigate and understand individual processes in isolation. Consequently, there is limited research that investigates how multiple cognitive functions, such as components of creativity, namely divergent, convergent and associative thinking, interact with each other and additional processes, such as higher-order executive functions, that together may influence creativity (Reiter-Palmon, 2014). Secondly, regarding the use of psychometric tests, these measures have come under criticism for focusing exclusively on the end-product while neglecting the processes underlying them as they are often difficult to research. The I-paradigm is, therefore, criticised for encouraging methodological reductionism by focusing on internal processes, including cognition and personality, to the exclusion of other, external factors, such as one's context and environment. As a result, theoretical models that explore individual creative cognition often develop in a social vacuum, which establishes creativity as an ability limited to internal dispositions while neglecting contextual factors. This criticism regarding the decontextualised conceptualisation resulted in the emergence of the We-paradigm of creativity (Glăveanu, 2010).

Any form of cognition, or the process by which individuals make meaning out of their experience, is immersed in one's social and cultural context (Glăveanu, 2010). This idea links to the socio-cultural approach, which stipulates that social interactions and culturally organised activities influence the development of cognitive functions, such as creativity (Luria, 1976; Vygotsky, 1978). Specifically, Vygotsky (1991, 2004) developed a socio-cultural conceptualisation of imagination and creativity which assumes that rich and highly diverse experiences from one's environment produce a variety of material that can generate creative products.

This idea demonstrates the necessity for any cognitive account of creativity to be contextually grounded. The primary goal of the We-paradigm is to, therefore, reintegrate the social into the theory of creativity and begins with the assumption that creativity occurs within, is comprised of, is influenced by and affects, one's social context. In doing so, the We-paradigm adopts a holistic and systemic perspective of creativity and maintains that any theory of creativity needs to take into account contextual factors (Glăveanu, 2010). This need to consider contextual factors when developing a theory of creative cognition is particularly relevant in South Africa, where the population is highly complex and culturally and linguistically heterogeneous compared to many others (Howell, 2019).

Therefore, the above-mentioned limitations associated with the creative cognitive approach are the primary research gaps that the present study aims to address. These research gaps form the basis of the study's aims and objectives, which the ensuing section outlines.

1.2. Aims and Objectives

The present research involves two main aims to address the above-mentioned research gaps. The first aim was to contribute to existing cognitive theory by elucidating the cognitive functions implicated in creative thinking and investigating the relationship between these. The processes focused on in the present study are cognitive functions that are commonly agreed upon to be implicated in creativity, including components of creativity, namely divergent, convergent and associative thinking, as well as various executive functions, including task-switching, inhibition and fluid intelligence. Specifically, since creativity relies on the generative role of divergent thinking to formulate novel output, and the analytic, evaluative role of convergent thinking to select or refine initial output into a useful idea, the present study considers both these components of creativity. Moreover, associative processes form the basis of these two components, thereby warranting the inclusion of associative thinking in the present research. Lastly, executive functions improve the efficiency of memory retrieval, strategy implementation and the manipulation of information, which presumably benefits the generation of creative ideas. In particular, creativity may rely on task-switching and inhibition, which operate together to optimise the retrieval of information from semantic memory and suppress strong competing, yet irrelevant information. Additionally, this study considerers the role of fluid intelligence as it is assumed to facilitate the allocation of the executive functions implicated in the creative process.

The first aim was achieved through the use of SEM to analyse structural relationships between the above-mentioned cognitive functions (i.e., divergent thinking, convergent thinking, associative thinking, task-switching, inhibition and fluid intelligence). In doing so, this study contributes to cognitive theory by developing a coherent theoretical model of creativity that may address the lack of consensus across existing theories regarding the cognitive functions underlying the creative processes, which has prevented the development of an integrated cognitive framework of creativity.

The second aim of the study was to investigate whether various demographic variables, including age, the number of spoken languages, SES, level of education, and gender, predict the individual cognitive functions identified as being implicated in the creative process. This aim was achieved through the use of group mean difference analysis to assess whether there were differences in cognitive test performance across the demographic sub-groups.

1.3. Thesis Structure

Chapter Two provides an overview of the existing research. This chapter includes a description of different cognitive theories of creativity, namely associative, executive control and dual-process theories, respectively. It discusses creativity in terms of commonly agreed upon cognitive components, including divergent, convergent, and associative thinking, as well as various executive functions associated with creativity, such as task-switching, inhibition, and fluid intelligence. Lastly, this chapter discusses the influence of particular demographic variables, namely age, multilingualism, SES, level of education and gender, on the creative.

Chapter Three contains a description of the research methods used to gather the data in this study. This chapter contains the rationale as well as the research questions and hypotheses addressed. Included in this discussion is a hypothesised theoretical model of creativity, which demonstrates the theorised relationship between the constructs. Additionally, this chapter provides a description of the research design, sample, and sampling strategies as well as the instruments, procedures and statistical analyses techniques used to address the research questions and test the hypotheses.

Chapter Four reports the findings of the current study. This chapter comprises of two main sections. The first section describes the pilot study and presents the results and any changes made to the large-scale study based on the findings from the pilot study. The next section presents the results from the large-scale study and includes three sub-sections. The first sub-section presents and discusses the descriptive statistics. The second and third sub-sections report the findings from the inferential analyses, including the findings from the SEM and group-differences analyses, respectively.

Chapter Five is the discussion section of the thesis. This section provides an interpretation of the results and discusses them in relation to the hypotheses and existing literature. Lastly, this chapter presents conclusions, identifies gained knowledge and limitations of the study as well as provides suggestions for future research.

Chapter 2: Literature Review

2.1. Introduction

The current chapter presents a written report of the existing research and debates relevant to the field of creativity. The primary purpose of this chapter was to familiarise the researcher with the current state of knowledge about creativity as well as to identify any gaps and unresolved issues that the current research could address. Additionally, the literature review functioned to develop the theoretical framework and methodology of this study. This stage of the research is crucial when conducting SEM as it constitutes the first step of the statistical analysis technique (Crockett, 2012). This step occurs before the data collection stage and involves developing the hypothesised theoretical model by using applicable, related theory and existing research.

The goal of the first sections of the literature review was to understand the existing theory and research that was relevant to the first aim of the study. As previously mentioned, the first aim of the current research was to develop a coherent theoretical model of creativity. Firstly, this chapter provides an overview of creativity, which includes the accepted definition and a discussion of traditional conceptualisations of the construct. Next, this chapter introduces the overarching field in which the current study is located, namely the creative cognitive approach. Briefly, the creative cognitive approach (Finke et al., 1992) uses methods and concepts from cognitive science to investigate the mental processes and structures underlying creative thinking.

The next section develops the theoretical framework of the current research. In particular, it introduces three predominant cognitive theories of creativity, namely the associative theory (Mednick, 1962), the executive control theory (Beaty et al., 2014b) and dual-process theory (Finke et al., 1992; Nijstad et al., 2010), and are each discussed in terms of their assumptions regarding the source of creativity and related research. The associative theory proposes that creativity relies on the ability to form associative components into novel combinations for a useful purpose (Mednick, 1962). An important aspect of this theory is the notion of associative hierarchies. Individuals with steeper hierarchies tend to generate close and common associative links, wheres individuals with flatter hierarchies would generate more discrete and, therefore, original associative combinations (Benedek & Neubauer, 2013). However, a common criticism of the associative theory (Mednick, 1962) is that it conceptualises creativity exclusively as a bottom-up, automatic process, which suggests that it occurs incidentally, without concomitant awareness and, therefore, operates independently of conscious control (Colzato et al., 2013).

This conceptualisation is problematic as, while automatic processing produces novel ideas, alone, it does not guarantee creative output (Runco & Jaeger, 2012).

This limitation of the associative theory led to the development of approaches that acknowledge the role of higher-order functions in the creative process. For instance, the executive control theory (Beaty et al., 2014b) emphasises the importance of top-down, executive control during the creative process, which is required to generate not only original output but also realistic and appropriate ideas (Benedek et al., 2017). In particular, this theory maintains that it is the cognitive processes that operate on memory that facilitates creativity rather than the structure of memory itself (Kenett et al., 2018). Although these two creativity theories focus on either associative or executive control processes, contemporary research provides evidence for the role of both associative and executive control abilities during the creative process (Beaty et al., 2015; Beaty & Silvia, 2012; Beaty et al., 2014b; Benedek et al., 2017; Lee & Therriault, 2013; Nijstad et al., 2010). These findings resulted in a dual-process account of creativity (Finke et al., 1992; Nijstad et al., 2010), which is the final theory of creativity discussed in this chapter.

The dual-process theory maintains that creativity results from a mix of Type-1 (associative) and Type-2 (evaluative) processes. In particular, the generative stage of creativity involves Type-1 processes, which produces novel output, and the evaluative stage relies on Type-2 processes, which select or refine initial output into a useful or valuable form (Sowden et al., 2015). Two dual-process models of creativity are discussed and compared in this section, including the Geneplore model (Finke et al., 1992) and the dual-pathway model (Nijstad et al., 2010). The Geneplore model proposes that creativity entails the cycling between two phases, namely the generation and exploration phases (Finke et al., 1992).

Similarly, the dual-pathway model maintains that creativity is a function of two independent stages or pathways, which include the cognitive flexibility and cognitive persistence pathways (Nijstad et al., 2010). While these dual-process both emphasise the importance of associative and higher-order processes during creative cognition, they differ in terms of how each mode of thinking operates (Benedek & Jauk, 2018). For example, the Geneplore model suggests that the processing stages for creativity are organised and operate serially, whereby one stage (generative phase) always precedes another (explorative phase), from the commencement to the completion of the task (MacKay-Brandt, 2011). However, while not necessarily implying that these two thinking styles operate in parallel, the dual-pathway model suggests that generative and evaluative processes function more in unison compared to the Geneplore model (Sowden et al., 2015). There is considerable evidence to support the dual-process approach which is why it was adopted here (Beaty et al., 2015; Beaty & Silvia, 2012; Beaty et al., 2014b; Benedek et al., 2017; Green et al., 2015; Lee & Therriault, 2013; Mayseless et al., 2015; Nijstad et al., 2010).

After establishing the theoretical framework of the study, the next stage of this chapter involved identifying the cognitive processes that potentially underlie creativity. As mentioned above, this stage is crucial when conducting SEM as it constitutes the first step in theory development (Crockett, 2012). The first two processes identified as implicated in creative cognition are divergent and convergent thinking (Guilford, 1956). Divergent thinking is an ideational thought process used to generate multiple ideas from a single starting point and is, therefore, used in a context where there are multiple correct solutions (Colzato et al., 2013; Simon & Bock, 2016; Webb et al., 2017). In contrast, convergent thinking is a systematic thought process used to extract a single, best-fit solution. As such, initial conceptualisations consider convergent thinking as the process that opposes both divergent thinking and creativity in general. Nevertheless, convergent thinking plays an essential role in the creative process as it enables variability to be explored, evaluated or criticised and is used to identify relevant and useful aspects (Cropley, 2006).

Divergent and convergent thinking are, therefore, assumed to play a joint role in the creative process, whereby divergent thinking accesses semantic networks to generate multiple potential solutions to a given problem, which convergent thinking then evaluate(Kharkhurin, 2012). This process continuously repeats itself, suggesting that creative cognition entails the repetitive cycles of both divergent and convergent thinking (Kharkhurin, 2012). This conceptualisation of divergent and convergent thinking implies that although creative cognition relies on these functions, they are unrelated or mutually exclusive processes (Runco, 2016). However, rather than being entirely independent processes, divergent and convergent thinking are thought to share a similar cognitive basis. Specifically, these modes of thinking may relate in terms of their reliance on the spread of activation through semantic networks, which suggests that associative thinking underlies both processes (Lee & Therriault, 2013). Therefore, this chapter explores the role of associative thinking and presents a theoretical model that illustrates the hypothesised relationship between divergent, convergent and associative thinking.

While the first subsections of the literature review argue for an associative basis for both divergent and convergent thinking, the next sections discuss how these two processes may differ from each other. One way in which these two processes may differ is in terms of their reliance on executive functions (Colzato et al., 2013). In brief, executive functions refer to various high-level cognitive functions that, through their influence on lower cognitive functions, allow individuals to regulate and control thoughts and actions during goal-oriented behaviour (Friedman & Miyake, 2017). While there is a lack of consensus about the processes that comprise executive function, a widely accepted set of functions include inhibition, shifting and updating (Miyake et al., 2000). However, a review of this three-factor framework revealed that inhibition correlates perfectly with a common factor shared by these three functions, suggesting that inhibition is a property that emerges from the interaction between different functions rather than a distinct function (Miyake & Friedman, 2012).

These executive control factors (Miyake & Friedman, 2012) presumably play a key role in regulating the balance between the persistence and flexibility pathways of creativity (Hommel & Colzato, 2017). The idea that cognition and behaviour emerge from the appropriate balance between persistence and flexibility is central to the Metacontrol State Model (MSM) developed by Hommel (2015). While this model provides an account of cognitive control in general, it can also be applied to creative thinking (Zhang et al., 2020). In particular, aspects of creativity rely on flexibility and persistence to differing extents, with the convergent thinking stage benefiting more from a bias towards persistence, and divergent thinking benefiting from a bias towards flexibility (Hommel, 2015; Zhang et al., 2020). Hence, creativity emerges from the right balance between persistence and flexibility for a given task and situation (Hommel, 2015).

Applied to the set of executive functions described by Miyake and Friedman (2012) this fluctuation between persistence and flexibility, or divergent and convergent styles of thinking, relies on the ability to disengage task-sets that are no longer appropriate, adopt a new, task-relevant schema, as well as inhibit competing representations (Jost et al., 2017). Therefore, the influence of the executive functions of task-switching and inhibition on creative performance are both considered. In addition, the current research also considers the role fluid intelligence plays in creative cognition as it may facilitate the allocation of executive functions (Benedek et al., 2014b).

After the discussing the role that the executive functions mentioned above (i.e., task-switching, inhibition and fluid intelligence) play in the creative process, this chapter presents models that include each executive function to the divergent, convergent and associative model developed in the earlier sections of the literature review, respectively. These models each depict the hypothesised relationships between the variables. The final model, which includes all the variables of interest, constitutes the hypothesised theoretical model of creativity evaluated in the current study using SEM.

While the first sections of the literature review present information that is relevant to the first aim of this study, the goal of the subsequent sections is to gain an understanding of the knowledge, theory and existing research that is relevant to the second principal aim of the study. As mentioned in Chapter 1, the second principal aim of this study was to investigate whether various demographic variables, including age, the number of spoken languages, SES, level of education, and gender, predict the cognitive functions identified as being implicated in the creative process. The first demographic variable covered in this section is age. The target sample of the current study was individuals aged 65 and above, which may provide insight into the creative abilities of a crucial developmental stage that research often overlooks. This section considers creativity with regards to the frontal lobe hypothesis, which is a theory that attributes age-related cognitive decline to underlying anatomical degeneration and functional decline of the frontal cortex. This hypothesis argues that the cognitive deficits experienced by the elderly are most prevalent in tasks that depend on executive functions due to the prefrontal cortex (PFC) facilitating these processes (Cabeza & Dennis, 2012). Since creativity may rely on executive functions, this would suggest that with ageing, there is a decrease in creativity.

However, this section introduces an alternative perspective, which proposes that age-related decline in executive control functions as a double-edged sword in that it could have costs and benefits for creative processing (Chrysikou et al., 2014). This idea is based on the previously mentioned MSM approach to executive function, which maintains that certain aspects of creativity rely on a higher degree of cognitive control than others (Hommel, 2015). As a consequence, a decline in executive function may be beneficial to certain tasks, such as divergent thinking, while negatively affecting other tasks, such as convergent thinking (Amer et al., 2016). Therefore, it is hypothesised in this study that divergent thinking abilities will remain unaffected by age, whereas an increase in age is expected to correspond with poorer performance on convergent thinking measures. The possibility of age-related decline in creative performances leads to the discussion of the potential role of the next demographic variable of interest in the current research, namely multilingualism.

Multilingualism has long been assumed to have significant cognitive effects (Bialystok et al., 2012). While this effect was initially thought to be negative, recently, multilingualism is argued to confer advantages in different cognitive domains, including creativity. Two approaches that attempt to explain the possible bilingual advantage in creative thinking are discussed in this section, namely Language Mediated Concept Activation (LMCA) (Kharkhurin, 2017) and cognitive control accounts (Bialystok et al., 2012). Kharkhurin's (2017) recent LMCA framework proposes that the architecture of multilingual memory facilitates a greater spread of activation between more discrete conceptual representations, therefore enabling the processing of a vast number of concepts from discrete categories simultaneously, which presumably stimulates creative thinking. This process is achieved through LMCA, which involves translation equivalents automatically activating each other through shared conceptual representations. In contrast, cognitive control accounts (Bialystok et al., 2012) of the bilingual advantage suggest that it is the continuous practice with multiple active language systems, during which they need to manage interference or conflicts in lexical retrieval, that enhances other cognitive processes.

The cognitive control account of the bilingual advantage argues that by having to continuously resolve this cross-linguistic competition multilinguals exercise and, therefore, develop a high level of skill associated with the control processes for other, non-linguistic cognitive functions, such as creative thinking (Bialystok et al., 2012). The above-mentioned theories imply that multilingualism confers advantages on both components of creativity (i.e., divergent and convergent thinking). Specifically, divergent thinking may benefit from the unique architecture of multilingual memory to a greater extent, whereas convergent thinking presumably benefits more from multilinguals' highly developed executive control mechanisms (Kharkhurin, 2015). As such, in the present study, the multilingual variable is expected to predict both divergent and convergent thinking.

The next demographic variables considered in this chapter are SES and level of education, which are discussed together as level of education is often considered to be a variable that comprises SES (Duncan & Magnuson, 2012). Both of these demographic variables are particularly important to take into consideration in the current study because the enduring legacy of apartheid means that there are high levels of inequalities across these spheres in South Africa (Lucas, 2013). These inequalities have the potential to be a significant source of test bias, or that the differential validity of test performance for groups (French, 2014). The variable SES refers to a composite measure of an individual or group's access to economic and social resources, as well as the opportunities, privileges and positioning that derive from these resources (Duncan & Magnuson, 2012). It is a multifaceted variable that encompasses not only income but also level of education, occupation, and financial resources, as well as subjective perceptions of both social status and class (Winters-Miner et al., 2015). Level of education is defined as either the highest degree attained or the number of completed years of formal education (Opdebeeck et al., 2016; Strenze, 2007). A candidate mechanism for SES and educational effects is cognitive stimulation and enrichment. For example, higher levels of SES and education often increase exposure to information, knowledge and general experiences, which could contribute to increased learning and cognitive flexibility as well as provide a greater context for both problem-solving and reasoning (Hackman et al., 2010). These experiences may, therefore, translate into improved cognitive functioning and contribute to cognitive reserve, which refers to an active capacity that retains cognitive function after age, affliction or injury-related decline (Richards et al., 2013). Therefore, higher levels of SES and education are expected to correspond with higher performance on the cognitive measures in the present study.

The last demographic variable considered is gender. This section discusses three possible accounts of the potential influence of gender on creative cognition. The first account argues that biological factors underlie gender-differences in creative cognition, including genetic and hormonal differences, as well as variations in terms of brain structure and organisation. Another perspective discussed is the socio-cultural account, which attributes the possible gender-differences in creative cognition to societal constraints, cultural factors, including gender rules, roles and assumptions, as well as differences in socialisation, such as gender labelling, differences in expectations and differences in schooling, among other significant resources that are a function of gender. Finally, this section discusses a contemporary account of gender difference in creative performance. This account attributes the gender-differences to alternative strategies employed by each gender when undertaking cognitive tasks (Abraham, 2016). This explanation may be plausible as individuals have been observed to engage in a range of strategies during creative performance, with only certain strategies yielding highly novel ideas (Gilhooly et al., 2007). While some research addressing gender-differences demonstrates that females perform better on assessments of creative cognition, the case for a female advantage is inconclusive the research is equivocal in this regard (Baer & Kaufman, 2008). Therefore, no gender-based differences were expected in this study.

2.2. Overview of Creativity

Creativity is a construct that spans multiple disciplines, has been subjected to several methods of analysis and encompasses multiple definitions, theories and models (Kharkhurin, 2012; Williams et al., 2016). It has, therefore, proven to be one of the more challenging areas of research in the cognitive sciences. While existing studies increased our understanding of creativity, findings from these studies are nonetheless contradictory, fragmentary and inconsistent (Kaufman & Sternberg, 2010). Consequently, there is a lack of convergent theorising on creativity (Akbari Chermahini & Hommel, 2010) and an absence of an integrated framework that sufficiently describes the creative process (Bowden et al., 2005; Kaufman & Sternberg, 2010).

The challenge of researching creativity lies partially in the definition and nature of the construct itself. In particular, the diverse, versatile, and multifaceted nature of creativity makes it an elusive phenomenon and, therefore, notoriously difficult to define and measure (Kara, 2015). Nevertheless, novelty or originality are typically at the centre of most definitions of creativity. These criteria are undoubtedly vital for creativity because if something is not different, new or unique, it is common, ordinary and mundane and hence not creative. However, they are insufficient in defining the construct. Ideas or products that merely meet the novelty criteria could also be nonsensical and useless and can even arise from a series of random or incidental events. For ideas or products to be considered genuinely creative, they must not only be novel and original but also be deemed to be effective, useful or of some value. Therefore, the definition of creativity used in the present study is bipartite: Creativity requires both novelty and usefulness (Runco & Jaeger, 2012).

The creative process has been theorised about in several different ways and has been applied to a variety of different domains (Glăveanu, 2010). Initially, creativity was thought to be a matter of divine inspiration, suggesting that the source of and processes enabling creativity are mysterious and un-researchable (Chen, 2018; Glăveanu, 2010; Kenett et al., 2014). Creativity, in this context, is exclusivist as it restricts this attribute to a select group of gifted individuals. This conceptualisation implies that those who demonstrate an exceptional aptitude for creativity possess rare and unique cognitive features or make use of mental processes in a profoundly different manner from those used by ordinary individuals (Kharkhurin, 2012). Additionally, creativity according to this approach refers solely to eminent creativity, that is, the highest levels of creation. The only ideas or products that are worthy of being deemed as creative are those that accomplish a high-level of achievement or produce significant breakthroughs and reputable novelties (Glăveanu, 2010; Runco, 2014a).

This conceptualisation represents not only the main appeal but also the limitations of the above-mentioned paradigm of creativity. While holding creative breakthroughs in such high regard makes creativity a desirable human capacity, it also separates high-level creative performances from moderate, everyday instances of creativity and therefore detracts from the significance of the latter (Glăveanu, 2010; Runco, 2014a). In doing so, it not only gives an elitist and essentialist account of creativity (Negus & Pickering, 2004) but also presents it as a dichotomous construct (Runco, 2014a). A criticism of this approach is that it lacks both substance and validation and, consequently, offers an account of creativity that is unrealistic and misleading (Chen, 2018; Runco, 2014a). Therefore, it is typically rejected in favour of more modern conceptualisations of creativity (Chen, 2018).

While the individual remains the unit of analysis, contemporary conceptualisations of creativity replace the genius with the average person (Glăveanu, 2010). This paradigmatic shift has been described as the "democratisation" of creativity as contemporary conceptualisations assume that everyone has the capability of being creative, albeit not to the same degree (Cropley, 2011; Glăveanu, 2010; Wimmer, 2016). Hence, creativity is no longer considered to be a capacity that is limited to the genius or a product of divine inspiration. A prominent manifestation of this conceptualisation is found in the cognitive sciences, which essentially consider creativity as a process of creative cognition (Glăveanu, 2010).

2.3. Cognitive Theories of Creativity

The creative cognition approach (Finke et al., 1992) employs methods and concepts of cognitive science to develop and improve understanding of creative processes. Additionally, this approach suggests new ideas about cognition by examining it through the lens of creativity (Smith et al., 1995). Cognitive theories of creativity emphasise the role of mental processes and structures underlying creative thinking as they are considered to be the essence and engine of creative thought (Kozbelt et al., 2010). Nevertheless, the cognitive basis of creativity remains poorly understood, which has resulted in various cognitive theories that explain and provide clarity on this seemingly elusive construct (Beaty et al., 2014b). The subsequent sections discuss three predominant cognitive theories of creativity, namely the associative, executive control and dual-process theories, respectively.

2.3.1. The Associative Theory

The associative theory, which is based on the seminal work of Mednick (1962), is a prominent theoretical account of creativity that regards underlying structures of semantic memory, or associative hierarchies (Mednick, 1962), as the root of creative thinking. In particular, the associative account of creativity is based on the semantic network model of semantic memory proposed by Collins and Loftus (1975). This theoretical framework (Collins & Loftus, 1975) maintains that concepts and their related properties are represented as nodes that are encoded in a larger semantic network. Bidirectional associative links connect these various nodes in the semantic network. Once a particular node is stimulated, the activation will spread along these associative links to, and automatically activate, other nodes in the semantic network that are connected to the original node (Foster et al., 2017).

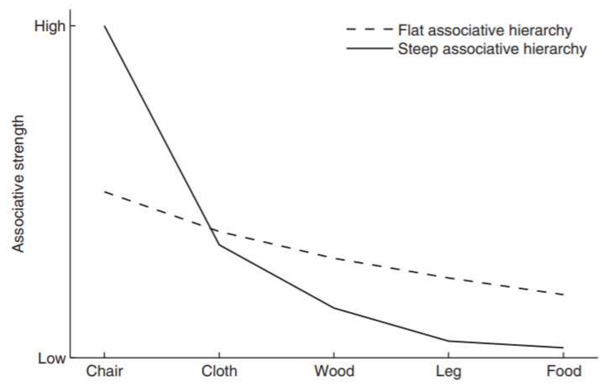
The various links in the semantic network each have a weight, representing the strength of the associative connection between the concepts they bridge. When a particular node is activated, some residual activation spreads along the network in proportion to the strength of their connections (Yu et al., 2016). The strength between associative links and, therefore, the extent of the spread of activation, depends on the frequency with which the associative link is used (Foster et al., 2017). That is, associated concepts that occur or are accessed frequently, such as nodes within the same semantic category (e.g., table-chair), have strong associative links. Consequently, they are more likely to be activated compared to those that occur infrequently, such as nodes from different semantic categories (e.g., dog-chair), or nodes that are remotely activated within or between cerebral systems (Cropley, 2011; Foster et al., 2017). Nevertheless, the spread of activation can reach, and partially activate, remote and discrete conceptual nodes, which establishes secondary and more complex connections (Yoruk & Runco, 2014).

Given the reliance on semantic processing, the hierarchical structure of semantic networks possibly govern individual differences in creative thinking (Roberts & Addis, 2018). Specifically, Mednick (1962) proposed the idea of associative hierarchies as the series of most common associative links to any particular concept that can be arranged according to their associative strength. The theory maintains that while people tend to show a similar ranking of associative elements, the hierarchy will differ between individuals in terms of gradient. In particular, highly creative individuals have flatter associative hierarchies, whereas steeper associative hierarchies are characteristic of less creative individuals (Benedek & Neubauer, 2013).

To provide an example of individual differences in associative hierarchies: when presented with a particular concept (e.g., table), the steeper hierarchies restrict less creative individuals to overly dominant and stereotyped responses (e.g., chair) as their associative hierarchies comprise of few conventional links that have high association strengths. In contrast, the flatter associative hierarchies of highly creative individuals demonstrate a less skewed distribution of association strengths that have subtler variances between different associative links (Benedek & Neubauer, 2013). Consequently, as demonstrated in Figure 1, when presented with a particular concept (e.g., table), creative individuals are likely to retrieve more remote associations that have a loose semantic connection to the initial stimulus (e.g., food). Flat associative hierarchies may benefit creativity as a dispersed organisation of conceptual representations is likely to increase the probability of generating novel combinations. The associative theory, therefore, maintains that creativity is contingent on the spread of activation through semantic networks and that creative ability is directly related to differences in the structure of semantic memory (Benedek et al., 2017).

Figure 1

Comparison of Associative Hierarchies



Note. This figure depicts flat and steep associative hierarchies for the concept "table". (Adopted from Mednick, 1962, p. 223). Mednick argues that less creative individuals show steeper associative hierarchies compared to more creative individuals.

Various studies demonstrating that associative abilities explain approximately half the variance in creative thinking task performance (Benedek et al., 2012b; Lee & Therriault, 2013) provide evidence in support of Mednick's (1962) associative theory. Additionally, Rossmann and Fink (2010) revealed that when required to consider and judge the associative distance between unrelated word pairs, highly creative individuals perceived stronger semantic relationships between largely unrelated concepts. The researchers suggest that the semantic memory of highly creative individuals is more condensed than those of less creative individuals (Rossmann & Fink, 2010), an idea that is supported by additional studies (Benedek et al., 2017; Kenett et al., 2014).

For example, Kenett and colleagues (2014) adopted a network science approach to directly investigate Mednick's (1962) associative theory and obtain a differentiated measure of semantic network structure. Network science is a field based on mathematical graph theory and provides a means to quantitatively investigate complex systems as networks. Their study entailed extracting and examining the structural properties of semantic network organisations of 96 cue words from low and high creative individuals via a novel computational method. The results revealed notable differences in general network characteristics between high and low creative individuals. In particular, the semantic networks of high creative individuals exhibited low average shortest path length (ASPL), which refers to the shortest distance between any two pairs of nodes in the network, and high small-worldness, which refers to the ratio between a clustering coefficient and ASPL, and low modularity values, which refers to the extent to which a network is partitioned into sub-communities (Kenett et al., 2014). These results correspond with those obtained by Benedek et al. (2017), which directly supports the associative theory of creativity by demonstrating that high and low creative individuals differ in terms of their semantic memory structure (Kenett et al., 2014).

These differences in the structure and organisation of semantic memory are key to understanding the creative abilities of high and low creative individuals. For example, by being small-worlded[1], the semantic networks of high creative individuals are less dispersed due to shorter distances between nodes or concepts and have both high connectivity and clustering. These characteristics increase the efficiency of information transfer and better enable the connection of discrete or remote associations, resulting in creative output. Additionally, by being less modular, the semantic networks of highly creative individuals are only moderately partitioned into smaller sub-communities, which increases the flexibility of the network (Kenett et al., 2014). Extreme structuring of semantic networks into smaller sub-communities presumably prevents low creative individuals' ability to break away from a particular module in their network and move onto or spread into other modules. As a result, the spread of activation becomes trapped or confined within a dense module and, coupled with its quick dissipation, leads to rigidity of thought (Kenett et al., 2016b). These findings support Mednick's (1962) theory of associative hierarchies in that high modularity values quantitatively express the "steep" hierarchies of less creative individuals, whereas low modularity scores quantitatively express the "flat" hierarchies of highly creative individuals (Kenett et al., 2014).

Together, these findings (Benedek et al., 2017; Kenett et al., 2014; Rossmann & Fink, 2010) suggest that the semantic networks of creative individuals are more flexible, highly

[1] This refers to networks that have a sparseness of connections and clustering as well as relatively short path lengths between nodes for its size (Kenett et al., 2014).

interconnected and comprise of a small number of large association clusters, all of which presumably facilitates a more efficient retrieval strategy when creating associations. This implies that high and low creative individuals differ in terms of their semantic memory structure (Kenett et al., 2014). Nevertheless, these findings do not correspond with those obtained in a study conducted by Benedek and Neubauer (2013). In this study, the researchers re-evaluated Mednick's (1962) associative theory by computing associative hierarchies for high and low creativity individuals. The researchers found that the associative hierarchies did not differ between the two groups, but that creative individuals obtained higher associative fluency scores and produced uncommon associative responses within the same time (Benedek & Neubauer, 2013). Based on these results, Benedek and Neubauer (2013) concluded that creativity might not imply a distinct structural organisation of semantic networks, but instead relies on advanced executive abilities to effectively access and process the content of semantic memory. This conclusion corresponds with a recent account of creativity, namely the executive control theory, which the subsequent section discusses in detail.

2.3.2. The Executive Control Theory

Creativity in the context of the associative theory is conceptualised exclusively as a bottom-up, automatic process, implying that it occurs incidentally, without concomitant awareness and, therefore, operates independently of conscious control (Colzato et al., 2013). Although automatic processing may result in novel ideas, which is an essential criterion of creativity, alone, it does not guarantee creative output (Runco & Jaeger, 2012). Individuals prone to automatic processing may experience thought perseveration, leading to stereotypic or conventional ideas and hence lower levels of creativity (Zabelina & Robinson, 2010). Indeed, an overreliance on associative processing has been found to bias search processes towards salient conceptual knowledge and, as a consequence, interfere with creative thinking (Gilhooly et al., 2007). Moreover, this processing mode may also result in unrealistic and inappropriate ideas or solutions as incoming content is neither actively selected nor filtered (Runco & Jaeger, 2012). This tendency to produce inappropriate ideas is demonstrated in a study conducted by Eysenck (2003), who found that, although the ideas generated by psychotic individuals were highly original, they were often nonsensical and therefore not truly creative as they failed to satisfy the effective or useful criteria of creativity (Runco & Jaeger, 2012).

Recent accounts of creativity, therefore, emphasise the importance of top-down, executive control during the creative process (Benedek et al., 2017). Broadly defined, executive control refers to a set of processes that facilitate the attainment of context-specific goals and intentions by flexibly and adaptively allocating cognitive resources as well as by selecting and monitoring both thoughts and actions (Fan, 2014). In the context of the executive control theory, creativity is a top-down process that draws on individual differences in the ability to control both attention and cognition (Beaty et al., 2014b). Specifically, executive control can benefit creativity motivationally by enhancing persistence, thereby minimising task unrelated thought that would otherwise result in premature termination of creative efforts (De Dreu et al., 2012). Additionally, creativity can benefit from executive control mechanistically by improving the efficiency of memory retrieval, strategy implementation and the manipulation of information, which presumably benefits the generation of ideas (Benedek et al., 2017). Therefore, the executive control theory diverges from the associative account by maintaining that it is the cognitive processes operating on memory that facilitate creativity rather than the structure of memory itself (Kenett, 2018a).

Evidence in support of the executive control theory is provided by Beaty and Silvia (2012), who evaluated the creativity of responses across an extended version of the alternative uses test (AUT). When examining the trajectory of creative responses across time, the researchers demonstrated a serial order effect. That is, participants' responses on the AUT became more unusual and creative as the trial progressed (Beaty & Silvia, 2012), the implication being that it takes time for the activation to spread across the semantic network, with distant associates accessed and activated later than those that are highly related to the original cue (Roberts & Addis, 2018). Although these findings seemingly support the associative theory, the researchers also found that fluid intelligence moderated this temporal pattern. In particular, fluid intelligence corresponded with higher creativity scores within a shorter progression of time, indicating that as fluid intelligence scores increased, the serial order effect diminished. Hence, time was not an essential factor for individuals with higher fluid intelligence scores to generate creative ideas. These are notable findings because if this temporal pattern were to solely reflect the associative principles, namely the spread of activation in semantic memory, fluid intelligence would not have moderated the serial order effect. Therefore, since individuals who scored higher on measures of fluid intelligence produced creative responses within a shorter period, the researchers concluded that their findings demonstrate the unfolding of executive control processes during creative thinking (Beaty & Silvia, 2012).

These results correspond with various latent variable studies that show the influence of higher-order cognitive functions on creative thinking, including fluid intelligence (Beaty et al., 2014b; Nusbaum & Silvia, 2011), cognitive inhibition (Benedek et al., 2012a; Benedek et al., 2014b), task-switching (Pan & Yu, 2018) and working memory capacity (Lee & Therriault, 2013). The following sections cover the role that specific executive functions play in creative cognition in greater detail which discuss the cognitive functions that underlie creativity. In brief, the above-mentioned functions may support creative thinking by providing the executive control required to guide memory retrieval and inhibit salient yet unoriginal ideas. Studies (Beaty & Silvia, 2012; Beaty et al., 2014b; Benedek et al., 2012a; Benedek et al., 2014b; Lee & Therriault, 2013; Nusbaum & Silvia, 2011; Pan & Yu, 2018) have provided evidence in support of the executive control theory of creativity by demonstrating that these processes are integral and essential to creative thinking particularly in terms of the evaluation of feasibility and appropriateness of creative output, conscious novelty seeking, interference resolution, and response selection, as well as the sustainment of goal pursuit (Chrysikou, 2018).

The two theories discussed above mainly focus on the role of either associative or executive control abilities (Beaty et al., 2014b). While the associative theory offers an automatic account and the executive control theory proposes a systematic account of creativity, both theories agree on the notion that semantic network structures form the basis of creativity upon which higher-order cognitive functions operate. This idea suggests that creative cognition is likely to rely on the joint role of, and interaction between, associative structures and executive control processes (Kenett, 2018a).

Evidence in support of this idea comes from a study conducted by Beaty et al. (2014b), who used multivariate SEM to investigate the relative influences of both associative and executive processes on creative thinking. Participants in their study were required to complete various verbal fluency tests and a series of executive function tests, which included broad retrieval ability and fluid intelligence. The researchers assessed the semantic distance between participants' responses on the verbal fluency test using Latent Semantic Analysis (LAS)[2], which served as a measure of associative ability. They revealed

[2] A theory and mathematical method used to extract and analyse the meaning of words which is applied to a large body of text (Landauer, 2013).

that both associative and executive abilities support creative thinking, suggesting a unique contribution by both constructs. Specifically, both the average semantic distance of responses made on the various verbal fluency tasks as well as individual differences in broad retrieval ability and fluid intelligence strongly predict the quality of creative responses (Beaty et al., 2014b).

Similar findings were obtained by Prabhakaran et al. (2014), who administered a variation of the verb generation task where participants were required to rapidly provide a verb in response to a series of nouns. The researchers used LSA to analyse the semantic distance of responses in terms of the novelty of the verb in the context of the noun (Prabhakaran et al., 2014). In addition to greater semantic distances corresponding to higher levels of both creative cognition and achievement as well as story writing ability, the researchers found a significant relationship between semantic distance and measures of both intelligence and executive function. These findings suggest that creativity does not exclusively rely on combining remote associations, but also on executive control processes to consciously access these associations (Prabhakaran et al., 2014).

Additionally, recent neuroimaging studies have demonstrated that creative cognition is supported by default and executive control network coupling (Beaty et al., 2016), which supports the results in the studies discussed above (Beaty et al., 2014b; Prabhakaran et al., 2014). The default mode network (DMN) refers to a network of interacting brain regions that demonstrate high activity during wakeful rest and in the absence of most goal-directed cognitive tasks presented in the immediate external environment (Raichle et al., 2001). Hence, the DMN is typically associated with cognitive processes that involve associative, spontaneous and self-generated thought, such as future thinking (Schacter et al., 2012), mental simulation (Hassabis & Maguire, 2007) and mind-wandering (Mason et al., 2007) among others. In contrast, the executive control network (ECN) refers to a set of interconnected regions that are engaged during cognitive tasks that rely on higher-order processes (Beaty et al., 2016). These include cognitive tasks that rely on externally-directed attention, such as relational integration[3] (Blumenfeld et al., 2011) and executive functions, including inhibition (Aron, 2007), task-switching (Dreher & Berman, 2002) and working memory (Curtis & D'Esposito, 2003).

[3] The ability to integrate multiple elements into a single cognitive representation (Dauvier et al., 2014).

Although findings from prior studies suggest that the DMN and ECN often act in opposition, whereby activation of one network corresponds with the deactivation of the other (Anticevic et al., 2012; Fox et al., 2005), these networks may also cooperate during cognitive processes that require extended evaluation or modulation of internal information, such as creativity (Andrews-Hanna et al., 2014). Indeed, various neuroimaging studies have reported a dynamic coupling of DMN and ECN during creative cognition (Beaty et al., 2015; Green et al., 2015; Mayseless et al., 2015), which presumably reflects the top-down control of automatic, associative processing during creative idea production (Beaty et al., 2015). This dynamic coupling between the DMN and ECN suggests that creative thinking relies on the paradoxical cooperation between networks associated with spontaneous thought and cognitive control, which points towards both focused internal attention as well as the top-down control of automatic, spontaneous cognition during the creative process (Beaty et al., 2015).

In summary, unlike the associative approach, the executive control theory describes creative cognition as a function of higher-order, top-down processes (Benedek et al., 2017). Specifically, the executive control theory maintains that it is the cognitive processes operating on memory that facilitate creativity, rather than the structure of memory itself (Kenett, 2018a). While each of these creativity theories mainly focuses on the role of one process or the other (Beaty et al., 2014b), current behavioural and neuroimaging research has provided evidence for the role of both associative and executive control abilities during the creative process (Beaty et al., 2015; Beaty & Silvia, 2012; Beaty et al., 2014b; Benedek et al., 2017; Green et al., 2015; Lee & Therriault, 2013; Mayseless et al., 2015; Nijstad et al., 2010). These findings cohere with the dual-process approach to creativity, which the next section covers.

2.3.3. Dual-process Theory

In addition to the associative and executive control accounts of creativity, a third theory that synthesises these two approaches is the dual-process theory of cognition. The dual-process theory is based on the idea that human cognition consists of two different types of processing, including automatic and controlled styles. While the concept of associative and controlled processes have received attention in early psychological research, the development of the dual-process theory is typically attributed to the work of Schneider and Shiffrin (1977). In particular, the researchers define automatic processes as the activation of a series of nodes in response to incoming stimuli that do not necessitate active control or attention. This ability for a process to occur without the involvement of control and attention is arguably one of the most salient features of an automatic process. Moreover, this form of processing uses relatively permanent associative connections acquired through a significant amount of training. In contrast, controlled processes involve the activation of a temporary series of nodes that occurs under the control of the individual. In addition, while these controlled processes are capacity limited, this disadvantage is outweighed by the fact that control processes are easily set up, adapted, and applied to new situations which automatic responses cannot address as they have never been learned (Schneider & Shiffrin, 1977).

This conceptualisation of automatic and controlled processes resembles the two-system approach popularised by Kahneman (2011). Like associative processing, the one kind of processes categorised as *System-1* are characterised as rapid, associative, automatic and affective-based, which corresponds with individuals' intuitions and instincts. Additionally, System-1 processes are trained, based on formed habits and are, therefore, difficult to alter or manipulate. Finally, this processing style is not limited to the capacity of working memory and is capable of rapidly associating and combining information that has been implicitly stored in memory with incoming sensory information without effortful processing or intervention and, is thus reflexive in nature (Sowden et al., 2015). In contrast, the other processes grouped as *System-2*, are characterised as slow, controlled, and volatile, as well as subject to deliberative judgments (Kahneman, 2011). Moreover, this form of processing is considered to be rule-based and enables these rules to be applied explicitly to current information and, is thus reflective in nature (Sowden et al., 2015).

Despite the widespread use of the terms System-1 and System-2, the dual-system distinction is criticised for being too ambiguous and lacking conceptual clarity. For example, this two-system terminology can be construed as a synonym for a two minds hypothesis, thereby implying that the two types of processes are situated in, and restricted to, two particular cognitive or neurological systems. As a consequence, rather than the existence of two separate systems, two types of distinct processing that account for the possibility that multiple cognitive functions or neural systems underlie them, namely *Type-1* and *Type-2* processes, are proposed. Specifically, Type-1 processes are defined as autonomous, initiate and terminate in the presence of relevant stimulating situations and do not rely on working memory. In contrast, Type-2 processes are controlled and rely on working memory (Evans & Stanovich, 2013).

An additional issue associated with the dual-process approach is how the two processes relate. Dual-process theories differ in terms of their assumptions regarding how both Type-1 and Type-2 processes interact (Glöckner & Witteman, 2010). In general, dual-process theories typically fall into one of three groups, including pre-emptive models, parallel-competitive and default-interventionist models (Evans, 2007). The pre-emptive models assume that, when individuals undertake a particular task, one type of processing is selected before the actual processing begins. The parallel-competitive models assume that both types of processing compete throughout the task. Lastly, the default-interventionist models assume that Type-1 processing is the default style of thinking with a given situation (e.g., driving) or undertaking a particular problem (e.g., solving an equation). However, if Type-1 processing fails to obtain a solution or if new contextual information contradicts the solution initially generated then Type-2 is additionally activated (Evans, 2007).

It is important to note that the dual-process models discussed above are often misunderstood as implying a binary all-or-nothing conceptualisation, whereby either automatic or controlled processing entirely guides cognition or behaviour (Furley et al., 2015). However, these dual-process models, especially the default-interventionist model which current research favours (Evans & Stanovich, 2013; Glöckner & Witteman, 2010), accept that cognition and behaviour do not rely solely on one type of processing, but on a combination of both (Kahneman, 2011). What differs between cognitive functions and behaviours is, therefore, the degree to which Type-2 processing is engaged (Furley et al., 2015). This notion suggests that individuals' thoughts and behaviour can depend on automatic or controlled processes, or somewhere in between these two processes.

Norman and Shallice (1986) developed an influential model of the dual-process theory. This model is based on the idea that thoughts and behaviour comprise of a set of fundamental actions referred to as schemas, which environmental conditions influence. These schemas are first activated by incoming sensory information through a set of triggers and, in response to this sensory input, each schema produces a particular thought or behavioural output. However, certain environmental situations activate multiple possible schemas, which compete for selection. The model comprises two main mechanisms that facilitate the selection of schemas: the contention scheduling system (CSS) and the supervisory attentional system (SAS). The CSS regulates the practice of familiar, routine and automatic thoughts and actions through the use of incoming sensory information to select the most appropriate schema to suit the task or situation at hand. These schemas are comparable to Type-1 processes as they are typically trained and habitual and can, therefore, be applied to routine situations with minimal conscious effort (Furley et al., 2015). Since these schemas operate relatively automatically, the CSS mechanism functions to select, priorities and engage the most suitable schema according to the situational demands. However, to prevent inappropriate schemas from being implement, or if the schema initially selected fails to achieve the task at hand, a more sophisticated, higher-level mechanism is required to intervene. In Norman and Shallice's (1986) model, this mechanism is the SAS, which is comparable to Type-2 processing (Furley et al., 2015). The SAS is, therefore, used when habit patterns or routine behaviours are no longer relevant, and cognition needs to be implemented in a goal-directed manner. However, the SAS does not take over the role of the CSS, but rather operates by biasing the activation of schemas in order for them to be appropriate for the situation.

In the context of creative cognitive, the accepted definition of creativity implies the joint role of Type-1 and Type-2 processes, with the generative stage required to formulate novel output and the analytic, evaluative stage required to select or refine initial output into a useful and valuable form (Sowden et al., 2015). In particular, CSS presumably facilitates the automatic activation of content that produces ideas that are novel and unconventional (Type-1 process). However, if this activation produces salient conceptual information or unrealistic ideas that are inadequate for the creative task at hand, the executive monitoring system, namely the SAS (Type-2 process), alters contention scheduling to activate additional content or inhibit irrelevant information, just as maintained in the default-interventionist framework. Several theoretical models of creativity cohere with this conceptualisation of cognition as they have in common the emphasis on the dual-process of generating ideas and, subsequently, evaluating them (Sowden et al., 2015). Two of these theoretical models are described and compared below, namely the Geneplore model (Finke et al., 1992) and the dual-pathway model (Nijstad et al., 2010).

The Geneplore model (Finke et al., 1992) is a well-known dual-process theory that considers creativity as a product of two distinct phases, namely the generative phase and evaluation phase. This theoretical framework assumes that the preliminary generative phase relies on several processes, such as the retrieval of information from semantic memory, general knowledge, associative thinking and the combining of concepts, among others to create mental representations. This process formulates multiple candidate ideas, or *preinventive* structures, that may not be fully formed creative products or solutions to a given problem but are instead possible starting points that may either facilitate or prevent creative ideas or solutions. Based on particular characteristics, such as novelty or aesthetic appeal, individuals gauge whether preinventive structures should be discarded or retained for further processing. Exploratory processes subsequently develop retained ideas. Specifically, these exploratory processes either elaborate, consider the implications, evaluate the limitations, or otherwise modify, transform or manipulate initial candidate ideas. The creative process, therefore, entails cycling between generative and exploratory phases (Ward & Kolomyts, 2010).

Similarly, the dual-pathway model (Nijstad et al., 2010) builds on and integrates earlier theories of creativity. This model maintains that creativity arises from two qualitatively different processes, namely the flexibility pathway and the persistence pathway. Creative products produced via the flexibility pathway are generated not only by establishing new links between discrete and distantly related concepts, but also by flexibly switching between conceptual categories and cognitive strategies. Additionally, this pathway requires reduced latent inhibition to permit remote associates to enter working memory, which produces original output. In doing so, it enables individuals to break set, overcome functional fixedness and abstain from both habitual thinking and fixed task strategies (Nijstad et al., 2010).

However, a drawback that often accompanies an increase in flexibility is a reduction in cognitive control. Although cognitive flexibility presumably facilitates creativity by lowering the threshold for multiple, discrete concepts to access working memory, it is inevitable that irrelevant information or inadequate problem solutions also gain access and are, thus, processed further. Therefore, the engagement of this evaluation mechanism, or "idea monitor", is essential as it judges the appropriateness of generated ideas and assesses whether cognitive processes or strategies need to be adjusted when deviating from the task at hand. These processes both require a degree of cognitive control to ensure that one's behaviour is in agreement with their goals.

This model, therefore, emphasises the role of the persistence pathway. This pathway represents the effortful production of creative products by systematically exploring specific conceptual categories or perspectives and evaluating possible creative products. While systematic processing tends to yield obvious ideas and leads to readily available problem solutions and, therefore, is not usually associated with creative thinking, it is an essential component of creativity as it evaluates readily available ideas and discards irrelevant ideas. However, the systematic processing employed in the persistence pathway may also hinder creative cognition. For example, while systematic processing entails a high degree of cognitive control that prevents distracting and irrelevant information from entering working memory, this may also result in individuals disregarding distantly related concepts as they are filtered out before achieving the threshold of activation required to enter working memory. As a result, individuals tend to be less distractible when using the persistence pathway, but at the cost of flexibility. This implies that effective creative ability relies on an optimal balance between flexible and persistence (Nijstad et al., 2010).

Evidence in support of the dual-pathway model comes from a meta-analysis of creativity studies that all made used of ideation tasks, which included brainstorming and divergent thinking (Nijstad et al., 2010). Creativity was scored in terms of the number of ideas or responses provided (fluency), the number of conceptual or content categories used (flexibility) as well as the number of ideas generated per category (within-category fluency). Creative output was also considered in terms of quality parameters, including the infrequency of ideas (originality) and the extent to which the produced idea can be realised (feasibility). The researchers present varies types of evidence in support of the dual-pathway model based on their review of the literature (Nijstad et al., 2010).

While cognitive flexibility directly related to the originality of output, original ideas were achieved via an in-depth exploration of a limited number of content categories, that is, cognitive persistence. In particular, individuals produced original ideas when they drew on conceptual categories. The researchers attribute these findings to the fact that drawing on multiple conceptual categories suggests that infrequently used categories are included during the generation phase and that content within these categories are highly original. Furthermore, the correlational analysis revealed a significant, positive relationship between within-category fluency and idea originality. Hence, original ideas arose when multiple ideas were generated from a category, as well as when a particular category was explored in greater depth, that is, higher cognitive persistence was evident. Nevertheless, a stronger relationship occurred between flexibility and originality than that between originality and persistence (Nijstad et al., 2010).

Additional findings included the tendency for individuals' creative ideas to be more original when they focus on a limited number of conceptual categories rather than superficially exploring multiple categories. These findings suggest that original ideas are likely to emerge when a specific rather than a generic topic is used to generate output, leading the researchers to conclude that persistence within specific conceptual categories can result in originality. These findings are supported by the correlational analyses, which revealed a significant relationship between fluency and originality in the narrow topic condition yet a non-significant relationship in the broad topic condition. Similar effects occurred when using a priming procedure, which involved focusing individuals more on certain categories than others. Specifically, the ideas generated were highly original when individuals, due to the priming procedure, focused on a particular conceptual category. Moreover, a significant, positive relationship occurred between the fluency within that category and the originality of ideas generated with that category, which demonstrates that cognitive persistence within categories may result in original ideas. Together, the results obtained in this meta-analysis cohere with the notion that creativity is not only achieved by flexible thinking, that is the ability to break set as well as to use diverse conceptual categories and remote associations, but also through a systematic and persistent search process (Nijstad et al., 2010).

Although the Geneplore model and the dual-pathway model agree that creativity relies on the joint role of bottom-up and top-down processes, each model makes different assumptions in terms of the degree to which the modes or thinking processes operate in series or parallel. For example, the Geneplore model suggests that the shifting between the different thinking modes occurs in series, implying that one mode of thinking needs to conclude before the other is engaged (Sowden et al., 2015). In terms of the dual-pathway model, the notion that an "idea monitor" continuously evaluates the output produced during the generation process is similar to the function of Type-2 processes described in the default-interventionist account of cognition. The default-interventionist model describes Type-2 processing as a reflexive function that may or may not intervene in intuitive, default responses initially generated during Type-1 processing (Evans & Stanovich, 2013). This approach suggests that the mode of thinking that facilities the evaluation process is readily available, and may be effectively applied to hold idea generation in check (Sowden et al., 2015). While the dual-pathway model does not maintain that the two creative processing modes function in parallel, it suggests that the generation and evaluation stages of the creative process are more integrated and operate in unison to a greater extent compared to the Geneplore model (Sowden et al., 2015).

To summarise, cognitive theories of creativity are varied and differ in terms of their underlying assumptions. While the associative theory maintains that creativity is contingent on the ability to form associative elements into novel combinations, the executive control theory emphasises the importance of top-down processes during creative thinking. In contrast, the dual-process theories stress the significance of both processes during creative cognition (Benedek & Jauk, 2018). A well-known dual-process theory of creativity is Fink and colleagues' (1992) Geneplore model, which maintains that creativity entails the cycling between two phases, namely the generation and exploration phases. This model provides a theoretical characterisation of the processing stages for creativity which is organised and operates serially, in which one stage (generative phase) always precedes another (explorative phase) from the commencement to the completion of the task (MacKay-Brandt, 2011). Building on the Geneplore account, Nijstad et al. (2010) propose the dual-pathway model, which maintains that creativity is a function of two independent stages or pathways, namely the cognitive flexibility and cognitive persistence pathways. While not implying that these two thinking styles operate in parallel, the dual-pathway model suggests that generative and evaluative processes function in unison to a greater extent compared to the Geneplore model (Sowden et al., 2015).

Although the associative, executive control and dual-process theories of creativity make different assumptions regarding the processes underlying creativity, they agree that creativity is not a singular entity and that no single creative process can be identified. Instead, creative thinking involves unique combinations of a cluster of basic cognitive processes that influence the likelihood of creative output (Kharkhurin, 2012). Individual differences in creative performance are, therefore, attributed to the richness and flexibility of these specifiable cognitive processes and the degree to which they are applied (Kharkhurin, 2012; Ward & Kolomyts, 2010). This notion suggests that although creativity is a construct that is both theoretically and empirically difficult to study, the multitude of cognitive functions implicated in creative processing can be used to effectively research this construct (Kenett et al., 2015; Kharkhurin, 2012).

The previous sections, therefore, provided an introduction to creativity and explored existing theories of creative cognition. This stage of the literature review enabled the researcher to evaluate, compare and select the most relevant cognitive theory of creativity, which formed the foundation for the current study. Consequently, the present study adopts a dual-processes approach to creativity and, specifically, coheres with the assumptions of the dual-pathway model. After establishing the theoretical framework of the study, the next stage of the literature review was to identify the cognitive processes underlying creativity. This stage is crucial when conducting SEM as it constitutes the first step in theory development (Crockett, 2012).

2.4. Cognitive Processes Underlying Creativity

As mentioned briefly in Chapter 1, the present study aimed to make use of SEM as a statistical technique to develop a theoretical model of creative cognition. The first step in conducting SEM is the model specification, which occurs prior to data collection and analysis. This step entails developing a theoretical model by using applicable, related theory and referring to research to identify relevant variables and the relationship between them. Additionally, it involves providing a plausible explanation for the relationships presented in the model, as well as the rationale for the overall model specification (Crockett, 2012). As this study adopted a dual-process approach, it conceptualises creativity in terms of flexible and systematic operations, as well as takes into consideration both associative and higher-order executive functions. Therefore, the following sections attempt to specify the relationships between components of creativity, namely divergent (flexible) and convergent (systematic) thinking, associative thinking, and executive functions, namely task-switching, inhibition and fluid intelligence. The researcher developed path diagrams, which accompany the review of the literature and existing research, to visually represent the hypothesised relationship between the variables.

2.4.1. Divergent and Convergent Thinking

Guilford (1956) was one of the first to distinguish and emphasise the importance of two basic types of information processing modes underlying creative thinking, namely divergent and convergent thinking. Divergent thinking refers to an ideational thought process to generate various novel and diverse ideas from a single starting point and is, therefore, used in a context where there are multiple correct solutions (Colzato et al., 2013; Simon & Bock, 2016; Webb et al., 2017). There are multiple standardised instruments available to measure divergent thinking, including the Unusual Uses test (Guilford, 1967), Torrance (1966) Test of Creative Thinking (TTCT) and the Wallach and Kogan (1965) Creativity Battery, among others. A common feature across divergent thinking measures is that individuals must produce multiple responses to an ambiguous and open-ended problem (Lee & Therriault, 2013). Although divergent thinking tests take slightly different approaches to scoring, performance is typically assessed according to various creativity criteria, including fluency (number of responses produced), flexibility (number of categories in which responses are drawn from), originality (novelty and uniqueness of responses) and elaboration (the degree to which individual embellish responses with details; Batey & Furnham, 2006; Leikin, 2013).

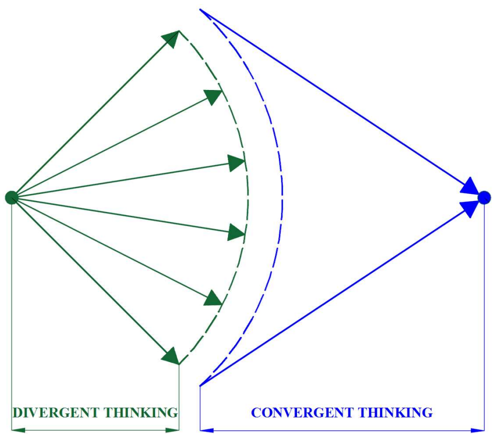
Despite there being insufficient evidence to suggest that creativity is a psychometrically unitary, monolithic construct (Arden et al., 2010), research often uses these tests of divergent thinking as primary psychometric measures of general creativity (Benedek et al., 2013; Simonton, 2015). The underlying implication of this research approach is that creativity is the product of a single type of process and that divergent thinking is synonymous with actual creativity. This assumption is problematic as divergent thinking tests were initially developed to evaluate individual abilities in ideation and primarily function as predictors or estimates of creative potential rather than criteria of creative performance (Runco, 2008). This approach is, therefore, criticised for oversimplifying creative cognition as it neglects the role of other processes that may benefit creativity, such as evaluation and convergent thinking (Sowden et al., 2015).

Convergent thinking refers to a systematic and highly constrained style of thinking. Consequently, initial conceptualisations consider convergent thinking as the process that opposes both divergent thinking and creativity in general. It is defined as the ability to extract a single, best-fit solution from stored information or deduce what is already known by implementing logical and conventional search, recognition and decision-making strategies (Cropley, 2006). While divergent thinking tests require individuals to generate multiple potential solutions, measures of convergent thinking, such as the Remote Associates Test (RAT; Mednick, 1962), entail producing a single, correct response in a deductive manner. Convergent thinking is typically responsible for generating orthodoxy, whereas divergent thinking produces variability. This idea seemingly confirms the notion that divergent thinking is synonymous with creativity; however, variability produced exclusively via flexibility, fluency, and originality does not, on its own, guarantee creativity. Convergent thinking is essential to the creative process as it enables variability to be explored, evaluated or criticised and is used to identify relevant and effective aspects (Cropley, 2006).

The function of divergent and convergent thinking is, therefore, viewed as a contemporary dual-process model of creativity (Sowden et al., 2015). Specifically, divergent thinking accesses semantic networks, which facilitates the search of vast conceptual representations for information that is required to generate multiple potential solutions to a given problem. Thereafter, convergent thinking evaluates the multitude of potential solutions generated during divergent thinking. This process relies on one's ability to control both cognition and attention, to evaluate ideas and ultimately extract a single solution that is distally related to the initial problem or concept (see Figure 2). This process continuously repeats itself, suggesting that creative cognition entails the repetitive cycles of both divergent and convergent thinking (Kharkhurin, 2012). This cyclical process demonstrates the need to consider both processing modes in order to provide a comprehensive account of the creative process. Therefore, the current research included both divergent and convergent thinking in the theoretical model of creative cognition.

Figure 2

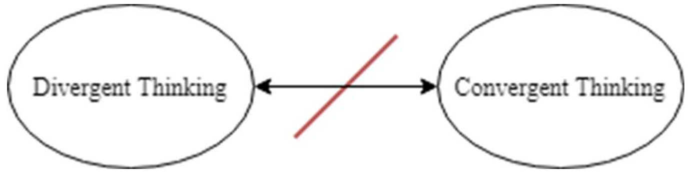
The Combined Effort of Divergent and Convergent Thinking.



This conceptualisation corresponds to the Geneplore model of creativity, with divergent and convergent thinking mapping onto the generative and explorative phases, respectively. As previously discussed, the Geneplore model has two distinct phases of creative processing: the generative phase (divergent thinking) and the exploration (convergent thinking). By presenting the role of two distinct phases, the model suggests that the shifting between divergent thinking and convergent thinking occurs in series. In doing so, the model implies not only that divergent thinking is a prerequisite for convergent thinking but also that one mode of thinking needs to terminate before the other is engaged (Sowden et al., 2015). Therefore, in terms of the relationship between divergent and convergent thinking, this perspective suggests that the two processing modes are dichotomous in nature (Runco, 2016). That is, although divergent and converging thinking are both implicated in creative cognition, this conceptualisation implies that they are entirely unrelated or mutually exclusive processes (see Figure 3).

Figure 3

Divergent and Convergent Thinking Dichotomy.



This idea is supported by a study which assessed reasoning in an ill-defined problem space via a Creative Reasoning Test (CRT) (Jaarsveld et al., 2012). The researchers administered the CRT, which involved participants who first completed the Standard Progressive Matrices test (SPM), to design an SPM-style test item, alongside a standard test of creativity, namely the Test of Creative-Thinking Drawing Production (TCT-DP). An elaborated scoring method elicited separate sub-scores of divergent and convergent thinking that the researchers compared within participants. The results demonstrated that no significant correlation occurred between the divergent and convergent thinking sub-scores, leading them to conclude that although creative processing relies on the interplay between both operations, divergent and convergent thinking are distinct and clearly distinguishable processes in this task (Jaarsveld et al., 2012).

However, the notion that divergent and convergent thinking are entirely separate functions that map neatly onto generative (Type-1) and explorative (Type-2) processes, respectively, has received some criticism. For example, Sowden et al. (2015) argue that although divergent thinking may be unconscious, automatic and associative in nature, with solutions emerging suddenly and without voluntary control, it can also be effortful and intentional. In this sense, divergent thinking may have more in common with explorative, Type-2 processing than with generative, Type-1 processing (Sowden et al., 2015). By the same token, solutions on measures of convergent thinking may emerge not only through step-wise analytical search but also via spontaneous insight. Unlike non-insight solutions, which are comparable to hypothesis testing, insight solutions are experienced as a rapid change in knowledge representation that results in a spontaneous solution to a problem (Kounios & Beeman, 2014). Given that obtaining solutions through insight typically entails unconscious processes and is accompanied by a defocused cognitive state, it stands to reason that convergent thinking could also result from generative, Type-1 processing (Sowden et al., 2015). Hence, the processes underlying convergent thinking may share similarities with those underpinning divergent thinking and, therefore, may not be entirely separate (Zhang et al., 2020).

Similarly, Runco (2016) proposed that, rather than being a dichotomous construct, creativity operates across a continuum and that divergent and convergent thinking occupy opposite ends of the spectrum. Tasks that engage either divergent or convergent thinking would, therefore, represent a specific position on the continuum whereby certain tasks are either more convergent or divergent than others rather than being either-or (Eysenck, 2003; Runco, 2016). In the process of cycling or shifting back and forth along the continuum between divergent and convergent thinking modes, the outputs produced via associative thought become ingredients for executive control processes, and vice versa (Gabora, 2010).

This conceptualisation of the relationship between divergent and convergent thinking corresponds with the assumptions of the dual-pathway model (Nijstad et al., 2010). As described in the previous sections, this model identifies two distinguishable routes to creativity, namely the flexibility and persistence pathway. Like the Geneplore, the dual-pathway model maintains that creativity relies on the joint role of divergent and convergent thinking. However, the dual-pathway model diverges from the Geneplore model in that it argues that divergent and convergent thinking are more integrated and operate in unison, rather than being entirely separate processes (Sowden et al., 2015). The dual-pathway model proposes that creative output as well as measures that target different aspects of creativity (i.e., divergent or convergent thinking) rely on both pathways but to differing extents (Nijstad et al., 2010). For example, while a higher degree of flexibility is required to effectively switch between remote associations to generate novel ideas or original creative products, persistence is also required to maintain focus on a current task and systematically explore potential creative products to find a final solution (De Dreu et al., 2012). How the two pathways to creativity collaborate is, therefore, assumed to differ between the two styles of thinking, with the flexibility pathway dominating in divergent thinking and the persistence pathway dominating in convergent thinking (Zhang et al., 2020).

Taken together, creative cognition involves two basic types of information processing modes, namely divergent and convergent thinking (Guilford, 1957). The function of divergent and convergent thinking is, therefore, viewed as a contemporary dual-process model of creativity. In particular, the distinction between divergent and convergent thinking is comparable to the generative and explorative processes in the Geneplore model (Sowden et al., 2015). That is, divergent thinking is required to generate multiple potential solutions to a given problem, which are subsequently explored further through convergent thinking (Kharkhurin, 2012). The present study acknowledges the joint role of divergent and convergent thinking and are, therefore, both included in the hypothesised theoretical model. In terms of the relationship between the two processes, divergent and convergent thinking in the context of the Geneplore model are mutually exclusive processes, implying that there is no relationship between them (Runco, 2016). However, the current study coheres with the dual-pathway approach as it maintains that divergent and convergent thinking are integrated to a greater extent than portrayed in the Geneplore model and that they have a similar cognitive basis. In particular, there is evidence demonstrating that divergent and convergent thinking relate to each other in terms of their reliance on the spread of activation through semantic networks, and this suggests that associative thinking underlies both processes (Lee & Therriault, 2013). This idea is explored further in the next section.

2.4.2. Associative Thinking

Returning to the associative theory of creativity, as previously discussed, this account of creativity regards the underlying structures of semantic memory as the foundation for creative thinking (Beaty et al., 2014b). Briefly, this theory maintains that concepts and their related properties are interconnected with each other via bidirectional associative links. Once a particular node is stimulated, the activation will spread along these associative links to, and automatically activate, other nodes in the semantic network that are connected to the original node (Foster et al., 2017). Creativity, in this context, is regarded as a process of spreading activation in semantic memory, whereby novel ideas are generated by activating and linking distantly related concepts (Beaty et al., 2014b).

Associative processes are typically linked to divergent thinking, as the latter involves accessing semantic networks to generate multiple potential problem solutions (Kharkhurin, 2012). This idea is supported by research, which has demonstrated a significant relationship between divergent thinking and associative processes (Beaty et al., 2014b; Benedek et al., 2017; Benedek et al., 2012b). Nevertheless, the extent to which convergent thinking relies on the spread of activation through associative networks remains unclear (Marko et al., 2019). This uncertainty is perhaps due to the fact that, since convergent thinking is a systematic and controlled processing style, it is assumed to predominantly rely on higher-order, executive functions (Sowden et al., 2015).

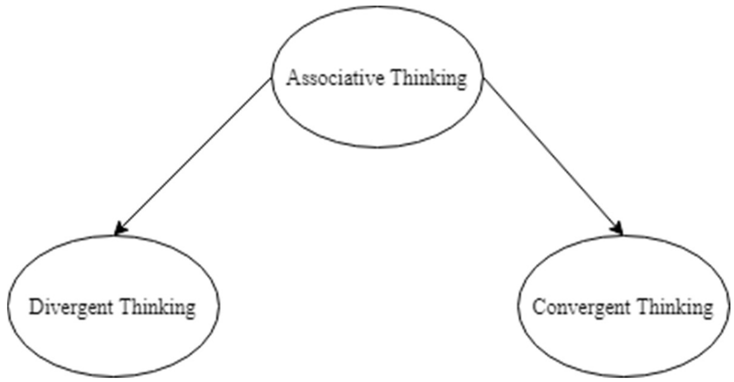
However, this idea is rejected by Marko et al. (2019), who conducted a study to evaluate the involvement of lexical-semantic (associative hierarchies) and executive functioning (inhibition and task-switching) in a measure of convergent thinking, namely the RAT. In addition to the RAT, the researchers administered a newly developed test that they created for their study, referred to as the Associative Chain Test (ACT). The ACT involved participants generating word chains that had to abide by specific rules. In the associate task, participants generated a word chain where each new response needed to be semantically related to the previous word. In the dissociate task, each new response needed to be semantically unrelated to the previous one and the associate-dissociate task involved participants providing associated and disassociated words in alternation. The researchers evaluated performance on the ACT in terms of the time required to initiate a word response (response time), response commonness and response remoteness. Response commonness and remoteness served as lexical-semantic measures. The difference in the reaction time between the dissociate and associate tasks served as the measure of inhibition. Finally, switching was assessed by calculating the difference in reaction time between the alternating task and both the associate and dissociate tasks, respectively (Marko et al., 2019).

The results obtained in this study indicated that while performance on the RAT was significantly related to lexical-semantic (more remote and less common responses) it was not significantly related to executive aspects (inhibition and task-switching) of the ACT. Overall, the researchers demonstrated that performance on the RAT involves a coherent cognitive ability to reach remote concepts in lexical-semantic and associative networks (Marko et al., 2019). These findings cohere with evidence of a significant, positive relationship between RAT performance and associative fluency (Benedek et al., 2012b; Benedek & Neubauer, 2013; Marko & Riečanský, 2018). Together, the results from these studies suggest that, like divergent thinking, convergent thinking relies on associative networks and the spread of activation through semantic memory. Therefore, rather than being mutually exclusive processes, divergent and convergent thinking appear to be related in terms of their reliance on associative thinking.

This idea is supported by a study conducted by Lee and Therriault (2013), who explored the cognitive underpinnings of creative processing. In particular, the researchers investigated the relationship between divergent thinking, convergent thinking, and associative thinking, among others. The results demonstrated that associative thinking significantly predicted both divergent thinking and convergent thinking. These findings are noteworthy as no direct relationship occurred between divergent and convergent thinking (Lee & Therriault, 2013), which supports the results obtained by Jaarsveld et al. (2012). These findings suggest that associative thinking underlies both components of creative thinking. Additionally, they support the notion that associative abilities, namely the spread of activation through semantic networks, form the basis of divergent and convergent thinking and, thus, creativity in general (Kenett, 2018a). For these reasons, the hypothesised theoretical model developed in this study included associative thinking. In particular, this model presents associative thinking as the process that relates to both divergent and convergent thinking (see Figure 4).

Figure 4

The Hypothesised Relationship between Divergent, Convergent and Associative Thinking.



Therefore, divergent and convergent thinking both appear to be significant components of creative thinking that relate in terms of their reliance on the spread of activation through semantic networks. This suggests that associative processing may be an essential component of creativity as a broader cognitive function that underlies divergent and convergent thinking (Lee & Therriault, 2013). While this section focused on the commonalities of divergent and convergent thinking, the subsequent sections address potential dissimilarities between these processes. One way in which these two processes may differ is in terms of their reliance on executive functions (Colzato et al., 2013).

2.4.3. Executive Functions

As discussed in the previous sections, by emphasising the role of associative and unconscious mechanisms, which passively unfold through semantic networks, early creativity theories either implicitly or explicitly maintain that creative thinking necessitates minimal executive function (Sowden et al., 2015). Nevertheless, a criticism of this conceptualisation is that it fails to acknowledge the role of higher-order, executive control, which recent research demonstrates (Beaty et al., 2015). Executive function is an umbrella term for a cluster of high-level cognitive processes that, through their influence on lower cognitive processes, enable individuals to regulate and control the dynamics of thoughts and actions during goal-oriented behaviour (Friedman & Miyake, 2017). Examples of these goal-directed abilities include decision making, problem-solving, maintaining and directing attention, future planning, behavioural control and emotional regulation (Daucourt et al., 2018). The principal idea is that the processes categorised as executive functions constitute a second layer of information processing. That is, while the first layer comprises of sensory and perceptual processes that translate incoming information, the second layer operates on the first by altering them so that cognition and behaviours are optimised and goals achieved (Hommel, 2015).

The challenge in determining the role of executive functions in creativity is due partly to the fact that, like the construct of creativity, studies tend to conceptualise executive function as a unitary construct (Chrysikou, 2019). Supporters of the unitary perspective argue that the components of executive function are highly intercorrelated and, thus, cannot be broken down into distinct subcomponents (Flanagan et al., 2018). Consequently, they conceptualise executive function as an emergent function of a single underlying and rudimentary construct such as general intelligence (g), fluid intelligence, reasoning and problem solving, or working memory (Banich, 2009), that would, therefore, affect creative processes in the same manner (Chrysikou, 2019). Other researchers argue the inverse to unitary approaches, namely that executive function comprises of multiple processes that group independently of each other (Stelzer et al., 2014). Both the unitary and non-unitary approaches have received criticism for failing to capture the complexity and dynamics of executive function (Hommel, 2015).

Researchers have, therefore, stressed the need to adopt a complex approach that acknowledges multiple components or subcomponents of executive function (Hommel, 2015). An influential example is the Unitary in Diversity model proposed by Miyake et al. (2000), which conceptualises executive functions as a set of interrelated yet distinct control processes, thereby integrating the opposing unitary and non-unitary approaches. Although the precise components of executive function are continuously disputed (Daucourt et al., 2018), the authors suggest the existence of three major subcomponents of the executive system, namely inhibition, shifting and updating. While the researchers initially identified all three functions as major subcomponents of executive function (Miyake et al., 2000), in an additional study, they managed to extract only Updating-Specific and Shifting-Specific factors while failing to obtain an Inhibition-Specific factor (Miyake & Friedman, 2012). Specifically, inhibition correlated perfectly with a common factor shared by these three functions, which possibly represents the unity component in the model. These findings suggest that inhibition is more of a general characteristic of executive function rather than a specific, distinct component comparable to updating and shifting (Hommel, 2015).

These control factors (Miyake & Friedman, 2012) possibly play a key role in regulating the balance between the persistence and flexibility pathways of creativity (Hommel & Colzato, 2017). The idea that cognition and behaviour emerge from the appropriate balance between persistence and flexibility is central to the Metacontrol State Model (MSM) developed by

Hommel (2015). While a high degree of cognitive persistence enables individuals to focus on relevant information and suppress irrelevant information, the cognitive system likely becomes too inflexible and nonreactive to alternative possibilities. Conversely, while a high degree of flexibility enables individuals to switch between actions and alternative possibilities effectively, it may increase distractibility and dysfunctional cross-talk amongst mental representations. Therefore, metacontrol, that is the control of cognitive control, establishes the correct balance between persistence and flexibility for a given task and situation. Hence, this model maintains that thoughts and actions emerge from the appropriate balance between persistence and flexibility (Hommel, 2015).

The MSM describes this balance in any form of action selection and decision-making, which the model considers as being competitive, whereby two or more representations of alternatives compete for selection (i.e., winner-takes-all). Additionally, the model assumes that decision making is selective and capacity-limited, whereby one or only a small number of competing alternatives can be chosen at a time. Therefore, if multiple representations compete for selection, then an increased activation of one representation would reduce activation of other representations to the extent to which the activation of one is maximised and all others are minimised or sufficiently low. The degree to which alternative representations compete and to which they are biased is, therefore, determined by the metacontrol state. A high degree of persistence would involve increased mutual competition and strong top-down bias, whereas a high degree of flexibility would entail reduced competition and weak top-down bias (Hommel, 2015).

The present study adopts the MSM approach to executive function as it bears similarities to the dual-pathway model of creative cognition, which assumes that creativity is a function of cognitive flexibility and cognitive persistence (Nijstad et al., 2010). The components of creativity, that is, divergent and convergent thinking, are therefore assumed to rely on flexibility and persistence to a different extent. Specifically, while convergent thinking is assumed to rely on, or benefit from, a bias towards persistence, divergent thinking is assumed to rely on, or benefit from, a bias towards flexibility (Hommel, 2015; Zhang et al., 2020). In terms of specific executive functions, since both the MSM and dual-pathway model emphasise the process of shifting between the poles of persistence and flexibility or divergent and convergent thinking, the role task-switching plays in creativity is investigated. In addition to task-switching, the current study explored the role of inhibition in creativity as the former process is often assumed to be accompanied by the ability to inhibit strong competing representations (Jost et al., 2017). Furthermore, the current study considers the role of both task-switching and inhibition in the creative process as they account for both the unitary (inhibition) and diversity (task-switching) aspects of executive function (Miyake & Friedman, 2012). Lastly, the influence of fluid intelligence on creative processing is also considered in the present study as it may facilitate the allocation of the executive functions (Benedek & Jauk, 2019; van der Meer et al., 2010). The relationship between each of these executive functions and creativity is discussed further in the following sections.

2.4.3.1. Task-Switching. As mentioned in the discussion of the theories of creativity, the widely accepted dual-process frameworks maintain that creativity emerges from a mix of both Type-1 and Type-2 processes. Although different dual-process models of creativity emphasise the significance of generative (Type-1) and evaluative (Type-2) processes, as well as stress the significance of the interaction between these processing modes during creative processing, each model conceptualises this interaction in a different way. For example, the Geneplore model suggests that shifting between Type-1 and Type-2 occurs in series, whereas the dual-pathway model proposes that these two modes of thinking operate in unison, whereby shifting occurs along a continuum between associative and analytic thinking. Nevertheless, a common feature of these models is that they both stress the importance of shifting from one processing mode to the other, or back and forth along the continuum. This idea, therefore, suggests that task-switching may be a key source of individual differences in creative ability (Sowden et al., 2015).

Task-switching is an executive function that involves the twofold process of (1.) disengaging from a prior, well-established task-set or schema[4] and (2.) adopting a new, task-relevant schema, which enables individuals to dynamically adapt to changing task demands and circumstances (Daucourt et al., 2018). In assessments of task switching, such as the Simon Task (Bialystok et al., 2004), individuals are presented with stimuli that allow for multiple responses or actions and are, subsequently, required to perform one of the tasks on the stimuli. Successful performance on measures of task-switching depends not only on the selection and maintenance of the relevant task but also the cognitive flexibility to update tasks when objectives change (Grange & Houghton, 2014).

In the context of creativity research, the potential role of task-switching in the creative process is evident if one considers the two-component model of semantic exploration proposed by Troyer et al. (1997). This framework maintains that two processes optimise the retrieval of

[4] Cognitive frameworks that are used to organise and interpret information as well as guide cognitive processes and behaviour (Kibler, 2011).

information from semantic memory, namely the network's structural properties, specifically clustering, and task-switching (Troyer et al., 1997). Structured semantic networks have information organised in a strongly modular or locally clustered manner. Although this structuring facilitates rapid transitions between semantically related concepts within a particular subcategory, the topology of the network may limit the spread of activation and, as a result, may have difficulty finding rare, or remote paths between conceptual nodes. Task-switching is, therefore, required to mitigate exploration limitations of network topologies by enabling individuals to jump or shift to alternative semantic fields, which extends the exploration of the network and allows the spread of activation to reach remote associations. For example, in the case of a widely used measure of lexical-semantic processing, namely the verbal fluency test, the structure of the network facilitates the generation of semantically related concepts within a subcategory (e.g., lion-tiger). Once the subcategory has been exhausted, individuals switch to different semantic categories to continue their search (e.g., tiger-shark). Therefore, optimal information retrieval relies on the balance between the underlying semantic network structure and the frequency of switching (Goñi et al., 2010).

The idea that task-switching potentially benefits creative performance by optimising information retrieval is supported by a study that investigated the relationship between task-switching and creativity using latent variable analysis and SEM (Pan & Yu, 2018). Creativity was measured by three tasks that were each scored in terms of fluency (total number of adequate answers), flexibility (number of conceptual categories used) and originality (novelty and uniqueness of responses). The results revealed a significant relationship between task-switching and creativity only on the quantitative (i.e., fluency and flexibility) and not on the qualitative (i.e., originality) aspects of creativity (Pan & Yu, 2018).

While another study (Nusbaum & Silvia, 2011) support the significant relationship between task-switching and creativity, Benedek et al. (2014b) found evidence to the contradictory. Task-switching in this study did not predict creativity, and there was no significant relationship between the variables. However, the different approaches to score may account for this discrepancy. For example, unlike Pan and Yu (2018), Benedek and colleagues (2014b) scored creativity only in terms of originality. As mentioned above, although shifting predicted creativity in Pan and Yu's (2018) study, this relationship only existed between task-switching quantitative (fluency and flexibility) and not qualitative (originality) aspects of creativity. Hence, the results obtained in Pan and Yu's (2018) study actually correspond with the results obtained by Benedek et al. (2014b). Together, the findings from prior research (Benedek et al., 2014b; Nusbaum & Silvia, 2011; Pan & Yu,

2018) suggest that task-switching is required to effectively shift between conceptual categories in semantic memory in order to produce multiple creative ideas. This ability presumably facilitates remote associations, which enables individuals to generate creative ideas using multiple conceptual categories (Pan & Yu, 2018).

Although task-switching may benefit creativity by enhancing memory retrieval processes, this strategy of generating creative output may also yield ideas that do not necessarily satisfy the novelty criterion of creativity (Lu, Akinola, & Mason, 2017). For example, when asked to think aloud while generating alternative uses for particular objects, Gilhooly et al. (2007) revealed that initial responses were based on a memory retrieval strategy as individuals automatically and rapidly elicited them in response to the item cue. This approach tended to result in less novel or original ideas as individuals tended to fixate on pre-known uses. However, once memory use production had been exhausted, the participants often switched to demanding and executively loading strategies that relied on abstract semantic knowledge of an item's properties. Disassembly strategies, in particular, which involved participants conceptually decomposing target items and using the resulting parts or recombining components, were typically accompanied by highly creative responses. The results obtained in this study revealed that generating original ideas relies on the ability to disengage less fruitful strategies (memory retrieval) and flexibly switch to new, productive strategies (i.e., disassembly; Gilhooly et al., 2007).

Similarly, Lu et al. (2017) argue that the ability to shift back and forth between processing modes or tasks can enhance creative performance by preventing individuals from cognitively fixating on ineffective ideas or unproductive problem-solving strategies. This idea is demonstrated in studies that show the constraining effect of existing knowledge structures on creative ideation. As mentioned briefly above, existing knowledge structures may lead to inflexibility-related limitations, such as functional fixedness, which refers to the undue focus on stereotypical object information (Chrysikou et al., 2016). Functional fixedness interferes with the ability to effectively adapt and accept different perspectives or alternative problems-solving methods and biases creative idea generation towards obvious, salient examples (Beaty et al., 2017; Chrysikou et al., 2016). As a consequence, features of existing knowledge and experience are often incorporated in creative products, which limits the originality and novelty of output (Ward & Kolomyts, 2010).

Duncker's (1945) seminal research demonstrates the constraining effects of acquired or existing knowledge structure. In this study, participants were given various materials, including a candle and a box of matches and pins. The participants were then instructed to secure the candle to a wall in such a manner that would enable it to burn properly and not drip wax. The researcher found that the majority of participants fixated on the pin box's function as a storage for pins and, therefore, failed to realise that it could convert into a candleholder (Duncker, 1945). Similar findings were obtained by Ward (1994), who had university students imagine life on planets that differ from Earth. The students were required to draw and describe a particular species of extraterritorial animals that could inhabit the imagined planet as well as an example of both another member from the same species and an animal from an entirely different species. The majority of the participants' creations possessed attributes that closely resembled characteristic of Earth animals, such as bilaterally symmetric eyes and limbs. Additionally, drawings of the second member of the same species tended to be altered only in terms of size or sex, whilst the shape of the initial animal did not change. Together these studies (Duncker, 1945; Ward, 1994) demonstrate that existing knowledge about an item's properties or characteristics can limit the novelty of creative products, a tendency which Ward (1994) referred to as structured imagination.

Building on these findings, recently, cognitive fixation has been established as a predominant hindrance to both components of creativity, namely divergent and convergent thinking (Lu, Akinola, & Mason, 2017). For example, in terms of divergent thinking, individuals were likely to produce fewer and more unoriginal designs when the design problem was presented together with an example illustration, as their drawings tended to conform to the provided example (Chrysikou & Weisberg, 2005). Individuals also tend to produce fewer unique ideas when they brainstorm in a group compared to when they brainstorm alone, as they are often preoccupied by and fixate on the ideas generated by other group members (Kohn & Smith, 2011). Similarly, cognitive fixation could impede problem-solving that relies on convergent thinking. For example, individuals often perceive the RAT as challenging as they may first conceive and fixate on a non-solution word that is highly associated with only one of the cue words, rather than think of an answer that is commonly associated with all three cue words (Storm & Angello, 2010). Individuals are also unsuccessful at solving insight problems since they typically fixate on unjustified assumptions and inappropriate strategies that hinder the necessary insight, such as in the case of Duncker's candle problem (Lu et al., 2017).

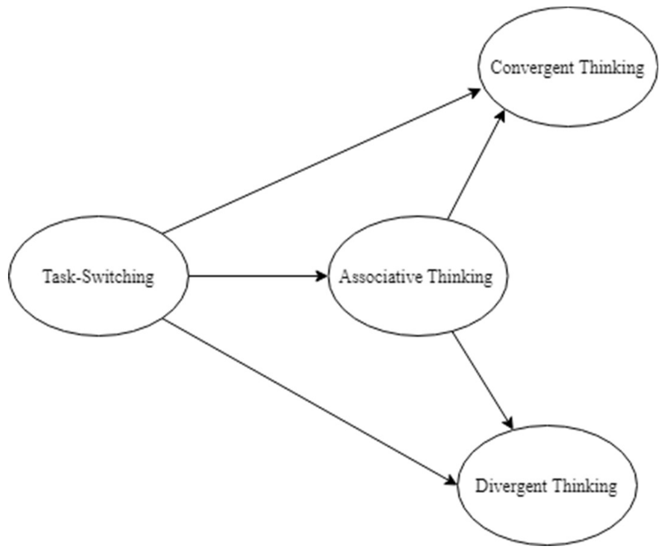
There is evidence in support of the idea that task-switching may improve creative performance on measures of both divergent and convergent thinking by mitigating the effects of fixation (Lu et al., 2017). For example, in two experiments, Lu et al. (2017) investigated the idea that individuals can overcome cognitive fixation by switching between multiple creative tasks. Each study investigated whether individuals' performance on divergent thinking (Study

1) or convergent thinking (Study 2) tests was enhanced if they were required to switch between different tasks. In both experiments, participants were randomly assigned to either a continual-switch, discretionary-switch, or midpoint-switch condition. The continual-switch condition involved the participants alternating back and forth between two tasks. The discretionary-switch condition involved participants switching task when they judged it was appropriate to do so. Lastly, the mid-point switch involved the participants dedicating half of the provided time limit to the one task and the other half to the second task. The researchers used the mid-point switch as a baseline condition since it entailed participants approaching the tasks sequentially, and was, therefore, compared against performance in the other two conditions. Individuals assigned to the continual-switch condition outperformed individuals in the discretionary-switch and mid-point switch condition on both divergent thinking measures (Study 1) as well as convergent thinking test and insight puzzles (Study 2). This finding suggests that task-switching enhances creative performance by mitigating the effects of mental fixation (Lu et al., 2017).

Together, these findings suggest that task-switching represents a form of cognitive flexibility that not only benefits creativity by facilitating memory retrieval processes but also by facilitating the rapid shift to alternative creative strategies that may prove to be more fruitful and mitigate fixation (Benedek & Jauk, 2019). Based on prior research, all components of creativity discussed in the previous sections are expected to be influenced by task-switching (see Figure 5). This hypothesis is supported by the notion that these components presumably rely on the spread of activation through semantic memory (Lee & Therriault, 2013) and that task-switching optimises the retrieval of information from semantic memory (Troyer et al., 1997). It is important to note that these findings also point towards the role of an additional executive function, namely cognitive inhibition, in the creative process. The ability to inhibit strong competing or previously relevant tasks accompanies flexible cognitive switching (Jost et al., 2017). That is, coupled with the requirement to switch between creative strategies or mental sets, is the need to inhibit interference from ineffective or redundant strategies as well as to prevent prior responses, obvious ideas and unsuitable content from gaining access to working memory for further processing (Gilhooly et al., 2007). The potential role of inhibition is, therefore, considered in the next section.

Figure 5

Hypothesised Relationship Between Task-switching, Divergent Thinking, Convergent Thinking and Associative Thinking.



2.4.3.2. Inhibition. As mentioned briefly in the above section, task-switching is often assumed to be accompanied by the ability to inhibit currently irrelevant, yet competing tasks. The role of inhibition can be observed when considering a typical measure of task-switching, which involves alternating or shifting between multiple tasks (Jost et al., 2017). For example, certain tasks involve switching between a colour discrimination task and a word-reading task (Koch et al., 2010). In these tests, the words *red* and *blue* are presented in either of these two colours. Participants are then required to select either the left or right response key depending on which key is assigned to the colour. Since word reading is often the more dominant, and well automated ability, individuals are required to rely on a strong task set when responding to the colour stimulus. Hence, when switching between the colour naming and word reading tasks, individuals have to switch between competing task sets (Koch et al., 2010).

Switch costs often accompany these measures of task-switching, that is an observed decrease in performance indicated by longer reaction times and higher error rates (Koch et al., 2010). These switch costs demonstrate that task-switching seemingly relies on effortful and time-consuming control processes that enable cognitive flexibility (Jost et al., 2017). Although there are various theoretical accounts of switch costs, it is currently accepted that two major factors contribute to this phenomenon. In particular, switch costs not only reflect processing demands in altering or updating task sets but that proactive interference from previously relevant sets, which referred to as task-set inertia, is also thought to contribute to switch costs

(Allport et al., 1994). Therefore, in addition to adapting the system to different task requirements, the elimination of previously relevant configurations presumably plays an important role (Jost et al., 2017). One cognitive mechanism theorised to facilitate this flexible switching is inhibition.

The function of inhibitory control involves the ability to deliberately suppress the processing or expression of information that would otherwise disrupt the achievement of a particular task (Diamond, 2013; Miyake et al., 2000; Simpson et al., 2012; van den Wildenberg et al., 2010). It provides the ability to resist and override interference from prepotent internal predispositions or external lures, in favour of desirable or appropriate actions (Diamond, 2013; Radel et al., 2015) and, thus, regulates the access of information to working memory (Dagenbach & Kubat-Silman, 2003). Tests of inhibition include conflict tasks such as the Eriksen and Eriksen (1974) or the Stroop (1935) tasks, among others. These tasks usually involve having to quickly and accurately respond to stimuli by selecting the relevant aspects of the provided stimuli, as well as inhibiting or overriding irrelevant features that elicit dominant, automatic yet incorrect responses. Slower reaction times and higher error rates tend to accompany incongruent trials, which involve a stimulus and response mismatch, compared to congruent trials, that is, when they correspond. This phenomenon is referred to as the interference effect and is thought to result from a conflict between competing responses (Radel et al., 2015).

There are varying conceptions regarding how inhibitory control relates to creativity. Earlier associative models proposed that creativity relies solely on automatic processes and, thus, benefits from a lack of both cognitive and behavioural inhibition (Benedek et al., 2012a). According to this perspective, reduced inhibitory control fosters both remote associations and intuitive thinking, which stimulates creative ideation (Camarda et al., 2018). This notion possibly stems from the observation that creative individuals tend to be better at both ideational and associative fluency (Benedek et al., 2012b), and characteristically impulsive (Burch et al., 2006). Empirical evidence for this idea comes from studies showing a negative relationship between inhibition and creative idea generation, which was assessed via divergent thinking measures (Dorfman et al., 2008; Kharkhurin, 2011; Lin & Lien, 2013).

However, an increasing body of research has provided contradictory findings that point towards the role of inhibition in creative thinking. For example, multiple correlational studies have demonstrated a positive relationship between performance on the Stroop test and various measures of creative cognition (Beaty et al., 2014b; Benedek et al., 2012a; Vartanian, 2009). Moreover, in a study that investigated the relationship between creativity and performance on a modified version of the Stroop task, participants identified as being highly creative, namely industrial engineers, outperformed the control group in both divergent thinking ability and inhibitory control efficiency (Edl et al., 2014). In addition, cognitive inhibition consistently predicts higher creative ability, as measured by divergent thinking, as well as both teacher ratings of creativity and self-reports of creative achievements (Benedek et al., 2012a; Benedek et al., 2014b; Cheng et al., 2016; Edl et al., 2014; Groborz & Necka, 2003; Zabelina et al., 2012).

These findings are in coherence with a study conducted by Benedek et al. (2014a), which aimed to identify the brain activation associated with the generation of novel ideas compared to ideas recalled from long-term memory. The AUT was administered to the participants while they were analysed using functional magnetic resonance imaging (fMRI). The study included a key experimental variation, which involved participants reviewing their responses after being scanned and identifying which were old or new ideas. Old ideas referred to creative uses for the given object that the participant had previously known and recalled during the experiment, whereas new ideas referred to previously unknown ideas generated for the first time during the assessment. In addition to categorising ideas as old or new, the quality of ideas was rated on a 4-point scale ranging from 1 (uncreative) to 4 (very creative), by three raters who were blind to the old/new distinction. Creativity was gauged in terms of originality and appropriateness in a single holistic evaluation (Benedek et al., 2014a).

The researchers found a link between the originality and appropriateness of creative products and the activation of the inferior frontal gyrus (Benedek et al., 2014a), which is a prefrontal brain region associated with executive function, such as response inhibition (Aron et al., 2014; Hampshire et al., 2010; Houdé et al., 2010). Benedek and colleagues' (2014a) findings support the results obtained in a meta-analysis of 45 FMRI studies. In this analysis, the researchers found that regions in the prefrontal cortex linked to conflict monitoring, inhibitory control and working memory (i.e., anterior cingulate cortex, the inferior frontal gyri and the middle frontal gyri respectively) activated during verbal and visuospatial creativity tasks (Benedek et al., 2014a). These findings suggest that the processes mentioned above play a significant role in creative ideation (Boccia et al., 2015). Therefore, research has provided inconsistent result regarding the role of inhibition in creative cognition as findings from different studies suggest that inhibition may either facilitate or hinder creativity.

Recently, evidence has emerged of an alternative perspective that may consolidate these seemingly conflicting results. For example, Cheng et al. (2016) revealed an interaction such that low levels of inhibitory control were advantageous for originality in the early stages of creative problem finding[5], which is an essential component of creative thinking and creative achievement. In contrast, the researchers found higher levels of inhibition to be advantageous during the later stages of the creative process (Cheng et al., 2016). Similarly, Zabelina and Robinson (2010) found that individuals who scored higher on measures of creativity exhibited a higher degree of flexible inhibitory control. That is, individuals who obtained a higher score on measures of creativity were not only better at exerting control over their cognitive processes but also at exerting fluctuating inhibitory control according to the task at hand and, hence, were adept at modulating their cognitive control system according to task-specific features (Zabelina & Robinson, 2010).

These findings suggest that creative thinking relies on neither high nor low levels of inhibitory control (Cheng et al., 2016; Zabelina & Robinson, 2010). Instead, levels of inhibitory control appear to be related to Hommel's (2015) MSM, which maintains that creativity relies on an optimal balance between flexibility and persistence, or associative and controlled processing. Specifically, decreased levels of cognitive inhibition may provide access to diverse and loosely connected concepts to combine and use as a foundation for novel ideas, thus, facilitating divergent aspects of creativity (Cheng et al., 2016; Rominger et al., 2011; Rossmann & Fink, 2010). In contrast, increased levels of inhibition may benefit the convergent aspect of creativity by promoting the deliberate and effortful search of novel ideas during context-specific tasks, as well as enabling the appropriateness of creative output to be continuously considered and evaluated (Chrysikou, 2019). Inhibition may, thus, support the convergence on a single, correct solution or idea by suppressing irrelevant information and restricting its access to working memory (Radel et al., 2015). Therefore, creativity appears to rely on the ability to differentially and flexibly engage inhibitory control in a context-sensitive manner (Benedek et al., 2012a). The Matched Filter Hypothesis (MFH) for cognitive control (Chrysikou et al., 2014) explains the manner in which creative tasks determine the flexible engagement of inhibition.

The MFH maintains that task performance is optimised not merely by engaging a high degree of inhibitory control regardless of the task at hand, but rather through an appropriate match between the extent of control applied and the degree to which tasks require lower levels of information to be filtered. The model predicts that, by extensively filtering raw input, high levels of inhibition enhance performance on certain cognitive tasks. In

[5] The ability to notice disparities and apparent contradictions and consider alternative perspectives of established problems, or to create novel problems to be solved (Runco, 1994).

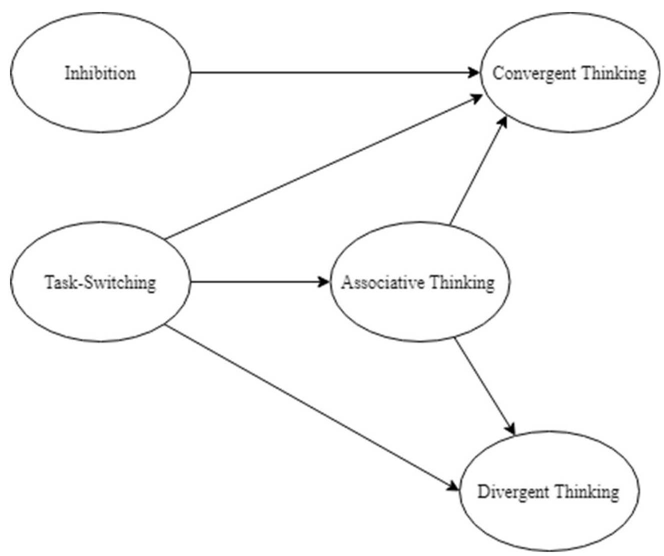
particular, inhibition confers advantages provided that these tasks are top-down, rule-based and goal-directed, which are tasks that are constrained by the capacity limits of working memory. Consequently, these tasks are not well suited to reduced levels of prefrontal cortex (PFC) activation. However, by restricting the regulatory filtering of input, low-levels of inhibition are advantageous to bottom-up or stimulus-driven tasks. Such tasks are not reliant on abstraction and can be accomplished irrespective of working memory limitations, which are tasks that not well suited to high levels of PFC activation. Hence, the MFH suggests that the appropriate level of inhibitory control is context or task-dependent (Chrysikou et al., 2014).

For example, reduced levels of inhibition may benefit certain aspect of creative thinking to the extent that optimal performance on creativity tasks relies on the availability of unrefined, lower-level input. Such tasks are typically associated with the generation of novel responses and tasks that have multiple correct and equally likely solutions, such as divergent thinking tasks. Rather than being guided by the implementation of explicit rules, such tasks rely on the access to low-level input to determine performance. The MFH, therefore, proposes that a reduction in inhibition limits the regulatory filtering of input, which may prompt alternative potential solutions before identifying a final, optimal solution. In contrast, the application of high levels of inhibition may lead to performance cost on such creativity tasks, due to crucial information that appears in low-level input being filtered out and discarded (Chrysikou et al., 2014).

This theory suggests that the need for inhibitory control changes depending on the stage or phase of the creative process. For example, during the earlier phases of divergent thinking, decreased levels of inhibition may permit loose associations and discrete conceptual representations to enter working memory, resulting in the generation of original ideas (Cheng et al., 2016; Nijstad et al., 2010). However, as the creative process progresses, divergent thinking may activate task-irrelevant information, which could negatively affect the originality of creative ideas due to cognitive overloading and difficulty with digressing from fruitless ideas or strategies due to fixation or perseverative thoughts (Benedek et al., 2012a; Cheng et al., 2016). In contrast, during systematic and convergent phases of creativity, a higher degree of inhibition is required to prevent task-irrelevant and distracting information from entering working memory (Cheng et al., 2016). However, excessive inhibition may also result in distantly related concepts not readily being considered as they are removed before reaching the threshold of activation required to access working memory (Harkins, 2006). Consequently, closely related and common associations are readily available and thus processed during creative thinking, resulting in less creative output (Cheng et al., 2016). Hence, the creative process relies on the appropriate balance of cognitive inhibition, and the degree of inhibition required depends on the current task (Chrysikou et al., 2014). Therefore, cognitive inhibition is expected to be more implicated in convergent thinking than in divergent thinking aspects of creativity (see Figure 6).

Figure 6

Hypothesised Relationship Between Inhibition, Task-switching, Divergent Thinking, Convergent Thinking and Associative Thinking.



Contrary to early theories of creativity, current research has demonstrated that the executive functions of task-switching and inhibition play an important role in the creative process (Beaty et al., 2015). In particular, task switching represents a form of cognitive flexibility that benefits creativity by both facilitating effective memory retrieval and enabling individuals to shift to alternative creative strategies that may prove to be fruitful (Benedek & Jauk, 2019). Inhibition is the cognitive function that presumably accompanies this process of switching between tasks (Jost et al., 2017), which may facilitate convergent rather than divergent thinking by suppressing task-irrelevant information as well as withholding dominant or inappropriate ideas, thereby reducing cognitive conflict (Benedek & Jauk, 2019). Therefore, creativity relies on an appropriate balance or level of cognitive control, which depends on an individual's goals and the characteristics of the task at hand (Chrysikou et al., 2014). Finally, the appropriate allocation of the executive functions discussed above (i.e., task-switching and inhibition) for creative processing is possibly facilitated by fluid intelligence (van der Meer et al., 2010). That is, depending on the nature of the creative task (i.e., divergent or convergent thinking), fluid intelligence possibly engages either a high or low degree of executive function (Benedek et al., 2014b). Therefore, the next section explores the role of fluid intelligence in the creative process.

2.4.3.3. Fluid Intelligence. Among the unresolved questions in creativity research is the nature of the relationship between creativity and intelligence (Sligh et al., 2005). Like creativity, intelligence as a theoretical construct that is difficult to both define and operationalise as it has a range of meanings in varying contexts. Thus, several diverse definitions of intelligence have been proposed, including the idea that intelligence is a general ability that entails the capability to understand complex ideas, problem solve, plan, reason, think abstractly, learn from experience and to effectively adapt to the environment (Haier, 2016).

A general framework developed by Sternberg and O'Hara (1999) describes five possible relationships between the two constructs, including intelligence and creativity being subsets of each other, coincidental, overlapping or entirely unrelated sets. A widely accepted theory regarding this relationship is that of the threshold hypothesis, which maintains that creativity requires a higher or at least above-average intelligence, namely an intelligence quotient (IQ) of 120 (Jauk et al., 2013). Specifically, creativity is assumed to be restricted by intelligence below this threshold, whereas differences in the level of intelligence become irrelevant to creativity above the threshold (Jauk et al., 2013). Accordingly, this hypothesis predicts a significant relationship between measures of intelligence and creativity but only in samples with a low or average IQ. In contrast, no significant correlation should occur between intelligence and creativity in a high IQ sample. An important implication of the threshold hypothesis is that intelligence is a necessary yet insufficient condition for creative achievement (Jauk, 2018; Runco, 2014b).

Although various studies have provided evidence in support of the threshold theory by demonstrating a non-linear relationship between creativity and intelligence (Jauk et al., 2013; Preckel et al., 2006), there is still uncertainty regarding the nature of this relationship (Plucker et al., 2015). Sligh et al. (2005) proposed that the lack of clear conclusions is likely due, at least in part, to the lack of differentiation between the core components of general intelligence, namely fluid and crystallised intelligence (Cattell, 1971, 1987). Fluid intelligence refers to both inductive and deductive reasoning capabilities applied during novel problem-solving (Haier, 2016), as well as the ability to generate, store and manipulate new information (Zaval et al., 2015a). This component of intelligence is considered to be independent of learning, existing knowledge and previous experience and is, thus, often contrasted with crystallised intelligence. Crystallised intelligence refers to the experience-based, knowledge aspect of intelligence that relies on long-term memory and involves the ability to both retrieve and use information accumulated over a lifetime (Kensinger, 2009).

As previously mentioned, creativity cannot be produced ex nihilo but is rather based and built on existing knowledge. Consequently, creativity may rely largely on crystallised intelligence (De Dreu et al., 2012). This idea is supported in a study that investigated the extent to which fluid intelligence and crystallised intelligence account for performance on measures of creativity (Batey et al., 2009). Creativity was operationalised via a battery of divergent thinking tests, whereby participants were required to complete various items within a given time limit. An overall divergent thinking score was obtained by totalling the number of responses made on each test. The researchers found crystallised intelligence to be the most powerful indicator of divergent thinking and, therefore, concluded that creativity relies largely on stored knowledge and experiences (Batey et al., 2009).

The results obtained by Batey et al. (2009) can be explained in terms of associative accounts of creativity. In particular, the increase in capacity of network structures that individuals with a higher level of knowledge possess possibly account for these findings. Individuals with a greater accumulation of knowledge tend to have expansive conceptual network structures that contain extensive information about concepts, their comprising features and the relationships between features. Complex networks have a large quantity of comprising features or components that are interconnected both within and between structures. Networks containing numerous conceptual representations form the basis of creativity by providing requisite information that serves as the raw materials for creative products (Dane, 2010). Since creativity, in the context of the associative theory, is thought to rely on the ability to associate distantly related concepts and assembled them into novel combinations (Roberts & Addis, 2018), the development of one's knowledge base increases the likelihood of producing novel combination owing to the fact that there are numerous conceptual representations at one's disposal (Dane, 2010).

However, as previously discussed, this explanation has been criticised for possibly exaggerating the structural and associative aspects of creativity whilst neglecting the role of higher-order processes in creative cognition (Nusbaum & Silvia, 2011). Specifically, the manner in which divergent thinking was conceptualised and measured in Batey and colleagues' (2009) study may account for the results demonstrating that crystallised intelligence significantly predicted divergent thinking. In the latter study, divergent thinking was quantified solely in terms of ideational fluency, thereby disregarding the originality of responses. Ideational fluency is likely to benefit from crystallised intelligence as the latter engages easy-to-reach network states that provide direct paths to access prior knowledge and experience, making information easily and rapidly accessible (Barbey, 2018). However, as ideational fluency tends to yield ideas that represent refinements or extensions of existing knowledge, it is unlikely to require radical manipulation or recombination of attributes and knowledge schemas, which may lead to ideas that are qualitatively less creative. Therefore the scoring method adopted by Batey et al. (2009) is problematic as it equates the quality of ideas to the quantity of responses and, as a consequence, this study may have overestimated the relationship between crystallised intelligence and creativity.

Although higher levels of crystallised intelligence may benefit creativity by increasing the number of conceptual representations that can be used to produce novel combinations, an over-reliance on crystallised intelligence may also yield ideas that are qualitatively less creative. Original ideas not only require the combination of distantly related concepts but also a substantial manipulation of conceptual features, which indicates the need for a clear departure from existing knowledge and practice (Dane, 2010). This idea suggests that creativity is not necessarily dependent on the number of conceptual representations in the semantic network but relies on how it is structured, both in terms of interconnections between concepts, as well as the cognitive processes that act upon these existing knowledge structures (Benedek et al., 2018). Fluid intelligence is, therefore, thought to play a significant role in the creative process by structuring the semantic network in a way that facilitates efficient search processes and conceptual combinations (Dane, 2010)

Evidence in support of this is provided by a study that assessed how creativity and fluid intelligence relate to the structure of semantic networks (Kenett et al., 2016a). In this study, participants completed a semantic verbal fluency task and were divided into four groups based on their performance on both measures of fluid intelligence and creativity. The results demonstrated that, while creativity was related to the flexible properties of the semantic network, which were exhibited by lower modularity of the network, fluid intelligence was related to the structural properties of the network, as demonstrated by higher modularity and longer ASPL. The researchers also found that the semantic networks of those who scored high on both fluid intelligence and creativity measures possessed both structural and flexible properties (Kenett et al., 2016a). Therefore, while the semantic networks of creative individuals encompass a flexible, chaotic nature, it is essential for these networks to contain some degree of structure to prevent semantic chaos (Faust & Kenett, 2014; Kenett et al., 2016a). These findings relate to Troyer and colleagues' (1997) two-component model of semantic exploration discussed in the previous sections. This model maintains that two processes optimise the retrieval of information from semantic memory, which include the network's structural properties and task-switching (Troyer et al., 1997).

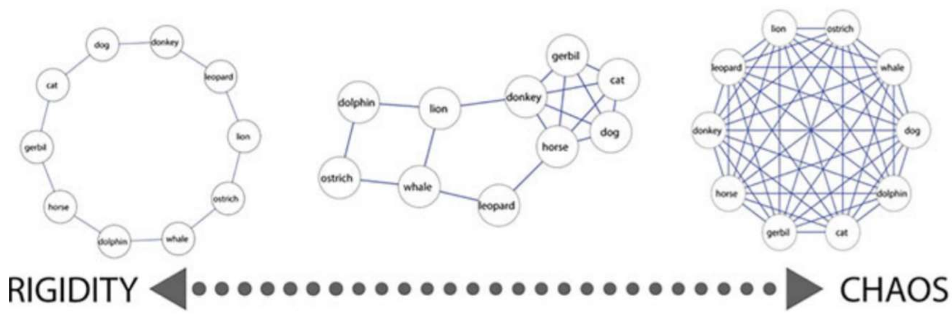
Moreover, the results obtained by Kenett et al. (2016a) can be clearly situated within recent cognitive theories that conceptualise both typical and atypical cognitive functioning as an interplay between flexible and rigid processes. For example, Faust and Kenett (2014) proposed a theory that explains the relationship between network structure and typical and atypical thought processes, and suggests that this lexical structure operates across a continuum. On one extreme of this continuum are excessively ordered, rigid structures, which are characteristic of individuals with Asperger syndrome (Kenett et al., 2016b). In contrast, on the other end of the continuum are excessively disorganised, chaotic structures that are characteristic of individuals with schizophrenia (Zeev-Wolf et al., 2014).

In terms of individual differences in creative ability, overly structured, rigid networks result in reduced cognitive flexibility and, thus, lack the spontaneity required to satisfy the novel criteria of creativity (Zabelina & Robinson, 2010). In extreme cases, this excessive structure may reach a point of pathology (Kenett et al., 2016a), which has been demonstrated in the manner in which individuals with autism have difficulty undertaking creativity tasks (Kenett et al., 2016b). On the other hand, while random, highly connected and chaotic networks may allow for flexible creative processing, which may produce novel ideas, they may disrupt conventional, literal processing and, thus, interfere with the relevance and appropriateness criteria of creativity (Faust & Kenett, 2014). In extreme cases, this may result in a pathological state (Kenett et al., 2016b). This idea is supported by studies that found a significant correlation between creative ability and schizotypical personality traits (Kaufman & Paul, 2014), as well as by research demonstrating that individuals with schizophrenia tend to judge and process novel metaphors in an atypical manner (Zeev-Wolf et al., 2015).

Creative ability, therefore, relies on an optimal balance of rigid and chaotic network structures, which enable efficient semantic processing via more effective transmission of information compared to network patterns that are either excessively random or overly interconnected (Dosenbach et al., 2008). Kenett (2018b) provides an effective illustration of this idea, which demonstrates a continuum of semantic networks (see Figure 7). This illustration presents ten nodes with different connectivity patterns, which range from highly rigid organisations (left) to highly chaotic organisations (right). It is important to note that this network supports the notion that creativity is not contingent on the amount of content in the network (i.e., crystallised intelligence) as all the networks presented in comprise of the same ten nodes. Instead, creativity relies on the manner in which the network is structured and connected.

Figure 7

Depiction of the Semantic Continuum.



Note. This figure demonstrates three semantic networks that each differ in connectivity ranging from rigid networks (left) to chaotic networks (right). Adopted from Kenett (2018b).

As demonstrated in Figure 7, networks with extreme rigidity have nodes that are connected to only one other node. Activation in such networks rapidly deteriorates as it spreads across multiple links. As a consequence, retrieval becomes repetitive as only a few nodes that are close to the source receive enough activation to be retrieved. In contrast, extremely chaotic networks have nodes that are connected to every other node in the framework. Highly interconnected networks result in disorganised retrieval, as numerous nodes are activated from a single source. In between these two extremes lies an integrated system (centre), which has nodes that are only linked to a few other nodes (rigidity). However, this system also has certain nodes that are highly interconnected with multiple nodes (Kenett, 2018b).

The structured semantic networks associated with high fluid intelligence is, therefore, thought to contribute to the ability to shift between small sub-communities of nodes with greater ease and, therefore, overcome conventional, salient ideas (Kenett et al., 2016a; Unsworth et al., 2011). These findings demonstrate not only the role of fluid intelligence in creativity but also the idea, introduced in the previous sections of this chapter, that task-switching constitutes an important component of the creative process. Nusbaum and Silvia (2011) provide evidence for the joint role of fluid intelligence and task-switching in the creative process. In particular, they conducted two latent variable studies to investigate the role of executive and strategic processes during creative cognition. Their research not only demonstrated that fluid intelligence significantly predicted divergent thinking but also found that task-switching mediated this effect. That is, participants who scored higher on measures of fluid intelligence tended to produce categorical switches during creative thinking tasks. These findings suggest that task-switching is a process that underlies the relationship between fluid intelligence and creative thinking (Nusbaum & Silvia, 2011). Therefore, in addition to the configuration of semantic networks, creative processing seems to rely on cognitive shifting to flexibly switch between semantic categories during memory retrieval, as this facilitates associations between remote concepts and enables multiple, novel ideas to be generated (Pan & Yu, 2018).

Additional research provides evidence that corresponds with the studies mentioned earlier (Kenett et al., 2016a; Nusbaum & Silvia, 2011). For example, studies have demonstrated a positive association between creativity and fluid intelligence (Cho et al., 2010; Jauk et al., 2013) which is generalised across different measures of creative potential, such as creative metaphor generation (Beaty & Silvia, 2013; Silvia & Beaty, 2012) and insight problem solving (Beaty et al., 2014a). Moreover, this relationship is pronounced when the originality of creative products is considered, rather than conceptualising creativity exclusively in terms of ideational fluency. For example, Benedek et al. (2012a) demonstrated that the qualitative aspect of creativity, namely the originality of creative ideas, relies more on intelligence than the quantitative aspects of creativity, that is the number of ideas generated.

Similarly, Lee and Therriault (2013) systematically investigated the relationship between intelligence and three fundamental creative processes, namely divergent and convergent thinking, as well as associative fluency. The researchers demonstrated that fluid intelligence directly predicts both convergent thinking and associative fluency, but not divergent thinking. However, fluid intelligence emerged as an indirect predictor of divergent thinking through associative fluency, but the links between these latent constructs were weaker than the links observed between intelligence and convergent thinking. These results are possibly attributed to the fact that convergent thinking aspects of creativity entail systematic and analytic cognitive processing and, thus rely heavily on fluid intelligence (Lee & Therriault, 2013).

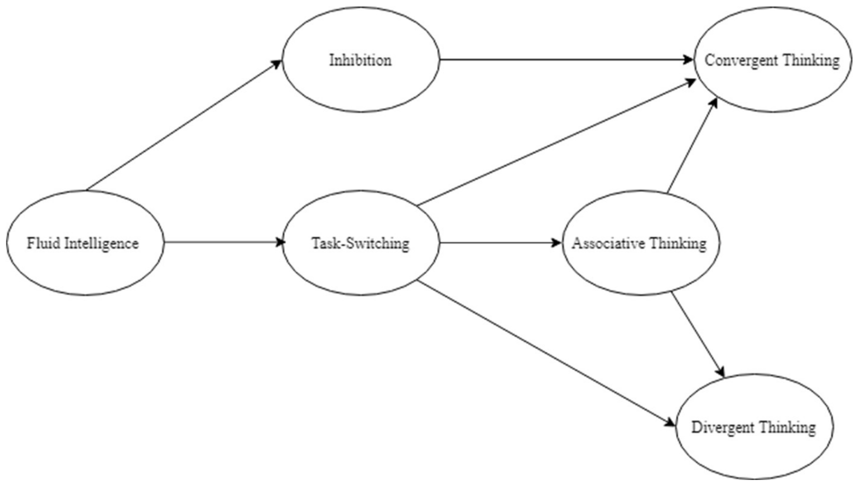
The notion that fluid intelligence facilitates convergent thinking aspects of creativity is supported by research demonstrating a positive correlation between performance on the Raven's Advanced Progressive Matrices (APM) and on a measure of convergent thinking, namely the RAT (Akbari Chermahini et al., 2012; Lee et al., 2014). A possible explanation for the finding that fluid intelligence significantly influences convergent thinking aspects of creativity is that it facilitates the effective implementation of executive control or top-down strategies over the mental resources required to produce creative ideas (Benedek & Jauk, 2019).

Evidence in support of this idea is provided by a study by van der Meer et al. (2010), who investigated the impact of fluid intelligence on the allocation of cognitive resources. They used a combination of choice reaction time measures and geometric analogy tasks to compare individuals with high fluid intelligence with controls who had an average level of fluid intelligence on the processing of low-level and high-level cognitive tasks. Speed and accuracy of processing on these measures were assessed together with pupillary measures, including phasic and tonic changes in participants' pupil diameter, which served as an indicator of resource allocation. The results demonstrated that individuals with higher levels of fluid intelligence processed the choice reaction time task (low-level processing) faster than the controls (van der Meer et al., 2010). However, the pupillary responses to this task did not differ significantly between groups. Additionally, in the geometric analogy task, individuals with a high level of fluid intelligence only processed the difficult task conditions faster and more accurately than the controls, but with greater task-evoked pupillary responses. The researchers interpreted their findings as evidence for their resource hypothesis, which maintains that individuals with high fluid intelligence allocate more available resources to cognitive tasks (van der Meer et al., 2010).

Applied to the field of creative cognition, these results (van der Meer et al., 2010) imply that fluid intelligence influences creativity by facilitating the implementation of cognitive resources, such as task-switching and inhibition, required during divergent and convergent thinking (Benedek et al., 2014b). Therefore, the researcher anticipated the executive functions of task-switching and inhibition to mediate the relationship between fluid intelligence and the components of creativity, namely divergent, convergent, and associative thinking (see Figure 8).

Figure 8

Hypothesised Relationship Between Fluid Intelligence, Inhibition, Task-switching, Divergent Thinking, Convergent Thinking and Associative Thinking.



In summary, the above section discusses the different ways in which aspects of intelligence influence creativity. While crystallised intelligence benefits creativity by providing requisite information that serves as the raw materials for creative products, it may also hinder creativity by yielding qualitatively less creative ideas (Dane, 2010). The potential negative effects of crystallised intelligence on creative thinking suggests that creativity is not necessarily contingent on the content of semantic memory, but relies on the interconnections between concepts and, therefore, how the network is structured (Kenett, 2018b). This idea points towards the role of fluid intelligence in the creative process. Research has demonstrated that the semantic networks of individuals with a high level of fluid intelligence and creativity possess both structural and flexible properties (Kenett et al., 2016a). These findings suggest that structured semantic networks associated with high fluid intelligence not only prevent semantic chaos, but also enable individuals to shift between small sub-communities of nodes effectively and, therefore, to overcome conventional ideas (Kenett et al., 2016a; Unsworth et al., 2011). It is important to acknowledge that there are alternative perspectives on how fluid intelligence may influence creativity. In particular, there is evidence that fluid intelligence facilitates the allocation of executive functions (van der Meer et al., 2010). This suggests that fluid intelligence influences creativity by facilitating the implementation of cognitive resources, such as task-switching and inhibition, required during divergent and convergent thinking (Benedek et al., 2014b).

Overall, the previous sections of the literature review focused on providing information that would enable the first aim of the study to be addressed. As previously mentioned, this was to develop a coherent theoretical model of creativity, which will be subsequently analysed using SEM in the following sections. These sections of the literature constitute the first stage of the SEM analysis procedure, namely the model specification stage. This stage involves identifying the variables underlying creativity, and the relationship between these processes are mapped out (Crockett, 2012). The next sections of the literature review are focused on discussing existing research and providing information to address the second aim of the study, which was to investigate whether various demographic variables predict the individual cognitive functions identified in the previous sections as being implicated in the creative process.

2.5. Factors Influencing Creativity

The research discussed in the above sections of the literature review is based on the creative cognitive approach, which focuses on investigating the mental processes and structures that underlie creative thinking (Finke et al., 1992). However, a significant limitation of this cognitive approach is that it focuses exclusively on internal processes, such as cognition and personality, thereby encouraging methodological reductionism (Glăveanu, 2010). As a consequence, this approach neglects the potential role of environmental and contextual factors, which may account for the variability between individuals in terms of the type and amount of creative output generated (Kharkhurin, 2016). This idea corresponds to the socio-cultural approach, which stipulates that social interactions and culturally organised activities influence the development of cognitive functions (Luria, 1976; Vygotsky, 1978).

This approach was applied to the field of creativity by Vygotsky (1991, 2004), who used his earlier theories of the development of higher mental operations as a basis for his socio-cultural conceptualisation of imagination and creativity. In brief, this approach argues that the development of cognitive function entails the transition from innate "lower mental functions" (LMF) into the "higher mental functions" (HMF). LMF refer to isolated and unmediated abilities, such as reflexes, simple movements and perceptions, whereas HMF refer to functions that are mediated and associated with each other (Subbotsky, 2014). The concept of mediation implies that factors external to the developing individual, such as family, culture, and educational environment, influence the development of the individual (Vygotsky, 1978). Hence, Vygotsky's socio-cultural theory stipulates that these external factors influence the development of HMF. Creative imagination is included in this group of HMF that is influenced by external factors. In particular, the richness and diversity of an individual's experiences directly influence creativity as they provide the foundation and material to construct creative products (Vygotsky, 2004). Richer and more diverse experiences, as a consequence, provide a variety of material that can be used to generate creative products.

Contemporary theoretical frameworks build on the socio-cultural themes and concepts that together form the basis of the We-paradigm of creativity. As previously mentioned, the We-paradigm aims to reintegrate the social in the theory of creative thinking and, in doing so, develops a more holistic and systematic approach to studying creativity (Glăveanu, 2010). Despite this, creativity research grounded in the We-paradigm is often criticised for incomplete theorisation as there are limited theories or models of creativity that link individual-level creative processing and output to social and cultural factors that help produce them (Glăveanu, 2020). Consequently, the present study attempts to address this research gap by investigating the potential influence of particular demographic variables on the cognitive processes identified in the previous sections as being implicated in the creative process. The factors discussed in the subsequent section include age, the individuals' experiences with multilingualism, SES, highest level of education and gender. It is important to note that while the aim of the We-paradigm is to take into consideration contextual factors when researching creativity, unlike the demographic variables of multilingualism, SES and level of education, age and gender arguably cannot be considered as contextual factors. Nevertheless, in order to be concise, *demographic variables* is used as an umbrella term to refer to the sample characteristics analysed in the present study, which included both contextual and non-contextual variables.

2.5.1. Age

The first demographic variable considered in this section is age. This section begins with a brief discussion of the increase in the elderly population both globally and in the South African context and demonstrates the importance of researching the effects of age on cognitive abilities, and creativity in particular. This section discusses the cognitive changes that accompany the natural ageing process with regards to the frontal lobe hypothesis. This hypothesis proposes that the elderly typically experience a decline in executive functions due to the prefrontal cortex (PFC) being most affected by healthy ageing (Cabeza & Dennis, 2012). Creative cognition is then considered in the context of the frontal lobe hypothesis, which suggests that age-related decline in executive functions may operate as a double-edged sword. In particular, certain aspects of creativity, such as divergent and associative thinking, may benefit from reduced executive function, whereas other components of creativity, namely convergent thinking, may be negatively affected. This section also considers an alternative explanation as to why specific components of creativity decline with age whilst others are preserved, namely the notion of functional compensation. This concept refers to the recruitment of additional processes to overcome any cognitive losses (Zaval et al., 2015b). Lastly, this section concludes with the explanation of whether the researcher expects to find differences in test performance between pre-defined age groups in the current study.

It is widely accepted that alterations in brain structure and function accompany the normal ageing process and that these are intimately linked to changes in both cognition and behaviour. It is important to understand the effect that ageing has on cognition as there has been a rapid increase in the elderly population (Murman, 2015). In recent years, a gradual transformation in demographics has taken place due to the life expectancy of the global population rising (Peace et al., 2007). Even in South Africa, the number of individuals over 60 years have both increased between 1996 and 2011. In particular, the elderly population has almost doubled from 2,8 million, recorded in 1996, to 4,1 million, recorded in 2011. Within this period, the proportion has also increased from 7,1% to 8,0%. Furthermore, the trends demonstrate that the elderly population will continue to increase and that by 2030 it is estimated that there will be approximately seven million elderly individuals in South Africa (Lehohla, 2014). Although ageing patterns of populations are unique to each country, there is a worldwide trend of increased longevity (Peace et al., 2007). One of the paradoxes of modern research is that, despite recognising this global trend, the elderly are poorly represented in, or altogether absent from, research across various disciplines (Briggs et al., 2012). As a consequence, a crucial developmental stage, namely the "golden years", is often overlooked.

Change across various cognitive domains as a normal ageing process is well documented. While certain cognitive functions appear to be more resilient to the effects of age, or to even improve over time, others have consistently been found to gradually decline with age (Harada et al., 2013). A predominant theory of cognitive ageing is the frontal lobe hypothesis, which attributes age-related cognitive decline to underlying anatomical degeneration and functional decline of the frontal cortex. This hypothesis is based on the idea that the cognitive deficits experienced by the elderly are most prevalent in tasks that depend on executive functions as these processes are facilitated by the prefrontal cortex (PFC), which is the region that is most affected by healthy ageing (Cabeza & Dennis, 2012).

For example, age-related atrophy and white matter decrements appear to be most prominent in the frontal lobes. Additionally, the availability and function of dopamine (DA) in the PFC also decrease with age. Given that DA plays a significant role in modulating PFC function, its decrease, together with substantial anatomical decline, provide a plausible explanation for the deficits in executive function observed in the elderly at the cognitive level (Cabeza & Dennis, 2012). This hypothesis is supported by findings that the cognitive changes in the elderly are especially pronounced on tasks that entail a high degree of cognitive control, which include but are not limited to fluid intelligence (Salthouse, 2009, 2012), mental flexibility and inhibitory capabilities (Andrés et al., 2008; Baum & Titone, 2014; Hasher et al., 2007; Manard et al., 2014). Therefore, this hypothesis suggests that, due to age-related cognitive decline, the elderly may experience difficulties in successfully undertaking creative thinking tasks (Formosa, 2013).

However, this decline in executive function may have interesting implications for the creative abilities of older adults as creativity, in terms of the dual-process theory, entails the paradoxical interplay between automatic and controlled processes (Hommel et al., 2011a). While a high level of cognitive control is best suited for deductive, analytical and rule-based tasks, decreased levels of control are more appropriate for automatic, spontaneous and open-ended tasks (Chrysikou et al., 2014). Therefore, the deficits in executive function that may be experienced by the elderly due to anatomical degeneration and functional decline of the PFC (Cabeza & Dennis, 2012) potentially have both costs and benefits for creative cognition (Chrysikou, 2018).

Specifically, reduced PFC activity may prove advantageous for aspects of creativity that entail open-ended tasks, which benefit from uninhibited, automatic and spontaneous thought, such as divergent thinking (Amer et al., 2016; Chrysikou, 2018). This idea is supported by research demonstrating that successful performance on divergent thinking tasks, namely the AUT, is linked to deactivation in the frontal control regions (Chrysikou & Thompson-Schill, 2011). Hence, reduced PFC activity resulting from age-related anatomical degeneration and functional decline of the frontal cortex (Cabeza & Dennis, 2012) may enhance the elderly's ability for bottom-up processing and, thus, divergent thinking (Chrysikou, 2018). Evidence in support of this idea comes from a study that examined the age difference in performance on both the AUT and associative fluency, and which revealed that older participants produced significantly more novel responses than the younger participants on both tests (Leon et al., 2014).

In contrast, despite divergent thinking presumably benefiting from reduced cognitive control, the contribution of these PFC-mediated systems is essential to top-down, close-ended or goal-directed tasks, such as convergent thinking (Chrysikou, 2018). That is, since convergent thinking entails the process of manipulating information, critically evaluating the novelty of ideas and selecting, from among the available information, the most appropriate response whilst inhibiting the irrelevant information, high levels of cognitive control are well suited to this aspect of creativity (Chrysikou et al., 2014). Therefore, older adults should exhibit reduced convergent thinking capabilities due to age-related decline in executive control. This notion is consistent with results obtained by Simon and Bock (2016), who found that older participants achieved significantly lower scores than younger participants on a test of convergent thinking, namely the Intelligenz-Struktur-Test-2000 (IST). The researchers argue that their findings coincide with accounts of age-related decline in higher-order functions, such as fluid intelligence (Simon & Bock, 2016).

An alternative account is that the elderly use additional functions as alternate pathways to effective creative thinking capabilities. This idea corresponds to the notion of functional compensation, which refers to the process of recruiting additional processes to overcome any losses or deficits and, therefore, minimise cognitive impairment (Zaval et al., 2015b). For example, Leon and colleagues (2014) argue that the elderly draw on their wealth of knowledge and experience accumulated throughout their life to enable them to undertake creative thinking tasks successfully. In other words, the elderly may rely more on processes that remain intact with age, such as crystallised intelligence (Salthouse, 2012) and semantic memory, as a strategy to offset any age-related deficits that may affect the creative process (Madore et al., 2016). As a result, divergent thinking aspects of creativity may remain relatively preserved in old age, which corresponds with research findings (Addis et al., 2016; Foos & Boone, 2008; Madore et al., 2016; Palmiero et al., 2014; Roskos-Ewoldsen et al., 2008). This interpretation fits well with research that has linked experience to performance on divergent thinking tests (Runco & Acar, 2012; Runco et al., 2006). Therefore, additional functions, such as crystallised intelligence and semantic memory, may provide an alternate pathway to effective creative thinking capabilities and possibly attenuate the effects of age-related decline.

Furthermore, given that functional compensation occurs in response to the mismatch between one’s processing capacity and task demands, compensation should be more prominent not only when there is an increase in cognitive decline, but also when there is an increase in task demands. That is, compensation activity increases as task demands become more taxing. However, it is argued that compensation has an inverted-U relationship with task demands, such that compensation activity initially increases alongside task demands, but only to a particular level of task difficulty. Once the task difficulty surpasses this point, the availability of cognitive resources is insufficient to sustain an increase in compensation and, as a result, compensatory activity starts to decline. Hence, compensatory functions begin to fail when functional capacity is exceeded (Cabeza & Dennis, 2012).

Although this pattern is not unique to older adults, ageing potentially shifts this inverted-U function leftwards due to the elderly requiring more cognitive resources at lower levels of tasks demands. As a consequence, older adults have fewer cognitive resource available to address the requirements of more difficult tasks and, thus, compensatory activity begins to fail at lower levels of task demands. Therefore, in the context of creative thinking, older adults may expend additional cognitive resources during creative cognition, namely divergent thinking, enabling them to perform as well as, or better than young adults, which corresponds with research findings. However, due to this early expenditure, older adults may have fewer cognitive resources available that are insufficient to sustain increased compensation (Cabeza & Dennis, 2012) and, as a result, they may be unable to meet the demands of more effortful aspects of creativity, such convergent thinking.

In summary, although a decrease in creativity may accompany the natural ageing process, research has yet to systematically examine the specific alterations in creative abilities that may be associated with increasing age. Moreover, the possible changes in cognitive functions that may alter creative performance with ageing also have not been thoroughly researched (Heilman & Fischler, 2018). Consequently, the extent to which creative cognition is affected by the ageing process remains unclear (Palmiero et al., 2014). Theories of ageing, such as the frontal lobe hypothesis, foster the idea that the elderly may experience difficulty in successfully undertaking creative thinking tasks due to age-related cognitive decline (Formosa, 2013). However, these assumptions may be too simplistic as age-related deficits in executive control, as described by the frontal lobe hypothesis, may have both costs and benefits for creative processing (Chrysikou et al., 2014). Therefore, age-related cognitive decline is possibly a double-edged sword for creative thinking as the process involves the paradoxical interplay between automatic and controlled processes (Hommel et al., 2011a). Specifically, fully engaged cognitive control may aid performance on certain tasks, such as convergent thinking, whereas other tasks, such as divergent thinking, seem to benefit more from less engaged cognitive control (Amer et al., 2016). This idea is supported by prior research demonstrating that open-ended tasks, which rely on a spontaneous and uninhibited style of processing (i.e., divergent thinking), remain unaffected by age (Addis et al., 2016; Foos & Boone, 2008; Leon et al., 2014; Madore et al., 2016; Palmiero et al., 2014; Roskos-Ewoldsen et al., 2008). In contrast, this bottom-up, automatic aspect of creativity may benefit from the reduced cognitive control abilities experienced by the elderly due to age-related decline in functionality of the PFC (Amer et al., 2016; Leon et al., 2014). Therefore, the researcher expects for there to be significant differences in test performance between age groups. In particular, the younger age groups are expected to perform better than older age groups on measures of executive functions, namely task-switching, inhibition and fluid intelligence, as well as the measures of creativity that presumably rely more on these executive functions, namely convergent thinking. Contrarily, older age groups are expected to perform better on measures of creativity that are less taxing on these executive functions, namely divergent and associative thinking, compared to younger age groups.

While cognitive decline often accompanies the normal ageing process, it is important to note that not all individuals experience significant declines in function with age (Lyu & Burr, 2015). A leading possibility proposed by the cognitive reserve hypothesis (Stern, 2009) is that the ability to maintain effective cognitive abilities in the face of the normal ageing process not only stems from the plasticity of the brain but also from an accumulation of lifetime experiences. These experiences enable certain individuals to overcome pathological burdens that would otherwise diminish the cognitive function of those without such experiences (Burke et al., 2019). A widespread view, which has received increasing attention, is that a particular type of linguistic experience, namely multilingualism, contributes in building and preserving cognitive function and, consequently, may mitigate possible age-related decline in creative cognition (Alladi et al., 2013; Bak et al., 2014; Bialystok & Craik, 2014; Bialystok et al., 2007; Bialystok et al., 2004; Calvo et al., 2016; Chertkow et al., 2010; Craik et al., 2010; Gold et al., 2013a; Schweizer et al., 2012; Woumans et al., 2014). The subsequent section considers the possible influence of multilingualism on creative cognition.

2.5.2. Multilingualism

The next demographic variable discussed in this section is multilingualism. This section begins with a description of linguistic diversity in the South African context, demonstrating the importance of considering the effects of multilingualism on creative cognition. Subsequently, it considers multilingualism as a form of creative cognition, followed by a discussion regarding the possible positive and negative effects of multilingualism on different cognitive functions.

The literature attributes the adverse effects of multilingualism on cognitive abilities to the way in which those studies conceptualise multilingualism. In particular, much research tends to provide an atomistic view of multilingualism, which considers languages separately and entirely independent of each other (Cenoz, 2013). This section then considers creative cognition with regards to the notion of the bilingual advantage, which refers to the idea multiple languages benefit other cognitive processes (Bialystok et al., 2009). Two possible ways in which multilingualism could benefit creativity are considered in this section, for example via language mediated concept activation (LMCA; Kharkhurin, 2017). Briefly, the LMCA argues that the unique architecture of multilinguals' memory facilitates a greater spread of activation between concepts, which enhances the creative abilities of multilinguals (Kharkhurin, 2017). The second way in which multilingualism may positively affect creativity is by conferring advantages to executive control systems. Specifically, since multilinguals are required manage multiple co-activated language systems, they are thought to exercises and, therefore, develop a high level of skill associated with the control processes for other, non-linguistic cognitive functions (Bialystok et al., 2005; Kroll et al., 2012). This section concludes with the explanation of whether the researcher expects to find differences in test performance between pre-defined language groups in the current study.

The extent and prevalence of cross-linguistic experiences have increased in recent years, both globally and in South Africa (Aronin & Singleton, 2008; Posel & Zeller, 2016). This trend has been attributed to globalisation, migration and an increase in the appreciation of local languages (Aronin & Singleton, 2008; Coetzee-Van Rooy, 2013). South Africa, in particular, has become a meeting ground for languages that originate from various local and international linguistic groups. The numerically predominant languages of South Africa include the nine Bantu languages, which are stratified into four clusters according to their relatedness along linguistic lines, namely the Nguni, Sotho, Tsonga and Venda clusters. The Bantu languages alongside the previously official languages, English and Afrikaans, constitute the 11 languages that have been granted official status. In addition to these official languages, there are several other Bantu languages (Shona, Kalanga and Chewa among others) spoken by a small number of migrant workers and more recent immigrants that originate from neighbouring countries. There are also numerous international languages spoken in South Africa that belong to the Indo-European language group, which consist of members from the Germanic branch (English, Afrikaans and German), the Indic branch (Hindi and Urdu to name a few) and the Romance branch (Portuguese). Other international linguistic groups include small communities of Chinese, Dutch, Italian and Polish speakers (Mesthrie, 2002). The prevalence of multiple, diverse languages in South Africa emphasises the need to assess the potential influence of multilingualism on the processes implicated in creativity. The following sections discuss the possible effects multilingualism has on the creative process.

As discussed in the earlier sections of the literature review, the conceptual framework of creative cognition is based on the assumption that creative products emerge from applying basic cognitive processes to existing cognitive structures (Ward, 2007). This suggests that creativity is a fundamental attribute of typical cognition and can, therefore, occur in everyday human activity (Kharkhurin, 2012; Ward et al., 1999). That is, creativity is not limited to obvious instances, such as artistic and scientific endeavours, but also occurs in subtler generativity related to everyday cognitive activities. A compelling example of such generativity is the productive capacity of language (Kharkhurin, 2012). This notion corresponds with Chomsky's (2006) assumptions which maintain that language is characteristically and fundamentally a creative cognitive capacity. Therefore, creative potential is reflected in both the use and structure of language especially since language production involves the use of a restricted number of words and a small set of rules to produce an infinite number of grammatical sentences (Kharkhurin, 2012).

Research into multilingual creativity occurs at the intersection of two highly elaborated yet elusive fields, namely creativity and multilingualism. Like creativity, the challenge with researching multilingualism is due partly to the controversy around the definition and conceptualisation of the phenomenon (Kharkhurin, 2015). A significant portion of existing research either implicitly or explicitly conceptualises multilingualism as the presence of multiple languages, or several variations of a particular language, in a given geographical area (Council of Europe, 2007). In this context, multilingualism is a characteristic of a place, that is a particular city, society or nation, where multiple languages are spoken, exclusive of the individuals who use them.

Multilingualism has long been assumed to exert cognitive effects. This effect was initially thought to be negative as evidence demonstrated that bilinguals experience cognitive deficits, particularly in verbal skills (Bialystok et al., 2012). For example, in terms of receptive vocabulary size, both bilingual children (Bialystok et al., 2010), as well as bilingual adults (Bialystok & Luk, 2011), have smaller vocabularies compared to monolingual individuals. Bilinguals are also comparatively slower (Costa & Santesteban, 2004) and less accurate (Gollan et al., 2007) than monolinguals on picture-naming tasks. Additionally, bilingual individuals achieve lower scores on verbal fluency tasks compared to their monolingual counterparts, especially in terms of semantic fluency conditions

(Portocarrero et al., 2007), despite being able to respond in either language (Gollan & Ferreira, 2009).

However, the findings mentioned above that support the linguistic deficiency hypothesis, which maintains that multilinguals experience various adverse cognitive effects, are possibly attributed to the manner in which these studies conceptualised multilingualism (Bhatia & Ritchie, 2016). Most research provides an atomistic view of multilingualism, by considering languages to be interpretable through the analysis of independent, distinct and separable fundamental components (Cenoz, 2013). Since this approach conceptualises multilingualism as the sum of multiple, separate language systems, the acquisition of more than one language may impose additional burdens on multilinguals as they are required to learn multiple sets of discrete grammars and vocabularies (Bialystok et al., 2009). Therefore, this approach maintains that multilinguals experience various impairments in both cognitive and linguistic capabilities due to cognitive crowding (Bhatia & Ritchie, 2016; Hinnenkamp, 2005). In contrast, current evidence has also demonstrated that multilingualism has a significant and systematic benefit on cognitive functions, specifically the components of executive control (Bialystok et al., 2005; Costa et al., 2008; Gold et al., 2013b), such as conflict management and inhibition (Bialystok, 2017; Kroll & Bialystok, 2013; Lee Salvatierra & Rosselli, 2011; Singh & Mishra, 2012; Tse & Altarriba, 2012; Valian, 2015) as well as cognitive flexibility and working memory (Cockcroft et al., 2017; Hilchey & Klein, 2011) among others.

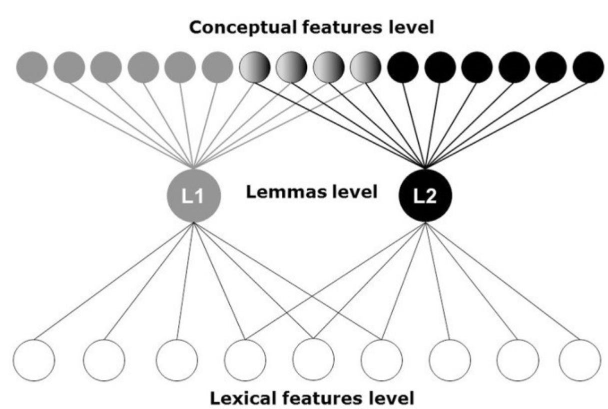
This bilingual advantage, which refers to the notion that the use of more than one language benefits other, nonverbal cognitive processes (Bialystok et al., 2009), has also been reported in the domain of creativity. For example, research has demonstrated bilingual advantages in various aspects of creative cognition, such as traits of divergent thinking, namely originality (Kharkhurin, 2009), fluency (Hommel et al., 2011c; Kostandyan & Ledovaya, 2013), flexibility (Adi-Japha et al., 2010), and elaboration (Kharkhurin, 2008; Lee & Kim, 2011), as well as insightful problems solving (Cushen & Wiley, 2011). The following sections discuss two possible ways in which multilingualism could benefit creativity, namely LMCA (Kharkhurin, 2017) and the idea that creativity benefits from multilinguals enhance cognitive control abilities (Bialystok et al., 2005). For the purpose of conciseness and convenience, the following sections use the terms *multilingualism* and *bilingualism* to refer to the presence of multiple languages, or several variations of a particular language, in a given geographical area (Council of Europe, 2007).

Underlying assumptions of the bilingual advantage maintain that the cognitive functions that support active language processing differ between monolinguals and multilinguals (Baum & Titone, 2014). A possible way in which multilinguals differ from monolinguals is in terms of the richness and flexibility of stored cognitive structures. Several models describe multilingual cognitive structures, all of which differ in the extent of cross-lingual connectivity. However, a common criticism of these models is that they have limited application as they do not address significant aspects of language processing. That is, although these models distinguish between conceptual and lexical levels in one or multiple languages, they fail to stipulate how different lexical forms are interconnected and do not take into consideration the selectivity of lexical access (Kharkhurin, 2012).

Consequently, Kroll and de Groot (1997) developed the distributed conceptual/lexical feature model (see Figure 9) to provide a more specialised description of multilingual cognitive structures. In particular, this model (Kroll & de Groot, 1997) focuses on specific representations and elucidates which ones are used in common across languages, as well as the extent to which access to the representation are selective. Furthermore, it evaluates how the interaction of multiple languages changes according to language modalities that are subjected to particular task conditions (Kharkhurin, 2012).

Figure 9

The Distributed Conceptual/Lexical Feature Model of Bilingual Cognitive Structure.



Note. This model demonstrates the three levels of representation of bilingual memory, including the conceptual features level, the lemma (lexical-sematic) level of the bilingual's first language (L1) and their second language (L2) as well as the lexical feature level. Adopted from Kroll and De Groot (1997).

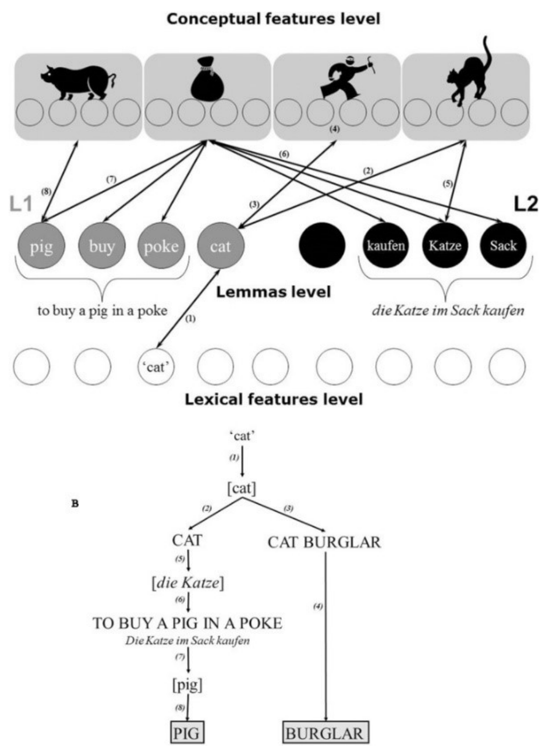
The distributed conceptual/lexical feature model presents multilingual cognitive structures as dynamic systems comprising of three levels of representation, including conceptual, lexical and lexical-semantic (lemmas) levels. The conceptual level consists of representations related to meaning, whereas the lexical level is comprised of information relating to word forms, which are both shared across the different languages familiar to the multilingual. Unlike the conceptual and lexical levels, the lemma level is language-specific and acts as a mediator between conceptual representations and lexical features, thus linking word forms to their meaning. During the language production process, once a word is initially retrieved, the lemma is subsequently selected, which provides access to information about the word. Although the lemma contains information about the meaning of words and the function of its syntax, it does not have any information regarding the word's form (Kroll & de Groot, 1997).

Building on Kroll and De Groot's (1997) model, Kharkhurin (2017) proposes that the spread activation mechanism functions as a system of communication between these three levels. This mechanism facilitates the dispersed feature representations at the respective levels whilst supporting both parallel processing and the communication between different features from each level. Communication between different language systems occurs at the lexical feature level and that the activation of shared word forms leads to the activation of the lemmas of both languages. The lemmas of each language directly link to the conceptual features level, which establishes shared conceptual representations between both languages. This link may result in the automatic activation of translation equivalents, a process for which Kharkhurin (2017) introduced the notion of language mediated concept activation (LMCA).

Despite translation equivalents sharing most conceptual features, it is important to note that these conceptual representations may not necessarily be identical (Kharkhurin, 2017). Disparities in conceptual representations of translation equivalents can result in the simultaneous activation of other concepts, which may broaden the spread of activation and, therefore, establish robust and elaborate connections between distant and unrelated concepts from different conceptual categories (see Figure 10). These concepts are activated through the lemmas representing the translation equivalents in multiple languages and via the word forms that these languages share. The structure of multilingual memory, thus, supports the spread of activation as it not only enables network information to become available for processing but also connects various discrete concepts to the initial source of activation, thereby possibly enhancing creative thinking capabilities. Therefore, the LMCA is a cognitive mechanism that may facilitate creative thinking due to translation equivalents automatically activating one another through shared conceptual representations (Kharkhurin, 2017).

Figure 10

A Diagram of Lemma Mediated Spreading Activation Underlying the LMCA.



Note. This figure illustrates both a portion of the structure of multilingual memory and the flow of information within bilingual memory (indicated using the labels 1-8). Adopted from Kharkhurin (2017).

Indirect evidence for Kharkhurin's (2017) LMCA model has been provided by cross-language studies that use either semantic (Kroll & Tokowicz, 2005) or translation (Altarriba & Basnight-Brown, 2007) priming paradigms. These studies (Altarriba & Basnight-Brown, 2007; Kroll & Tokowicz, 2005) demonstrate that the automatic spread of activation occurs not only between words that are semantically related, but also between different languages. More recently, Kharkhurin (2017) directly evaluated the feasibility of the LMCA model by comparing the performance of Russian-English bilingual to Russian monolinguals on the Abbreviated Torrance Tests for Adults (ATTA), which measured divergent thinking, and a translingual priming test (TLP). The TLP was created as a lexical decision priming test, whereby the prime was unrelated to the participant's dominant, first language (L1) but was related to the bilinguals' second additional language (L2) via their translation equivalents. The results revealed that the bilingual participants performed significantly better than their monolingual counterparts on the divergent thinking criterion of cognitive flexibility and this was explained to be a result of the TLP effect (Kharkhurin, 2017).

Adi-Japha and colleagues (2010) obtained similar findings in a study that compared the performance of monolingual children to English–Hebrew and Arabic–Hebrew multilingual children on cognitive flexibility assessments. In the cognitive flexibility test, participants drew an existent and non-existent version of the same object. The multilingual children made more inter-representational changes, involving associations between components from different categories, whereas the monolingual children made more intra-representational changes, which involved basic changes in positioning, dimension and same category alterations. The results suggest that the multilingual children had superior creative capabilities as they were better at generating stronger associations between concepts from unrelated categories. This suggests that due to the lemma and lexical level mediating the activation of concepts, more distant conceptual categories can be engaged during creative thinking (Kharkhurin, 2017), which enabled the multilingual children to make inter-representational manipulations more efficiently than their monolingual counterparts (Adi-Japha et al., 2010).

Together, the research results not only reveal the benefits of multilingualism for creativity but also suggest that the structure of multilingual memory account for these benefits (van Dijk et al., 2018). In particular, the unique architecture of multilingual memory may facilitate a greater and more dispersed spread of activation between conceptual representations, which, in turn, possibly supports creative thinking. However, an alternative explanation of the bilingual advantage points towards enhanced cognitive control functions as the mechanism underlying multilinguals' advantages in creative abilities (van Dijk et al., 2018). This idea is discussed further in the following sections.

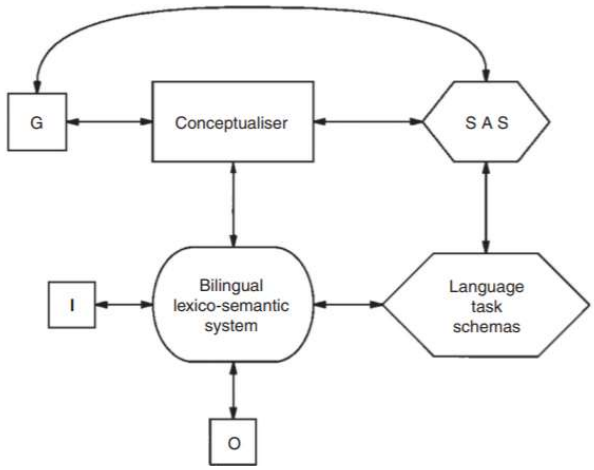
A compelling theory for the organisation of multilinguals' minds is that they comprise of independent languages systems that are accessed exclusively (Bialystok et al., 2012). However, current research has revealed that the language systems of multilinguals are, in fact, co-activated and that there is bidirectional interaction between these systems even if the multilingual is highly proficient. Additionally, research demonstrates that language processing is non-selective; that is, both language systems are accessed even in contexts where only one is present (Kroll & Bialystok, 2013). These findings suggest that there is a need for multilinguals to select the appropriate language system whilst inhibiting the non-target language depending on the context.

Although this linguistic selection may result in ordinary language processing becoming more effortful for multilinguals, which possibly explains the costs demonstrated in the studies previously discussed (Bialystok & Luk, 2011; Bialystok et al., 2010; Costa & Santesteban, 2004; Gollan et al., 2007; Gollan & Ferreira, 2009; Portocarrero et al., 2007), language errors and interference rarely seem to occur (Bialystok et al., 2012). This finding indicates that multilinguals are capable of selecting the target language with relative accuracy and, therefore, suggests that multilinguals develop cognitive control processes that allow them to negotiate cross-linguistic competition (Bialystok et al., 2012; Kroll & Bialystok, 2013). An influential model that explains how multilinguals manage control over the co-activation of languages is the Inhibitory Control (IC) Model (Green, 1998), which describes the language selection process that occurs when language storage and access is non-specific.

The IC Model (see Figure 11) maintains that multilingual language production comprises of task schemas, that is, mental devices or networks that develop or adapt to achieve a particular task (Szubko-Sitarek, 2014). The task schemas are implemented by the language-independent conceptualiser (C), which is responsible for generating representations based on information stored in long term memory, and accomplish either routine (L1 production) or non-routine (L2 production) goals (G). Language processing goals may result in the parallel activation of multiple task schemas (translation schemas or language production schemas) and, as a consequence, will compete to control the output (O; Pivneva et al., 2012; Szubko-Sitarek, 2014). To ensure adequate and appropriate levels of language performance, the SAS, as described by Shallice and Burgess (1996), implements cognitive control operations to modify existing schema, alter the activation of lexical representations, and inhibit output in order to meet particular task goals (Bartolotti & Marian, 2012). Accordingly, when engaging in a dialogue using their L2, a multilingual's conceptualiser transmits input (I) from the lexico-semantic system to the SAS, which, subsequently, implements inhibitory control processes to suppress the inappropriate yet dominant, or more routine, L1 language schema. Additionally, depending on the amount of cross-language interference experienced and the ability to recognise words in the target language, the SAS can adjust the degree of activation or inhibition of words within each language to ensure that appropriate words are selected and output (Pivneva et al., 2012).

Figure 11

Inhibitory Control (IC) Model.



Note. *G* represents language processing goals, *I* represents input, *O* represents output and SAS stands for supervisory attentional system. Adopted from D.W. Green, 1998, p. 69.

This co-activation and interaction between language systems is a possible mechanism for understanding the influence of multilingualism on both linguistic and non-linguistic processing (Bialystok et al., 2012). Specifically, the co-activation creates competition between language systems that does not exist for monolinguals. Multilinguals are, therefore, required to manage conflicting input to ensure appropriate levels of performance and to enable language processing to proceed fluently in the target language without the interference from the non-target language (Kroll & Bialystok, 2013). The mechanism responsible for continuously resolving this cross-linguistic competition (i.e., the SAS), is thought to be the same as that which is engaged in other cognitive domains (Bialystok et al., 2005). Due to the frequent use of multiple co-activated language systems, multilinguals presumably exercises and, therefore, develop a high level of skill associated with the control processes for other, non-linguistic cognitive functions (Bialystok et al., 2005; Kroll et al., 2012). This understanding, alongside converging evidence (Adesope et al., 2010; Blumenfeld & Marian, 2011; Singh & Mishra, 2012; Tse & Altarriba, 2012; Zied et al., 2004) has led to the conclusion that multilinguals are more adept at tasks that entail executive control (Bialystok et al., 2005). Hence, since creativity relies on executive control to inhibit salient ideas, retrieve and manipulate task-relevant information and enhance the flexibility of strategy use (Gilhooly et al., 2007), creative cognition may benefit from multilingual practices.

Kharkhurin (2011) considers this idea in a study that investigated the role of the cognitive mechanisms implicated in cognitive control in multilingual creative thinking performance. The performance of individuals with varying multilingual proficiency was compared on a battery of creativity and cognitive assessments. Specifically, participants were compared on the ATTA, which assessed divergent thinking, and the Invented Alien Creatures task (IAC), which the researcher used as a measure of structured imagination. Executive control was assessed using the Stroop test, and a standard Culture Fair Intelligence Test (CFIT) was administered to assess fluid intelligence. The results revealed a general advantage of highly proficient multilinguals on both the creative and cognitive assessments. Therefore, the results not only demonstrate that multilingualism facilitated the cognitive mechanisms investigated but that they also contributed to enhanced creative abilities (Kharkhurin, 2011).

However, a study conducted by Hommel et al. (2011c), which compared the performance of high-proficient Dutch-English multilinguals and low-proficient German-English multilinguals on creativity measures, yielded contradictory results. Unlike Kharkhurin (2011), Hommel and colleagues (2011c) found that low-proficient multilinguals outperformed high-proficient multilinguals on a divergent thinking assessment, namely the AUT. In contrast, the high-proficient multilinguals obtained higher scores on a measure of convergent thinking, namely the RAT, than low-proficient multilingual. As a possible explanation, the researchers maintain that the cognitive style that is seemingly obtained by learning several languages is well suited to the style implicated in convergent thinking rather than that implicate in divergent thinking (Hommel et al., 2011c). That is, multilinguals' enhanced cognitive control mechanisms resulting from the constant need to manage the joint activation of language systems presumably makes them better at convergent thinking as it is a process that relies on, and benefits from strong top-down bias (Colzato et al., 2012).

Moreover, the results demonstrating that lower proficient multilinguals outperformed the high proficient multilinguals on the measure of divergent thinking are possibly attributed to the formers' weaker control abilities (Hommel et al., 2011b). Weaker top-down control capabilities may enable low-proficient multilinguals to broaden the search space in order to activate various concepts that address loosely defined criteria (Colzato et al., 2012). Therefore, low-proficient multilinguals may experience enhanced divergent thinking capabilities as minimal top-down control enables them to easily and rapidly "jump" from one idea to the next in a weakly guided fashion (Hommel, 2012).

The results obtained by Hommel (2012) suggest that multilingualism may facilitate particular aspects of creativity differently. Specifically, divergent thinking may benefit from the architecture of multilingual memory, whereas convergent thinking possibly benefits from multilinguals' highly developed cognitive control mechanisms. As previously discussed, divergent thinking involves the activation and processing of multiple unrelated ideas simultaneously as well as the ability to access concepts from discrete categories. It is, thus, a process of spreading activation that simultaneously activates multiple conceptual representations stored in semantic memory. Due to the distributed nature of semantic networks, the spread of activation among distant conceptual representations may establish associations between more unrelated concepts, which provides a rich pool of ideas from which creative products may be extracted. Therefore, the acquisition and maintenance of multiple languages may enhance divergent thinking aspects of creativity due to the LMCA facilitating a greater spread of activation between mental representations, which enables multilinguals to process various unrelated concepts from discrete categories simultaneously (Kharkhurin, 2018).

In contrast, convergent thinking aspects of creativity entail finding the single best or correct solution to a given problem (Cropley, 2006). This cognitive function is engaged when a large pool of potential responses or ideas, generated via divergent thinking, must be narrowed down to a single creative solution. These possible candidate ideas must be further explored, evaluated and critiqued in order to obtain the best fit for the defined problem. It is, therefore, argued that efficient executive control mechanisms support creative thinking at the stage where conscious, attention-demanding processes facilitate the narrowing down of multiple potential ideas to a single creative solution (Kharkhurin, 2015). Hence, benefits in executive control experienced by multilinguals due to the regular engagement of top-down processing to manage interference and resolve competition between co-activated language systems may, in turn, enhance particular aspects of the creative process, namely convergent thinking (Hommel et al., 2011b; Zmigrod et al., 2015).

In summary, research supports the bilingual advantage in creativity, and that alterations in both the structure and function that occurs due to the use of multiple languages result in this advantage. Both divergent and convergent thinking aspects of creativity appear to be facilitated by multilingualism, whereby divergent thinking benefits from a specific architecture of multilingual memory whereas convergent thinking benefits from multilinguals' highly developed executive control mechanisms. The structure of multilingual memory may facilitate a broad spread of activation between more discrete conceptual representations, which enables multilinguals to process more contents and a vast number of concepts from discrete categories simultaneously, presumably stimulating divergent thinking (Kharkhurin, 2015). This is achieved through LMCA, which involves translation equivalents automatically activating each other through shared conceptual representations (Kharkhurin, 2017). In contrast, multilinguals continuous practise with two or more active language systems, which involves managing interference or conflict in lexical retrieval, facilitate their cognitive control mechanisms (Kharkhurin, 2015). The SAS, which is the mechanism responsible for resolving this cross-linguistic competition, is also engaged in other cognitive domains (Bialystok et al., 2005). By continuously managing the co-activation of multiple language systems, multilinguals presumably exercise and develop a high level of skill associated with the control processes for other conscious, attention-demanding processes, such as convergent thinking (Kharkhurin, 2015). Consequently, the researcher expected multilingualism to predict all components of creativity in the current research.

Nevertheless, while multilingualism potentially confers advantages across various cognitive domains, these benefits can also be altered by certain environmental factors. For example, various factors underlying SES, such as level of education, among others, may influence an individual's creative ability above and beyond the influence of multilingualism (Kharkhurin, 2016). This idea is explored further in the subsequent sections.

2.5.3. Socio-economic Status (SES) and Level of Education

This section discusses the potential influence of SES and level of education on the creative cognitive process of interest in the present study. These two variables are considered together as level of education is often conceptualised as comprising SES. This section first explains the significance of considering these contextual factors, especially in the South African context. Subsequently, research that assesses the influence of each demographic variable on various cognitive processes, including creative cognition, is discussed. This section concludes with a statement of the researcher expected SES and level of education to predict the cognitive functions of interest in the present study.

The cognitive frameworks of creativity described in the previous sections of the literature review, such as the Geneplore model, have often come under criticism for acontextual theorising, which refers to the tendency to conceptualised creativity purely in terms of cognitive processes. This approach to creativity research may be limited as the creative process does not occur in a vacuum and, therefore, cannot be fully comprehensible outside its particular context. Instead, various contextual factors come into play during creative cognition and possibly shape both its process and products (Glăveanu, 2014). Key among various contextual factors that are often associated with cognitive function, especially in the older population, is SES and level of education (Zhang et al., 2015).

Socio-economic status refers to a composite measure of an individual or group's access to economic and social resources as well as the opportunities, privileges and positioning that derive from these resources (Duncan & Magnuson, 2012). It is a multifaceted assessment that encompasses not only income but also level of education, occupation and financial resources as well as one's subjective perceptions of both social status and class (Winters-Miner et al., 2015). These factors have been investigated both independently and in relation to each other, with evidence suggesting that there is an aggregate or cumulative effect of SES on cognitive function. Additionally, SES is a lifespan phenomenon, whereby various SES indicators influence cognitive functions differently at specific stages of the life course. For example, early-life factors such as level of education and late-life factors such as income may affect the trajectory of cognitive functions through different pathways (Zhang et al., 2015). While SES comprises of multiple intimately intertwined factors, level of education has been one of the most extensively researched variables (Lee et al., 2010). Level of education is either operationally defined as the highest degree attained or the number of completed years of formal education (Opdebeeck et al., 2016; Strenze, 2007).

These contextual variables are crucial to take into consideration when conducting research in South Africa as the enduring legacy of apartheid has resulted in high levels of inequalities across several social spheres. There are vast disparities in SES due to unequal distribution of wealth and income, access to basic goods and services, as well as unemployment and poverty burdens. These disparities in SES have also resulted in a dualistic education system in South Africa, with the more affluent population receiving higher quality education compared to their poorer counterparts. The dualistic educational system has significant implications in terms of learning outcomes, cognitive skills and access to higher education, among others (Moses et al., 2017). It is, therefore, essential to consider these SES and education disparities when investigating the processes implicated in creativity as they may have a bidirectional influence on cognition in general (Peng & Kievit, 2020).

Research has demonstrated the effects of SES and level of education across various cognitive functions. For example, level of education positively predicts performance on measures of both fluid (Kaufman et al., 2009) and crystallised intelligence (Cliffordson & Gustafsson, 2008; Kaufman et al., 2009). Educational attainment is also associated with higher performance in adolescence on measures of cognitive control, as measured via the Stroop task (Noble et al., 2013) as well as in tests of both working memory and cognitive reasoning, but not processing speed, in the elderly (Guerra-Carrillo et al., 2017). Together, these results suggest that level of education has differential moderating effects on different cognitive abilities.

In addition to having significant associations with performance on cognitive tests, level of education has been a consistent and reliable predictor of various outcomes throughout the lifespan, including mental health and cognitive function among the elderly (Smith & Ryan, 2016). For example, level of education influences brain structure as well as cognitive level, especially the slowing of age-related cognitive decline (Kramer et al., 2004). Moreover, epidemiologic research has demonstrated that individuals with a higher level of education have a great degree of cognitive reserve as well as a reduced risk of Alzheimer's disease and dementia (Hall et al., 2009; Stern, 2012b).

A candidate mechanism for these educational effects is cognitive stimulation and enrichment. Education provides exposure to information, knowledge and general experiences, which may contribute to increased learning and cognitive flexibility, as well as provide a better context for both problem-solving and reasoning (Hackman et al., 2010). These experiences could translate into improved cognitive functioning and, therefore, add to cognitive reserves, which enables elderly individuals with higher educational attainment to develop compensatory cognitive strategies and adapt more efficiently to the cognitive loses that accompany the normal ageing process (Pickholtz & Malamut, 2008). Thus, educational attainment presumably forms the basis for the continuation of intellectual stimulation throughout the life course, which possibly results in improved cognitive functioning in late adulthood (Wilson et al., 2009).

This preservative effect of high educational achievement has also been demonstrated in the field of creative cognition. Specifically, when investigating factors associated with creativity in the elderly, Zhang and Niu (2013) found age-related impairment in creative performance but also demonstrated that level of education accounted for a significant portion of the variance in individual differences in overall creativity. That is, older participants with a higher level of education were less likely to have reduced creative ability (Zhang & Niu, 2013). However, certain aspects of the creative process may benefit more from level of education as educational attainment may affect higher-order cognitive functions to a greater degree than lower-level functions (Guerra-Carrillo et al., 2017), which supports research findings (Ritchie et al., 2015).

These findings suggest that convergent thinking aspects of creativity are likely to benefit more from higher levels of education compared to divergent thinking aspects as the former rely more on higher-order functions (Colzato et al., 2013).

Although strong positive correlations often occur between level of education and various cognitive abilities, the meaning of this association is controversial. For example, there seems to be a reciprocal or interactive effect between education and the level of cognitive functioning. That is, while more education is likely to enhance cognitive abilities by providing a stimulating environment, it is also possible that, due to the selectively in admission and promotion policies, access to higher levels of education require higher cognitive abilities. Moreover, many of the influences of education on cognitive function may be indirect, operate through and thus confounded by other factors related to SES (Salthouse, 2010).

Turning to SES, a growing body of research using an assortment of cognitive measures has demonstrated significant associations between factors comprising SES and specific cognitive functions (Duncan & Magnuson, 2012). For example, childhood SES had significant effects on language processing and more moderate effects on executive function, particularly working memory and cognitive control (Farah et al., 2006; Kishiyama et al., 2009; Noble et al., 2007). Studies with an adult population demonstrated similar SES related disparities in performance on cognitive flexibility and verbal fluency as well as memory storage, retention and retrieval (Turrell et al., 2002). Similarly, in an elderly population, multiple socio-economic related risks have been associated with cognitive impairments, with a combined vulnerability in wealth, household income, level of education and occupation predicting poorer cognitive functioning in both males and females (Lee et al., 2010).

In the context of creativity, the social and contextual underpinnings of creative potential have been overlooked in the literature. This lack of research attention is due, in part, to the fact that studies typically conceptualise and assess creative cognition in terms of individual differences. Most current studies focus on cognitive or personality factors in relation to creative performance, whereas research that considers SES-related factors are either sparse or outdated. In order to address this gap, Dai et al. (2012) compared the creative abilities of students from schools within different districts, including a suburban, middle to upper-class community and an urban community that included many impoverished families. Additional SES and contextual factors considered were perceived parental and teacher support as well as parental educational attainment, academic achievement and neighbourhood type (Dai et al., 2012).

Type of school (which was an indicator of participants' residing communities), as well as parental levels of education were the two main predictors of performance on a measure of divergent thinking. In particular, there was a distinct difference that favoured high-SES schools, which demonstrates how various contextual factors such as school, home and community environments may influence the development of fluency, flexibility and originality components of creative potential (Dai et al., 2012). These results concur with those that demonstrated that higher levels of SES correspond with an increase in creative ability (Castillo-Vergara et al., 2018).

Similar findings were obtained in a study that investigated the interplay of individual factors, including knowledge, intelligence, thinking styles, personality and motivation, and context-related variables, such as family and school, of the creative performance of students (Niu, 2007). Once the researchers controlled for the influence of intelligence, the context-related variables predicted as much variance as the combined individual factors in creativity, which suggests that the contextual factors play a significant role in predicting creative performance (Niu, 2007). Therefore, these variables are likely to be relational rather than residing exclusively in the individual or context. That is, individual characteristics of abilities that are beneficial to the creative process are likely to be either interconnected, enhanced by certain contextual structures, or negatively affected by a lack of particular resources, such as education and cognitively enriching environments (Dai et al., 2012). Thus, both individual and SES factors potentially have a joint contribution to the creative process (Niu, 2007).

Therefore, based on prior research, the researcher expects there to be significant group differences in all the cognitive processes across both SES and education groups, respectively. In particular, since educational attainment presumably affects higher-order cognitive functions (Ritchie et al., 2015), the higher education group is expected to outperform the lower group on measures executive functions and creativity tests that rely more on these higher-order functions (i.e., convergent thinking). In terms of SES, research suggests that aspects of creativity that rely on a high and low degree of executive function are affected by SES (Castillo-Vergara et al., 2018; Dai et al., 2012). Therefore, the researcher expected differences in all functions included in the theoretical model across SES groups.

2.5.4. Gender

The last demographic variable considered in the literature review is gender. This section begins with a discussion of the inconsistencies prevalent in creativity research regarding the effect of gender. It first describes two possible accounts of gender-based differences, namely biological and socio-cultural. Subsequently, this section considers a third account which attributes variations in the creative abilities of males and females to the different strategies employed by each gender when undertaking cognitive tasks (Abraham, 2016). Finally, this section concludes with the explanation of whether the researcher expects to find differences in test performance between males and females in this study.

The role of gender in creative cognition has been investigated to determine not only whether there are significant differences between males and females in terms of creative ability or creative output, but also to identify the factors that possibly contribute to the likely differences (Abraham, 2016). Nevertheless, empirical research on creative cognition among diverse populations is inconclusive with regards to the influence of gender (Abraham, 2016; Baer & Kaufman, 2008; Pagnani, 2011; Runco et al., 2010). For example, certain studies have demonstrated that females outperform males on various creativity tasks (Anwar et al., 2012; Hong et al., 2013; Kousoulas & Mega, 2009). However, other studies have reported the opposite, whereby males score higher than female participants on measures of creative thinking (Furnham et al., 2009; He et al., 2013; Stoltzfus et al., 2011). In contrast, prior research has also found no gender-based differences in creative performance (Charyton, 2005; Cheung et al., 2004; Harris, 2004; Kaufman & Baer, 2004)

Possible accounts to explain the supposed differences between males and females in creative, as well as non-creative, output typically fall into either biological or socio-cultural categories. The most frequently discussed biological variations thought to underlie gender-differences in cognition include genetic and hormonal differences, as well as variations in brain structure and organisation. Although these biological accounts provide compelling grounds from which to explain how cognitive and behavioural differences emerge, it is still unclear how biological distinctions result in biases in terms of information processing that affect both creative and non-creative cognition (Abraham, 2016). As a consequence, socio-cultural accounts are more widely used when explaining the differences between males and female in behavioural performance, especially in terms of creative cognition (Baer & Kaufman, 2008; Pagnani, 2011). Briefly, socio-cultural perspectives discuss gender-based differences in creative achievement in terms of societal constraints, cultural factors, such as gender rules, roles and assumptions, as well as differences in socialisation, including gender labelling, differences in expectations and differences in schooling, among other significant resources that are a function of gender (Abraham, 2016).

However, a recent study supports an alternative explanation for the gender differences in creative performance. In particular, gender differences in both cognition and behaviour may not necessarily be directly reflected in behavioural outcomes, but rather observed in the differences in strategies employed during cognitive tasks. Although minimal research that investigated these gender-specific differences in cognitive strategies in the context of creativity, they have been widely demonstrated in other cognitive and behavioural domains (Abraham, 2016). A functional neuroimaging study by Abraham (2014) revealed that while male and female participants performed comparably on measures of creativity and divergent thinking, differences in brain activity suggested that they may use different cognitive strategies when performing these tasks. These are noteworthy findings since individuals appear to engage in a range of strategies during creative performance, yet only particular cognitive strategies produce highly novel ideas (Gilhooly et al., 2007).

Research findings are inconsistent and, consequently, there is a lack of explicit support for gender differences in creative cognition. However, to the extent that a case can be made for gender differences, the majority of available literature suggests that females tend to score higher on assessments of creative cognition compared to males. Nevertheless, this case for a female advantage is inconclusive as there is research which provides opposing evidence and which reports no significant gender differences (Baer & Kaufman, 2008). Investigating gender differences in creativity is a controversial line of research, the overview of the available literature suggests that males and females do not differ significantly in terms of general or specific functions or abilities but rather in terms of cognitive strategies or styles as well as functional tasks that each may be predisposed to employ. However, this requires further research, especially in the field of gender difference in creative cognition (Abraham, 2016). Due to the inconsistencies prevalent in existing research, the researcher expected no gender-based differences in creative ability in this study.

2.6. Summary

This chapter provided a systematic examination and analysis of the existing literature relating to the field of creative cognition. The literature review comprised of two main sections, each which analysed, examined and synthesised research findings and theories relevant to the two main aims of the study. As previously mentioned, the first aim of the study was to develop a coherent theoretical model of creativity. Therefore, the first section of the literature review defined creativity, discussed prevalent theories that attempt to explain the origin of the construct as well as identified cognitive functions that underlie the creative process. The second main section of the literature view provided an overview of existing knowledge, theories and research findings regarding the possible influence of the demographic variables, namely age, multilingualism, SES, level of education and gender, on various cognitive functions potentially implicated in the creative process.

In summary, creativity is a multifaceted construct that is difficult to define and test, and is therefore under-researched and insufficiently understood (Kara, 2015). Although traditional conceptualisations consider creativity as a product of divine inspiration, recent theoretical frameworks based on the cognitive sciences conceptualise creativity as a process of creative cognition (Glăveanu, 2010). In the context of the creative cognition approach, creativity a process that leads to the generation of ideas that are both novel and useful (Runco & Jaeger, 2012). Several cognitive theories of creativity attempt to describe this construct (Beaty et al., 2014b), each emphasises the role of mental processes and structures underlying creative thinking (Kozbelt et al., 2010).

A prominent theoretical account of creativity is the associative theory (Mednick, 1962), which regards underlying structures of semantic memory, or associative hierarchies as the root of creative thinking. In particular, Mednick (1962) argued that creativity is a function of an individual's associative hierarchies, whereby individuals with steep gradients make common, stereotyped associations and individuals with flat hierarchies generate discrete associative links (Benedek & Neubauer, 2013). Creativity in the context of the associative theory is contingent on the spread of activation through semantic networks and is directly related to differences in the structure of semantic memory (Benedek et al., 2017). However, a common criticism of this theoretical framework is that it oversimplifies creativity by conceptualising it exclusively as a bottom-up, automatic process, suggesting that it operates independently of executive control (Colzato et al., 2013).

The executive control theory is, therefore, proposed as an alternative to the associative approach. This account of creativity emphasises the role of top-down, executive control during the creative process. Executive control may benefit creativity both motivationally, by enhancing persistence, and mechanistically, by improving the efficiency of memory retrieval, strategy implementation and the manipulation of information (Benedek et al., 2017). This account maintains that it is the cognitive processes operating on memory that facilitate creativity rather than the structure of memory itself. Nevertheless, both the associative and executive control theories agree on the notion that semantic network structures form the basis of creativity upon which higher-order cognitive functions operate. Creative cognition thus appears to rely on the interaction between both associative structures and executive control processes, which form the basis of the dual-process theory of creative cognition (Kenett, 2018a).

A well-known dual-process theory of creativity is Finke and colleagues' (1992) Geneplore model, which maintains that creativity entails the cycling between two phases, namely the generation and exploration phases. These two phases are comparable to the two processes identified as underlying creative cognition, namely divergent and convergent thinking (Sternberg & Kaufman, 2011). Divergent thinking refers to the process of generating multiple creative ideas from a single starting point (Colzato et al., 2013), whereas convergent thinking involves the ability to extract a single, correct solution for close-ended tasks (Cropley, 2006). The generative role of divergent thinking is required to formulate novel output, and the analytic, evaluative role of convergent thinking is required to select or refine initial output into a useful form (Sowden et al., 2015).

However, the literature criticises the Geneplore model for conceptualising the two phases of creative thinking as being mutually exclusive (Runco, 2016). Therefore, the dual-pathway model was introduced as an alternative dual-process theory (Nijstad et al., 2010). This model argues that creativity arises from two different processes, namely the flexibility pathway and the persistence pathway (Nijstad et al., 2010). Unlike the Geneplore model, the dual-pathway framework suggests that the generation and evaluation stages of the creative process are integrated and operate in unison (Sowden et al., 2015). Therefore, the two processes implicated in creative cognition, including divergent and convergent thinking, possibly operate across a continuum (Eysenck, 2003; Runco, 2016). Moreover, these two processes relate in terms of underlying associative processes (Lee & Therriault, 2013). While divergent and convergent thinking presumably both rely on associative thinking, they are argued to differ in terms of the degree to which they each require executive functions (Colzato et al., 2013).

Various executive functions have been identified as potential contributors to creativity, each of play a unique role during the creative process (Krumm et al., 2018). Task switching represents a form of cognitive flexibility that presumably benefits both aspects of creativity (i.e., divergent and convergent thinking) by facilitating effective memory retrieval and by enabling individuals to shift to alternative creative strategies that may prove to be more fruitful (Benedek & Jauk, 2019). Inhibition accompanies the processes of task switching (Jost et al., 2017), which may facilitate convergent rather than divergent thinking by suppressing task-irrelevant information as well as withholding dominant or inappropriate ideas, thus, reducing cognitive conflict (Benedek & Jauk, 2019). Additionally, fluid intelligence may facilitate the implementation of these executive functions over the mental resources required during divergent and convergent (Benedek et al., 2014b). However, creative performance is optimised not merely by engaging a high degree of executive control, but rather by relying on an appropriate match between the extent of control applied and the degree to which tasks require lower levels of information to be filtered (Chrysikou et al., 2014). This idea suggests a sensitive balance between the engagement and disengagement of these executive functions during creative thinking (Chrysikou, 2019).

The sections of the literature that discuss existing knowledge relating to the cognitive processes implicated in creative cognition constitute the first stage of the statistical analysis technique employed in this study, namely SEM. The review of the literature enabled a hypothesised theoretical model to be developed and specified. In particular, it helped to identify the variables underlying creativity (i.e., divergent thinking, convergent thinking, associative thinking, task-switching, inhibition and fluid intelligence) and enabled the relationships between these processes to be mapped out (Crockett, 2012). Thereafter, information regarding whether different demographic variables predict the individual cognitive functions included in the theoretical model of creative cognition, was considered in the subsequent sections of the literature review.

Despite the potential to be creative existing within each individual (Glăveanu, 2010), there is still considerable variability among individuals in terms of the type and amount of creative output generated, which is attributed to various factors (Abraham, 2016). For example, age-related cognitive changes in executive functions may have both costs and benefits for the creative abilities of elderly individuals (Chrysikou, 2018). In addition, the multilingual experience may confer cognitive advantages in creativity due to LMCA (Kharkhurin, 2017) and may enhance executive abilities experienced by multilinguals (Bialystok et al., 2005). Moreover, contextual factors, such as SES and level of education, potentially come into play during creative cognition and possibly shape both its process and products by providing cognitively stimulating environments (Glăveanu, 2014). Lastly, gender difference in creative abilities may occur due to differences in cognitive strategies or styles as well as functional tasks employed by each gender (Abraham, 2016).

The subsequent chapter sets out the research methods employed in the current research. In particular, it describes the exact steps undertaken in this study to address the two major research aims.

Chapter 3: Research Methods

3.1. Introduction

This chapter provides an outline of the research methods and processes used in the present study. It first informs the reader of the rationale of the current research, which justifies the significance and novelty of the study. Two main aims informed the rationale. The first aim was to develop a coherent theoretical model of creativity. The second aim was to investigate whether certain demographic variables, namely age, multilingualism, SES, level of education and gender, predict the individual processes included in the theoretical model. The rationale discusses four areas in which this study contributes, including its theoretical, methodological, applied, and social significance.

Next, this chapter establishes the research questions, which formulate the problem that this study intended to investigate. This study addressed two main research questions, each of which were informed by the two aims of the study, respectively. The first research question investigated whether the reproduced covariance matrix (S) was equal to the theoretical matrix (Σ), that is, to assess whether the data supported the theoretical model. The second research question investigated whether there were any statistically significant differences between various demographic variables, namely age, multilingualism, SES, level of education and gender, on the individual cognitive functions included in the model. The hypotheses were then developed based on the research questions mentioned above. Hence, the discussion comprises of two sections. The first section presents the null and alternative hypothesis of the overall SEM model, as well as the hypothesised theoretical model, which presents eight hypothesised relationships. The second section presents the statistical hypotheses assessed for each of the demographic variables, including age, multilingualism, SES, level of education and gender.

The research design chosen for this study and the reason for this choice is then discussed. Broadly, the research design adopted for the present study was quantitative. A brief description of quantitative research is provided, which includes the goals and characteristics of this research design. This section also includes a description of two approaches to conducting quantitative research, namely experimental and non-experimental. A non-experimental approach was selected based on the specific characteristics of the study. These characteristics included a lack of manipulation of the variables and an absence of both comparison groups and random assignment. Lastly, this study used an explanatory correlational research design and was cross-sectional. This section concludes with a brief description of the strengths and weaknesses of the chosen research design.

Next, the sample and sampling strategy are described. A total of 125 participants aged 65 years and above, who were capable of independent living and functionally fluent in English, were recruited through a combination of non-probability sampling strategies. Convenience sampling involved placing advertisements in communal areas and approaching organisations where the relevant population were known to reside. The current study used snowball sampling as an additional strategy to recruit participants via chain-referral. The sample was categorised according to specific demographic characteristics, including age, gender, home language, number of self-reported known languages, SES group and level of education. Lastly, this section outlines the exclusion criteria of the study, which included the presence of any conditions that could affect the participants' performance on the cognitive tests. The researcher used the Lawton Instrumental Activities of Daily Living (IADL) and the Montreal Cognitive Assessment (MoCA) to assess the participants' ability to undertake the cognitive tests.

The methods chapter then describes the instruments used to collect the data. As described in the literature review, the constructs investigated in the present study included aspects of creativity, namely divergent convergent and associative thinking, and components of executive function, such as task-switching, inhibition and fluid intelligence. Next, each instrument is discussed in detail. This includes a description of each test, the functions they assessed, the instrument's reliability and validity, as well as the application of the instrument in the South African context. Finally, the administration and scoring procedures are provided.

The last section of this chapter describes the research procedure used in this study. This section first describes two processes undertaken before the data collection stage began. The first stage involved the researcher receiving training from Dr Ferreira-Correia (research supervisor/registered clinical psychologist) on how to administer the cognitive tests correctly. The training ensured that the researcher administered all instruments competently, accurately, and ethically. The second stage involved a pilot study, which the researcher conducted to investigate the feasibility of the methods and instruments intended for the ensuing large-scale study. Chapter 4 describes the pilot study in greater detail. Next, this section describes the data collection process, which involved the gleaning stage and the data cleaning stage. The gleaning stage entailed disclosing all research information to the participants and obtaining their consent to participate. The next phase of the data gleaning stage involved obtaining information about the participants' demographics, language proficiency as well as administration of the IADL, MoCA and the battery of cognitive tests. This section also provides a brief description of the research environment and the duration of the testing procedure. The second phase of the data collection process involved the organisation and refinement of the raw data. This section discusses methods of data coding and procedures used to clean the data, which included possible-code and contingency cleaning. Finally, the statistical analyses techniques used to address the two main research aims of the current study, namely SEM and group-difference analysis, are discussed in this section. In particular, an overview of SEM is first provided, which is followed by a rationale for the use of this technique in the current study. Additionally, a description of the statistical assumptions associated with SEM, as well as the steps undertaken during the SEM analysis, namely model identification, model estimation, model testing and model modification is provided. In terms of the group-analysis technique, the statistical assumptions are first discussed, followed by a brief rationale of selecting the two group-difference analysis techniques, namely Welch's *t*-test and Welch's analysis of variance (ANOVA). Lastly, a description of the post hoc test used to explore the differences between multiple group means, namely the Games-Howell post hoc test, as well as the method of assessing the size of a found effect, namely Cohen's *d*, is provided.

The last section of this chapter discusses ethical considerations, which centre around the principles of autonomy and beneficence. The researcher informed participants that their participation was entirely voluntary and that they could withdraw at any point without fear of any negative consequences. In doing so, this study adhered to the principle of autonomy. Additionally, the participants were informed about study's protocol and notified about aspects of the research that may have influenced their willingness to participate, such as any anticipated risks of distress involved in the study (Michie, 2008). Finally, this study adhered to the principle of autonomy by making it mandatory for participants to sign an informed consent sheet after they read the information sheet. The researcher also took measures to ensure that the study adhered to the principle of beneficence. This included ensuring that any information gathered from the participants remained confidential. Confidentiality was achieved by replacing all personal information from the participants with identification numbers and storing the file linking their identity to their identification number on a password-protected computer. The researcher stored test protocols in a locked filing cabinet, which remain private with access restricted to the individuals involved in the research. Finally, the Human Research Ethics committee (medical) of the University of

Witwatersrand reviewed and accepted the research proposal of the current research, enabling the study to proceed.

3.2. Rationale

The purpose of the following section is to justify undertaking the current research topic. The underlying basis for the research is discussed, including a description of the areas in which the study potentially makes significant contributions. This section discusses four areas of significance in terms of the current research, namely theoretical, methodological, applied, and social.

In terms of theoretical significance, the findings from the current research may contribute additional information and knowledge to the theoretical framework in which the study is rooted, namely the field of creative cognition. Creativity research has been described as fragmentary, with researchers from diverse sub-disciplines in psychology, such as cognitive, social, and organisational sub-fields, having little convergence regarding how they approach the study of creativity. While a review of the existing creative cognition literature revealed that research has contributed important knowledge regarding the creative process, there are also notable inconsistencies between research findings (Bowden et al., 2005; Kaufman & Sternberg, 2010).

Contradictory findings in creative cognitive research are particularly prevalent across studies that investigate the role that higher-order, executive functions play in the creative process. These studies either suggest that executive function facilitate creativity or provide evidence that they interfere with the creative process (Barr, 2018). As a consequence, existing research advocates for either associative or executive control theories of creativity and, thus, primarily focuses on the role of one of these processes or the other (Beaty et al., 2014b). However, current behavioural and neuroimaging research provides evidence in support of both associative and executive processes during creative thinking (Beaty et al., 2015; Beaty & Silvia, 2012; Beaty et al., 2014b; Benedek et al., 2017; Green et al., 2015; Lee & Therriault, 2013; Mayseless et al., 2015; Nijstad et al., 2010).

The current research addressed the issue mentioned above by considering and evaluating the relative contribution of associative and executive processes. Notably, evidence demonstrating the role of either executive or associative processes are not necessarily contradictory but, instead, reveals the complementary role between both abilities in the creative process. By investigating the interaction of autonomous, associative abilities and controlled, executive processes, the current study may assist in unifying cognitive approaches, bridging gaps in creativity theory and, in doing so, providing a nuanced and dynamic conceptualisation of creativity (Barr, 2018).

Therefore, by examining the joint role of associative and executive control aspects of creativity, as well as considering how each may direct the other and benefit from a reciprocal and synergetic relationship, this research is likely to have meaningful implications for and contribute to theoretical frameworks of creative cognition. These are notable contributions as creativity is a construct that is under-researched, insufficiently understood and, as a result, lacks an integrated theoretical framework that sufficiently describes the creative process (Kara, 2015). In order to develop a possible theoretical model of creative cognition, the current study applied alternative research methods that, in of themselves, may have significant implications, the following sections discuss.

The methodological approaches undertaken in the current study make notable contributions to the creative cognition literature. This study has methodological significance as it uses innovative statistical analysis techniques, revised approaches to operationalising creativity, as well as the inclusion of a sample that is often overlooked in creativity research. Firstly, while research has already identified key components implicated in the creative process, there are areas of creativity research that warrant attention. Creativity research tends to exclusively investigate the role individual factors play in the creative process (Fryer, 2012). Therefore, there is a need for additional research that focuses on the combined effect of multiple variables on the core components of creativity. The present research addresses this need by using a multivariate statistical technique, namely SEM, to determine and make sense of the complex relationships between multiple cognitive functions implicated in the creative process. Furthermore, by using SEM to determine the relationship between executive functions and associative processes, as well as to investigate effects that these variables have on the final creative outcome, this study addresses the recognised need for a broader framework in which the relative contributions of each process are acknowledged (Barr, 2018).

The second main methodological contribution made by the current study is that of a revised operationalisation of creativity. A review of the literature revealed that research tends to use measures of divergent thinking as primary psychometric indicators of general creativity. In doing so, the literature either implicitly or explicitly conceptualised divergent thinking as being synonymous with creativity and, thus, indicative of creative potential (Benedek et al., 2013; Simonton, 2015). This approach implies that creative thinking relies exclusively on automatic, associative processes and that it occurs incidentally and unconsciously (Colzato et al., 2013). The sole reliance on divergent thinking measures to evaluate and draw conclusions regarding general creative potential is problematic since there is little evidence to suggest that creativity is a psychometrically unitary construct (Arden et al., 2010). Moreover, the dominance of divergent thinking measures in creativity research is surprising, since several theoretical premises maintain that creativity comprises of an array of cognitive processes, including both divergent and convergent thinking (Lee & Therriault, 2013).

In order to acknowledge the joint role of associative and analytic aspects of creative thinking, this study operationalised creativity in terms of divergent and convergent thinking, which are both included in the theoretical model. In doing so, this study moves beyond the overreliance on divergent thinking tests as measures of creative production and as proxy for overall creativity. Instead, it provides a nuanced comprehension of creative cognition as well as progress towards a comprehensive evaluation of the manner in which specific creative processes are executed (Lee & Therriault, 2013).

A final methodological contribution made by the current study is the choice of the research sample, namely older adults. Negative stereotypes that portray elderly individuals as vulnerable and incapable of undertaking certain tasks may lead to various forms of social exclusion. This exclusion may occur in different domains such as the accessibility to particular services and resources, social relations, involvement in community or civic activities, as well as participation in empirical research (Mannheim et al., 2019). Such exclusion in empirical studies is particularly prevalent in creativity research as it predominantly focuses on samples of either children or young adults that are most likely from university, thus limiting the generalisability of creativity research findings (Bialystok et al., 2004). The exclusion of individuals on age grounds without scientific justification presents certain ethical issues, especially in terms of the obligation to equitably distribute the advantages of research. Hence, in doing so, researchers may prevent this sector of the population from reaping the benefits of research (İlgili et al., 2014). Therefore, by focusing on the creative abilities of older adults, this research can extend generalisability of creativity research results as well as contribute new knowledge and information regarding the creative process of an underrepresented research sample (Herrera et al., 2010). The information gained about the creative abilities of the elderly may have applied and social significance, which the next sections discuss.

Regarding applied significance, the decision to focus on the creative abilities of the elderly may prove beneficial in elucidating or potentially addressing practical matters such as those concerning the promotion of cognitive reserve and active ageing. As previously mentioned, cognitive reserve refers to an active capacity to retain cognitive function in older age, following illness or injury-related decline (Richards et al., 2013). It is thought to act as a resistance or safeguard against the functional consequences of cognitive decline through compensatory mechanisms or via flexible and adaptive networks (Stern, 2012a). The current research makes applied contributions, in terms of cognitive reserve and creativity, in two distinct ways: First, findings from this study could provide information regarding the effects of age on the processes underlying creativity and whether age affects the creative abilities of the elderly. Second, this study could indicate how creativity could potentially preserve other cognitive abilities. Due to the underrepresentation of the elderly in creativity research, there is a lack of knowledge about either topic (Herrera et al., 2010).

Although certain cognitive functions remain more or less intact across the lifespan, including crystallised abilities such as verbal knowledge and language (Harada et al., 2013; Salthouse, 2012), other cognitive abilities, such as fluid intelligence (Salthouse, 2012), which includes attending to stimuli, inhibition and task-switching (Harada et al., 2013) decline with age. Hence, the cognitive functions identified in the literature review as underlying creative cognition are typically associated with age-related cognitive decline, suggesting a potential knock-on effect in aspects of creative thinking. However, the extent to which creative cognition is affected by ageing is unclear (Palmiero et al., 2014). Therefore, with regard to cognitive reserve and creativity, this study may provide information to clarify how age affects the creative process. Specifically, by investigating the combined effect of multiple variables on different aspects of creativity, the current study could pinpoint which area or stage of the creative process is affected by age and whether this has consequences for the creative abilities of the elderly. These findings may have significant applied implications in identifying cognitive activities that can strengthen any affected functions and, consequently, assisting with the retention of creative (and possibly broader cognitive) abilities in later adulthood.

In terms of the topic of cognitive reserve and creativity, the act of engaging in creative endeavours may act as a capacity that preserves cognitive abilities in late adulthood. This is based on the observation that many of the proxies used to evaluate cognitive reserve share the characteristic of enabling the elderly to use alternative or different thinking strategies, which presumably help this population to cope better with a decline in cognitive abilities. The skills needed to use these alternative strategies resemble those used to define and characterise the creative process. Specifically, the process of accessing and applying different strategies relies on the ability to keep an open mind, generate novel and alternative relationships, and the ability to change perspective (Colombo et al., 2018). Creativity is, therefore, identified as indicative of optimal cognitive functioning, psychological well-being and adjustment (Simonton, 2000).

Support for this idea is provided by Colombo et al. (2018), who investigated the relationship between cognitive reserve and creativity. The researchers measured cognitive reserve using three subtests from the Wechsler Adult Intelligence Scale (WAIS-IV), including the Vocabulary, Similarities, and Digit Span subtests, and a test that involved participants reporting the frequency with which they participated in activities that they believed would increase cognitive reserve, as well as their years of completed education. The two indicators of creativity included the AUT and an acronym generation task, which involved participants providing as many terms that fit into three common acronyms (SOS, OMG, TGIF) as possible in a given time. These indicators were used together with the main occupation (past and present) of the participants, which the researcher coded as being either creative (e.g., musician, college professor, art gallery manager) or non-creative (e.g., bank teller, post office employer, lab technician). Jobs were considered as creative if they involved non-routine activities, entailed constant flexibility of thought, the generation of novel thoughts and ideas, and changes in perspective. After controlling for age-related differences, WAIS-IV scores positively and significantly correlated with performance on the measures of creativity. Additionally, when considering the type of activities and the frequency that individuals performed them as well as when comparing individuals who had creative jobs to individuals with routine jobs, a clear relationship emerged between creativity and cognitive reserve (Colombo et al., 2018).

Based on this finding, the current research may have additional applied significance by demonstrating the potential preservative effect of creativity in the elderly. This finding could assist with identifying and developing maintenance or preventative strategies involving creative tasks. These strategies may assist older adults in adapting to cognitive changes and difficulties that occur with age (Flood & Phillips, 2007). In doing so, the present study may also have significant social implications.

There is an increased awareness that health involves more than merely the absence of disease (Clift, 2012). This idea is reflected in the World Health Organisation (WHO) European review on health inequalities and the health divide which acknowledged that, while the determinants of health overlap with the determinants of well-being, they are not identical (Marmot et al., 2012). Additionally, there is a need to identify both personal and social factors that promote not only health but also well-being (Marmot et al., 2012). Creativity is a factor that plays a significant role in enhancing lifelong well-being and quality of life, even in disadvantaged environments. Consequently, there is interest in the role that creativity plays in health care, community-based health, as well as health promotion initiatives. This increased the demand for research that addresses these topics (Clift, 2012). Findings from creativity research, such as the present study, open possibilities for future research regarding the therapeutic effects that creative performance can have for the elderly, and may contribute to the development of wellness programs and activities for use in the healthcare context (Flood & Phillips, 2007).

In summary, the present research may make significant contributions to four areas, namely theoretical, methodological, applied and social. The main theoretical implication of the present study is the development of a coherent theoretical model of creative thinking. The use of multivariate statistical analysis, a revised operationalisation of creativity and the inclusion of a sample that is often overlooked in creativity research constitute the methodological significance of the study. Regarding applied significance, the contributions relate to cognitive reserve and creativity, namely, the potential effects of age on the processes underlying creativity and how creativity could contribute to cognitive reserve. Lastly, the social significance of the present research pertains to the manner in which creativity research can prompt future research into the therapeutic effects of creativity, as well as potentially develop health and well-being promoting initiatives.

Once the significance of the study was established, and familiarity with creative cognition achieved by reviewing the existing literature, the next stage of the research methodology was to define and develop appropriate research questions and hypotheses, which the subsequent sections present.

3.3. Research Questions

The present study addressed two main research questions. Firstly, by studying the roles of fluid intelligence, task-switching and inhibition in three cognitive functions underlying the creative process, namely divergent, convergent and associative thinking, the investigation focused on whether or not the empirical data supported the theoretical model of creative cognition. The current study first investigated the following research question: Is the reproduced covariance (S) matrix equal to the theoretical (Σ) matrix? Secondly, in the study of whether particular demographic variables predict the individual cognitive functions included on the model of creative cognition, the following research question was subsequently investigated: Are there significant differences in the relative contributions of demographic variables to the contributions made by executive functions and creativity? These research questions were operationalised as the following hypotheses.

3.4. Hypotheses

3.4.1. The Relationships Among Fluid Intelligence, Task-Switching, Inhibition, Associative Thinking, Divergent Thinking and Convergent Thinking.

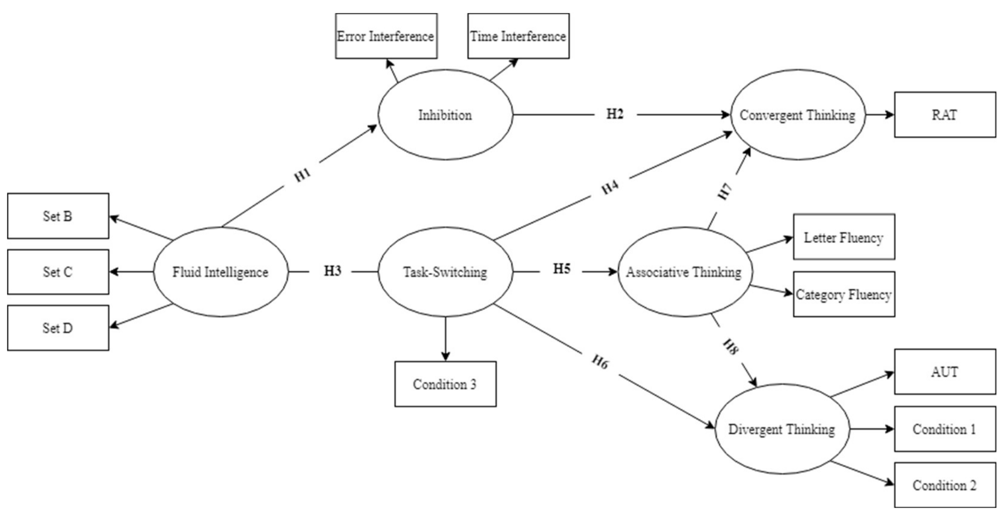
Based on the discussions of existing research and literature, a hypothesised theoretical model was constructed (see Figure 12). The primary purpose of statistical modelling is to evaluate whether there is a good fit between the theoretical model and the observed data. The theoretical model is imposed on the observed data, and the covariance matrices of the reproduced and theoretical model are compared to determine the similarity or goodness of fit. If the matrices are (approximately) equal to zero, the null hypothesis is accepted, and the model deemed acceptable (Blunch, 2008). The statistical hypotheses for the model as a whole are as follows:

H_0: $S = \sum$

H_1: $S \neq \sum$

Figure 12

Hypothesised Theoretical Model of Creative Cognition.



In the hypothesised model, the ellipses depict the latent variables, and the rectangles depict the indicators. The lines with arrows represent the hypothesised path, that is, the direction of influence. Fluid intelligence has been specified as an exogenous variable. Task-switching, inhibition, associative, divergent, and convergent thinking are specified as endogenous variables. Briefly, exogenous variables refer to a factor in a causal model that is not influenced by other variables in the model and, therefore, correspond with the independent variables (IV) in multiple regression. In contrast, endogenous latent variables correspond with the dependent variables (DV) in multiple regression as they are dependent or caused by other latent variables in the model (Mancha & Leung, 2010). While task-switching and inhibition are specified as endogenous variables, they are hypothesised to function simultaneously as both independent and dependent constructs[6]. The current study hypothesises the following relationships between the variables:

H1: Fluid intelligence predicts inhibition.

H2: Inhibition predicts convergent thinking.

H3: Fluid intelligence predicts task-switching.

H4: Task-switching predicts convergent thinking.

H5: Task-switching predicts associative thinking.

H6: Task-switching predicts divergent thinking.

H7: Associative thinking predicts convergent thinking.

H8: Associative thinking predicts divergent thinking.

No direct relationship between fluid intelligence and convergent thinking is presented in the model. It is, therefore, hypothesised that both inhibition and task-switching mediate the relationship between fluid intelligence and convergent thinking. A direct path has been depicted between task-switching and convergent thinking. Additionally, an indirect path between task-switching and convergent thinking via associative thinking has also been proposed. Hence, it is hypothesised that associative thinking partially mediates the relationship between task-switching and convergent thinking. No direct path between fluid intelligence and divergent thinking and between task-switching and divergent thinking has been specified. It is, therefore, hypothesised that effects on divergent thinking are mediated by associative thinking.

[6] A notable feature of SEM is that, unlike multiple regression analysis, it enables endogenous latent variables to function simultaneously as both independent and dependent constructs (Mancha & Leung, 2010).

3.4.2. Differences in Scores Across Demographic Variables on measures of Fluid Intelligence, Task-Switching, Inhibition, Associative Thinking, Divergent Thinking and Convergent Thinking.

Once the relationships among the components of creativity and executive functions were explored using SEM, group mean difference analysis was used to evaluate whether there were in scores across the demographic variables of age, multilingualism, SES, level of education and gender on any of the measures of the individual cognitive processes included in the model. The statistical hypotheses for each demographic variable are as follows:

3.4.1.1. Age:

H_0: μ1 = μ2 = ... = μk.

H_1: At least one μ_i different

3.4.1.2. Multilingualism:

H_0: μ1 = μ2 = ... = μk.

H_1: At least one μ_i different

3.4.1.3. SES:

H_0: μ1 = μ2= ... = μk.

H_1: At least one μ_i different

3.4.1.4. Education:

H_0: μ1 = μ2.

H_1: μ1 ≠ μ2

3.5.1.5. Gender:

H_0: μ1 = μ2

H_1: μ1 ≠ μ2

3.5. Research Design

In order to address the two research questions, the study adopted a quantitative research design. The goal of quantitative research is to ultimately describe current situations, evaluate relationships between variables of interest, and occasionally explain causal relationships between variables (Mertler, 2016). The quantitative research process, including the various designs that fall within this category, is relatively well-established as it typically operates under widely accepted procedures, which guided the current research process. In addition, there is limited flexibility in terms of the procedures and strategies used. The following section summarises the additional characteristics of quantitative research that were applied to the current study:

1. The literature review not only provided background information about the topic but also informed the choice of research methods, measurement instruments, the population and sample, as well as the analytical techniques used in the study.
2. The purpose of the study was specific and focused on a few measurable variables.
3. This study relied on well-established data collection processes. The research process was developed before the commencement of the study and, once the study had begun, the instruments, procedures and sampling strategy did not change. In doing so, the goal of this study was to maximise rigour and ensure objectivity.
4. As generalisability of the research results is an essential aspect of quantitative research, data was collected from a large number of individuals, which helped to ensure that the data reflected the population from which the sample was drawn.
5. Data analysis and the interpretation of quantitative research was based on statistical procedures, which also ensures the objectivity of quantitative research.
6. The format of research findings was reported in a standardised manner, which prevented biases from the researcher and further introduced objectivity into the study (Mertler, 2016).

A quantitative approach is best suited to research that aims to either identify variables that influence an outcome, the suitability of an intervention or to identify which factors best predict a particular outcome (Creswell & Creswell, 2017). Since the present study entailed the testing of a theoretical model, as well as the identification of factors that predict the cognitive processes implicated in creativity, the use of quantitative research was justified.

There are various approaches to conducting quantitative research, each of which falls into one of two categories, namely experimental or non-experimental research designs (Creswell & Creswell, 2017). This study was non-experimental as there was no manipulation or control of any variables (Sousa et al., 2007). That is, variables were evaluated as they occurred naturally, without the intervention of the researcher. This lack of manipulation was either due to the difference occurring naturally (e.g., male vs females) or because it was not possible, feasible or ethical to do so. In addition, there was an absence of both comparison groups and random assignment, thereby further justifying the non-experimental approach (Sousa et al., 2007).

Specifically, the researcher adopted a correlational, cross-sectional research design in the present study. Correlational research is a form of non-experimental research designs that serves the purpose of discovering and measuring the strength, magnitude and direction of the relationships between the variables under assessment. This design was appropriate for a study that aimed to associate multiple variables and evaluate their influence on each other (Sousa et al., 2007). There are two types of correlational research designs, namely explanatory and predictive designs. The goal of predictive correlational studies is to forecast future conditions or behaviours, whereas explanatory designs aim to describe and understand related condition or behaviours (Mertler, 2016). The present study used an explanatory correlational research design since its goal was to investigate the relationships between the cognitive processes underlying creativity, namely divergent, convergent and associative thinking, as well as the executive functions of task-switching, inhibition and fluid intelligence. Lastly, this research was cross-sectional as data was collected and analysed from the administration of the various instruments at a single section or period in time (Liu, 2008).

There are various strengths and weaknesses associated with the research design selected for this study. Firstly, in terms of strengths, this approach is useful for both testing and validating existing theories about phenomena, as well as for testing hypotheses developed before data collection and analysis. Additionally, the use of scientific techniques of data collection and analysis, and the large sample size that is characteristic of quantitative research enables research results to be generalised to the larger population and sub-populations (Johnson & Christensen, 2010). Another strength of using the scientific method is that it relies on clear guidelines and objectives, which make quantitative studies replicable. Moreover, one of the greatest advantages of correlational designs is that they can be applied when experimental research is not possible because the predictor cannot be manipulated. Additional strengths of correlational research include the simplicity of the design, as well as its ability to describe relationships between variables objectively and to study behaviour as it naturally occurs (Mertler, 2016).

There are also various limitations associated with the chosen research design that need to be taken into consideration. The main limitation for non-experimental research, and correlational research designs, in particular, is that they typically have low internal validity, or ability to validate the conclusion that changes in an IV cause changes in the DV. That is, correlational research cannot provide results regarding causal relationships among variables, but can only indicate associations (Patino & Ferreira, 2018). It is important to acknowledge these limitations so that correlational information is not misused. Although each approach to conducting research has its own set of strengths and weaknesses, a non-experimental, correlational, cross-sectional research design was ultimately chosen to best address the research questions.

3.6. Sample

A total of 125 participants over the age of 64[7] who were capable of independent living[8] and functionally fluent[9] in English were recruited through a combination of non-probability sampling strategies. Convenience sampling was used to solicit volunteers through advertising (see Appendix A) at community centres, such as churches and social clubs. Organisations where the relevant population were known to reside, including retirement villages, nursing homes and non-profit organisations, were also approached to request permission to invite their residents to take part in the study (see Appendix B). Letters of approval were obtained from the organisations that agreed to take part before applying to the Human Research Ethics Committee (medical) of the University of the Witwatersrand. Additional participants were recruited via snowball sampling, or chain-referral, whereby participants who had already taken part in the study provided suggestions about other members who met the eligibility criteria (Chromy, 2008).

The sample comprised of 44 male and 81 female participants, with a mean age of 73.14 years (SD = 6.347) and an average of 12.8 years of education. The participants' home languages were as follows: 72 English, 22 Afrikaans, 7 isiZulu, 2 isiXhosa, 3 southern Sesotho, 8 Batswana, 1 north Sesotho, 2 Venda, 1 Xitsonga, 1 Ndebele, and 6 participants whose home language were international languages, such as French, German and Portuguese. Participants were categorised in low, middle, upper, or high socio-economic brackets based on the scores obtained on the Living Standards Measure (LSM; Haupt, 2006). Lastly, participants were categorised according to the number of languages they reported being able to speak. The sample comprised of 7 monolinguals, 60 bilinguals and 58 multilinguals (individuals who spoke three languages and more). Table 1 presents the sample demographic characteristics.

[7] The conventional definition of *elderly* is the chronological age of 65 and above (Orimo et al., 2006).
[8] Evaluated using a shortened version of the Lawton Instrumental Activities of Daily Living (IADL) (Roehrig et al., 2007) and the Montreal Cognitive Assessment (MoCA).
[9] Functional language proficiency means that individuals can use English well enough to handle most common social situations and certain work situations but does not require a thorough or confident command of the language (O'Loughlin, 2001).

Table 1

Demographic Characteristics of the Sample

Variable	*N* (mean, SD)	Percentage
Age	125 (73.14, 6.347)	
65-70	53	42.4
71-75	27	21.6
76-80	24	19.2
81-85	16	12.8
86-90	5	4
Education	125 (12.8, 3.309)	
≤12 years	63	50.4
≥13 years	62	49.6
Gender	125	
Male	44	35.2
Female	81	64.8
SES	125	
Low	3	2.4
Middle	21	16.8
Upper	54	43.2
High	47	37.6
Home Language	125	
English	72	57.6
Afrikaans	22	17.6
IsiZulu	7	5.6
IsiXhosa	2	1.6
Southern Sesotho	3	2.4
Batswana	8	6.4
Northern Sesotho	1	.8
Tshivenda	2	1.6
Xitsonga	1	.8
IsiNdebele	1	.8
Other	6	4.8
Linguistic Category	125	
Monolingual	7	5.6
Bilingual	60	48
Multilingual	58	46.4

Participants with cognitive impairments, psychiatric disorders or who abused substances, all of which could have affected their performance on the cognitive tests, were excluded based on their scores on the Lawton Instrumental Activities of Daily Living (IADL) and the Montreal Cognitive Assessment (MoCA). This limited the influence of extraneous variables that the researcher wished to control. Furthermore, participants who were receiving medical care or taking prescription medication, were not excluded unless such interventions adversely affect their ability to execute the activities of daily living. The rationale for including these participants was that since in the elderly the chances of falling into these categories are extremely high and is, therefore, considered normal at this age.

3.7. Instruments

A battery of measures was administered to participants, which gathered information regarding demographics, creative ability, higher-order functions, and linguistic experience. Table 2 provides a summary of the instruments and the constructs they measure. The instruments were administered in the order that they are listed in Table 2. This section then discusses the instruments in detail, including a description of each test and the functions they assess. Following this is a discussion on each instrument's psychometric properties and their application to the South African context. Finally, this section describes the administration and scoring procedures of each test.

Table 2

Instruments to Assess Constructs.

Construct	Instrument
Sample Characteristics	Demographic Questionnaire
SES	Living Standards Measure (LSM)
Multilingualism	Language Experience and Proficiency Questionnaire (LEAP-Q)
Independent Living	Lawton Instrumental Activities of Daily Living (IADL)
Cognitive Screen	Montreal Cognitive Assessment (MoCA)
Divergent Thinking	Alternate Uses Test (AUT)
Convergent Thinking	Remote Associates Test (RAT)
Associative Thinking	Verbal Fluency Test
Nonverbal Fluency	Design Fluency Test (DF) Condition 1 & 2
Task-switching	Design Fluency Test (DF) Condition 3
Fluid Intelligence	Raven’s Standard Progressive Matrices (SPM)
Inhibition	Victoria Stroop Test (VS)

3.7.1. Demographic Questionnaire

The participants first received a paper-and-pencil based demographic questionnaire (see Appendix C) that provided characteristics of the sample, including their age, gender, level of education and home language. The demographic questionnaire also included the Living Standards Measure (LSM) as an indicator of the participants’ SES. The South African

Advertising Research Foundation (SAARF) developed the LSM, which serves as a multivariate marketing research tool to group individuals according to their standard of living. The questionnaire uses the extent of urbanisation, car ownership and possession of particular appliances and assets, as well as the accessibility to essential services such as water and electricity as indicators of SES (Haupt, 2006).

The study used the 2011 LSM update, which consists of 29 variables, with two items from the previous version replaced (i.e., Swimming pool and Air conditioner replaced the items VCR and Hi-fi music centre). The group ranges for this update version were adjusted to enable individual scores to be comparable to previous versions of the LSM. The participants' SES was calculated by first summing the weights for the 29 items. A constant of -.81052 was then added to the total scored obtained in the previous step, which served as a final SES score. Individuals were then allocated to one of ten groups based on their final LSM score, with LSM 1 being the lowest level of SES and the decile with the least means and LSM 10 being the highest level of SES and the decile with the greatest means (Haupt, 2006).

3.7.2. Language Experience and Proficiency Questionnaire (LEAP-Q)

The LEAP-Q is a self-report tool developed by Marian et al. (2007) as a valid and reliable instrument for assessing the language proficiency of multilingual individuals. The questionnaire comprised of a combination of forced-choice, Likert-type scale and open-ended questions. It aims to establish a comprehensive multilingual profile by gleaning information regarding the number of languages the participant knows and gauges their proficiency across various domains for each language identified (Marian et al., 2007).

Although self-report instruments are often criticised for being incapable of providing accurate parameter estimates for the relationship between constructs (Chan, 2009), psychometric analysis of the criterion-based validity has demonstrated that self-report, language proficiency tests are indicative of multilinguals' linguistic performance on standardised linguistic measures (Marian et al., 2007). Specifically, in terms of L1, the self-reported and behavioural measures of language comprehension were found to be the strongest correlates (speaking; r = .541, comprehension; r = .481, and reading; r = .661). Moreover, Marian and colleagues (2007) found the strongest correlates in relation to the written and verbal comprehension (speaking= .741, comprehension= .621, and reading= .634). The researchers also demonstrated that the LEAP-Q has high internal consistency. This was indicated with high Cronbach's alpha values for the majority of the indicators, with the highest values being for the L1 Competence (α = .85), L2 Competence (α = .92), L1 Maintenance ($\alpha = .80$) and Media-Based Learning ($\alpha = .75$) items (Marian et al., 2007). Lastly, the LEAP-Q has also proven to be an effective tool to provide a better understanding of the effects of multilingualism in a South African population (Cockcroft & Laher, 2018; Motlhabane, 2016).

The researcher adapted the original LEAP-Q to create a shorter version that excluded several questions found in the original test (see Appendix D). Specifically, questions already covered in the demographic questionnaire as well as any questions that were not relevant to the present study, such as items assessing age of acquisition, culture and immigration, were excluded. Thus, proficiency questions were limited to the speaking, comprehension and reading domains. The researcher first piloted this version of the LEAP-Q to assess the appropriateness and feasibility of the selected questions (see Chapter 4). Completion of this version of the LEAP-Q took approximately 5 minutes. The information obtained from this test was used to categorise the participants according to the number of languages they knew.

3.7.3. Lawton Instrumental Activities of Daily Living (IADL).

The original Lawton Instrumental Activities of Daily Living (IADL) is an appropriate measure to assess aspects of functionality essential for independent living (Newquist et al., 2015). Therefore, the IADL is typically used as a baseline cognitive assessment (Graf, 2008). This study used a shortened version of the test, developed by Roehrig et al. (2007), as a rapid and primary indicator of the participants' cognitive functioning. This variation comprises of items from the original IADL, namely the items 'grocery shopping' and 'food preparation' as individuals who have difficulty with successfully undertaking either one of these items can automatically be assumed to have general cognitive limitations. The variation also includes the items 'medication use', 'laundry' and 'transportation' as they improve the screening rate of the instrument (Roehrig et al., 2007). This measure entailed participants answering "true" or "false" when asked if they have difficulty or require assistance with the activities mentioned above.

The IADL scale has well-documented validity and reliability scores, particularly for the older population (Newquist et al., 2015). For example, a study conducted by Vergara et al. (2012) demonstrated that the IADL had high internal consistency, with a Cronbach alpha coefficient equal to .94. Additionally, the researchers used exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to assess the divergent and convergent validity of the test. Regarding the results from the EFA, the researchers found factor loadings ranging between .67 and .90, as well as item communalities ranging between .45 and .81. In terms of the results from the CFA, the model fit indices were satisfactory (RMSEA = 0.08, TLI = 0.99 and CFI = 0.99), and the factor loadings were all statistically significant, which were between .84 and 0.96 and, thus, suggesting homogeneity of the construct (Vergara et al., 2012). In the South African context, Ramlall et al. (2013) observed that the ability to perform the tasks included in the IADL had diagnostic significance for dementia, mild cognitive impairment (MCI) in this population. Therefore, the IADL was used in the present study as a baseline assessment to identify whether individuals were incapable of undertaking the cognitive tests and also to provide informed consent. Hence, individuals were included in this study on the condition that they could execute all activities on the IADL.

3.7.4. Montreal Cognitive Assessment Version 7.2 (MoCA)

The MoCA is a 30-point, paper-and-pencil test that assesses various cognitive domains, including executive functions, language, visuo-constructional abilities, attention, memory, conceptual thinking, calculations, and orientation, to detect mild cognitive impairment. The test has strong test-retest reliability (r = .92) and good internal consistency (α = .83). Additionally, the MoCA correlates significantly with the Mini-Mental State Examination (MMSE; r = .87), thus establishing the content validity of the test (Nasreddine et al., 2005). However, the MoCA is more sensitive than the MMSE in discerning the early stages of cognitive decline. Additionally, it has been validated for use in the elderly, as well as for the screening of various conditions, such as Parkinson's Disease (PD) and Alzheimer Disease (AD) (Hobson, 2015).

Robbins et al. (2013) evaluated the applicability and the utility of the original MoCA in detecting HIV-related cognitive impairments in one of South Africa's most distinct cultural groups, namely the isiXhosa population. The study not only investigated whether MoCA scores could accurately distinguish between the cognitive functioning of HIV+ and their demographically and psychiatrically matched HIV- counterparts, but also evaluated how each test item performed in this population. The results revealed that, despite being able to identify cognitive impairment in the HIV+ individuals effectively, the item-by-item analysis demonstrated that various tasks exhibited strong floor effects. In particular, the researchers found floor effects on the one abstraction item (Watch, Ruler), serial 7's, cube drawing and the rhinoceros item of the confrontation naming sections of the test, which suggests that these items are inappropriate for South Africans (Robbins et al., 2013). Therefore, the present study used

Version 7.2 of the MoCA, which replaces the items that exhibited floor effects in Robbin and colleagues' (2013) study.

Lebedeva et al. (2016) compared the difficulty of items taken from alternative versions of the MoCA developed by Chertkow et al. (2011), namely version 7.2 and version 7.3, to the items on the original test (Nasreddine et al., 2005). A Rasch model was used to obtain estimates of difficulty for the 28 original items and five items taken from alternative versions, including the drawing item taken from Version 7.3 (Copying a drawing of a cylinder), two naming items from Version 7.2 (Bear, Hippo), as well as abstraction items from Version 7.2 (Diamond, Ruby) and Version 7.3 (Trumpet, Piano). The result revealed that the Cylinder drawing task was too easy to be used as an effective alternative to the Cube drawing task. The abstraction items from both alternative tests were also easier than those in the original MoCA (Lebedeva et al., 2016).

These results suggest that the abstraction item from Version 7.2 (Diamond, Ruby) is more appropriate for the South African population than the item from the original test (Watch, Ruler) as the participants in Robbins and colleagues' (2013) study performed poorly on that item from the original test. Lastly, large discrepancies were observed on naming a Rhino and Bear, as well as on naming a Camel and Hippo. Specifically, while the Bear was an easier alternative to the Rhino, the Hippo proved to be a challenging alternative to Camel (Lebedeva et al., 2016). Although the Hippo proved to be a challenging alternative (Lebedeva et al., 2016), findings from Robbins and colleagues' (2013) study suggests that it may be a more appropriate item for a South African population since they found that participants often mislabelled the Rhino as a Hippo, which may indicate that the latter is familiar to this population.

Therefore, the present study used Version 7.2 of the MoCA. This version has been found to have good alternative form reliability, which involves comparing an individual's score on two different versions of the same test (Costa et al., 2012). Specifically, Costa et al. (2012) found that the performance of healthy participants on the original MoCA significantly correlated with their performance on the MoCA version 7.2 (r = .69). Moreover, this significant relationship was stronger in their clinical groups, namely in patients with MCI (r = .83) and Alzheimer's patients (r = .95). The researchers also demonstrated that, like the original MoCA, version 7.2 had a strong positive association with the MMSE (r = .88) and had good internal consistency (α = .82; Costa et al., 2012). The test administration involved the researcher providing verbal instructions for each task, which the participant was required to respond to accordingly. The scores obtained for each item were calculated to provide an overall MoCA score, with zero being the lowest score in which a participant could achieve and 30 points being the total possible score. The test took the participant approximately 10 minutes to complete.

3.7.5. The Alternate Uses Test (AUT).

The AUT was developed by Guilford et al. (1978) as a measure of divergent thinking. While this test has yet to be standardised for a South African population, the AUT has been used to investigate the relationship between language experience and the cognitive function of divergent thinking and working memory in a South African population (Anthony, 2018). The AUT requires participants to provide as many alternative or different uses as possible for a set of everyday objects, and the creativity of responses are subjectively scored according to set criteria (Guilford et al., 1978). Although cognitive tests that involve a subjective scoring have been criticised for being unreliable methods of assessment (Shin, 2013), the psychometric properties of the AUT have been found to be satisfactory. For instance, the AUT has high inter-rater reliability (IRR) for both total number of responses (IRR = .97) and the number of valid responses (IRR = .82) (Wilson, 2016). Additionally the AUT has been reported to have acceptable internal reliability ($\alpha = .74$; Batey et al., 2009), as well as discriminant validity (Runco & Acar, 2012). Thus, the AUT is a quick, reliable, and valid assessment of divergent thinking.

The AUT used in the present study consisted of two sections that were timed separately. Each section had three everyday items that participants needed to consider and provide up to six uncommon uses for each item. The first section comprised of the objects: (1.) shoe, (2.) button and (3.) key, and the second section comprised of the objects: (4.) wooden pencil, (5.) automobile tyre and (6.) eyeglasses. Participants were provided with a 4-minute time limit for each section, totalling 8 minutes to complete the entire test (Guilford et al., 1978)

The researcher used the scoring guidelines provided in the AUT manual (Guilford et al., 1978) to guage whether responses were acceptable, which received 1 point, or unacceptable, which received no points. In order for participants' responses to be deemed as acceptable, the researcher assessed whether the given use for the object was plausible and original but as well as whether the response provided was different from the item's conventional use. Unacceptable responses were considered by the researcher to be those that included ideas that were obviously overworked or too vague. Various conceivable interpretations of the items that were provided by the participants were also deemed acceptable provided that they were in accordance with the set of rules outlined above (Guilford et al., 1978). Scores for both sections were added together, which served as one of the indicators of divergent thinking, with zero being the minimum score in which a participant could achieve and with 36 points being the total possible score.

3.7.6. The Remote Associates Test (RAT)

The RAT (Mednick, 1962) is a domain-general test that assesses the ability to establish new combinations from associative items. Although the RAT measures associative abilities, a unique characteristic of the instrument that distinguishes it from the AUT and other divergent thinking tests is that there is a single correct solution for each item (Lee et al., 2014). Therefore, research widely uses the RAT as a reliable and valid measure of convergent thinking (Akbari Chermahini et al., 2012).

The RAT items used in this research were based on the 30 items selected and evaluated by Lee et al. (2014). Firstly, the researchers found high Cronbach's alpha values for their 30-item version of the RAT ($\alpha = .82$), indicating evidence for the internal reliability of the test items. Additionally, the researchers used item response theory (IRT) to assess the psychometric properties of the items selected from Bowden and Jung-Beeman's (2003) RAT item bank. Their results provided strong evidence for external validity, including both convergent and discriminant validity. In particular, the researchers provided evidence for convergent validity as there was a significant, positive relationship between scores on the 30-item RAT and performance on insight problems, working memory tasks, processing speed and intelligence tasks, as well as grade point average (GPA) with r values ranging from .14 to .42. Moreover, the researchers provided evidence for discriminant validity as they found that performance on their 30-item variation was not significantly correlated with performance on measures of other measure of creativity, namely the AUT and the Abbreviated Torrance Test for Adults (ATTA). Therefore, this 30-item version of the RAT has satisfactory psychometric properties, particularly in terms of its internal and external structure (Lee et al., 2014). The current study first piloted this version of the RAT to assess the appropriateness and feasibility of the items (see Chapter 4). Certain items from this version of the test were found to be inappropriate for the current sample. Therefore, the researcher identified and replaced inappropriate items and used this variation in the current study (see Appendix E).

Each RAT item comprises of three seemingly unrelated stimuli words. The participants were required to identify a fourth mediating word that was related to all three stimuli words via the formation of a compound word (Lee et al., 2014). For example, given the words: *cake, break,* and *bean,* the participant was required to identify the linking word: *coffee* (Bowden &

Jung-Beeman, 2003). Participants had to provide as many solutions as possible within a 10-minute time limit. The score for convergent thinking was determined by the total number of correct responses giving within the designated time, with zero being the minimum score in which a participant could achieve and with 30 points being the total possible score.

Given that creativity is generally under-researched (Kara, 2015), it is unsurprising that creative thinking abilities remain a largely unknown field within the South African context (Meintjes & Grosser, 2010). The researcher consulted various familiar electronic databases (i.e., PubMed, SA ePublications, SAGE Premier Online, ScienceDirect, Springer, Taylor & Francis, Wiley Online Library) on 8 January 2021 using the keywords: creative thinking, convergent thinking, South Africa, Remote Associates Test, combined or separate yielded no relevant results. Therefore, to the researcher's awareness, the RAT has yet to been used in a South African context.

3.7.7. Verbal Fluency Test

The verbal fluency test consists of two tasks, namely letter and category fluency, that are extensively used as a measure of verbal functioning and associative fluency (Lezak et al., 2012). The wide-spread use of these instruments is, in part, attributed to their compelling face validity (Shao et al., 2014) and favourable test-retest reliability, diagnostic and predictive validity (St-Hilaire et al., 2016). In particular, St-Hilaire et al. (2016) demonstrated high test-retest reliability scores for animal category fluency (r = .71) and letter fluency (r = .49) in health older adults. The researchers also showed that the category and letter fluency tests had good diagnostic validity as, compared to healthy participants, individuals with Alzheimer's disease performed significantly worse on both these measures. Similarly, the category fluency task was found to have good predictive validity as it was found to be useful at classifying participants on a binary classifier system, (e.g. healthy, not healthy; St-Hilaire et al., 2016). Finally, performance on the letter fluency task moderately correlates with performance on the category fluency task (r =.42; p < .001), which provides sufficient evidence of convergent validity (Lee & Therriault, 2013). Therefore, the present study used both the letter and category fluency tasks, which the following sections discuss in further detail. The total number of correct responses provided in the letter and category fluency test in the two-minute time frame (60 seconds per test) were combined to provide an overall verbal fluency score.

3.7.7.1. Letter Fluency Task. The letter fluency task gathers information regarding associative thinking via assessing phonetic fluency (Lee & Therriault, 2013). The test involves individuals orally producing as many words as possible beginning with a particular letter. While the letter F, A and S are most commonly used, the correct letter choice is an important factor that needs to be taken into consideration as it may affect test results due to letter difficultly and word frequency for each letter (Strauss et al., 2006).

There is general scepticism as to whether this test can be appropriately applied to a South African population given the diverse morphological structures amongst the various official languages, which would render the use of particular letters inappropriate (Bethlehem et al., 2003). Nevertheless, Ferrett et al. (2014) empirically investigated various letter sets in order to determine which were appropriate for South Africa's cross-linguistic context. The letter B was amongst the few letters that were suitable for three predominant language groups in South Africa, namely English, Afrikaans and isiXhosa (Ferrett et al., 2014).

The letter B was, therefore, selected for the current study. Participants were first informed of inadmissible words, which included proper nouns (e.g., Belgium), different variations of words that had the same root (e.g., brush and brushing) and repetitions (Strauss et al., 2006). They were then asked to provide as many examples of words beginning with the letter B in a 60 second time limit that abided with these rule (Ferrett et al., 2014). Correct, incorrect and repeated responses were all recorded, with the total number of correct responses serving as the overall letter fluency score (Strauss et al., 2006).

3.7.7.2. Category Fluency Task. Similar to the letter fluency task, the category fluency task requires participants to generate words that adhere to particular criteria (Lee & Therriault, 2013). The current research used the animal fluency task as the variables of gender and language affect this category less than other categories, such as fruits and vegetables (Acevedo et al., 2000).

A study that assessed animal verbal fluency in a subset of the South African population, namely Zulu-English bilinguals, demonstrated that level of education and language influenced performance on the animal fluency task less than other categories (Bethlehem et al., 2003). This suggests that the animal fluency category is an appropriate choice for a cross-linguistic sample. The animal fluency task is also recommended when studies only use one category (St-Hilaire et al., 2016). Participants had 60 seconds to provide as many examples of different types of animals as possible (St-Hilaire et al., 2016). The number of correct responses served as the total score for category fluency, and both repeated and incorrect responses were recorded (Strauss et al., 2006).

3.7.8. Design Fluency (DF) Test

The DF test is a component of the Delis- Kaplan Executive Function System (D-KEFS), a standardised assessment of higher-order functions in individuals between the ages of 8 and 89. The D-KEFS comprises of various stand-alone tests, which can be administered either as a group or individually (Homack et al., 2005). The DF is a non-verbal test of fluency, cognitive flexibility and task-switching and requires that individuals produce novel and abstract designs within the framework of a given set of rules (Lezak et al., 2012). The ability to generate unique responses on the DF relies on multiple processes, including creative thinking, spontaneous generativity, divergent reasoning as well as cognitive fluidity and flexibility (Kraybill & Suchy, 2008). As such, the DF has been applied in research to assess creativity, particularly as a means to evaluate fluency aspect of divergent thinking (Jung et al., 2010; Nemoto et al., 2005).

The D-KEFS has satisfactory reliability and validity scores. Specifically, the test has good ecological validity, especially in terms of the switch condition in the DF, which is sensitive to frontal lobe dysfunction (Cato et al., 2004; Kramer et al., 2007). In addition, Krivenko (2017) found that the DF has acceptable test-retest reliability, especially in terms of the total unique design scores ($r = .69$). Lastly, the DF was recently applied to a South African population in a study conducted by Ferreira-Correia et al. (2020). The researchers included the DF in a comprehensive battery of neuropsychological test to evaluate and compare the neuropsychological profile of individuals with Huntington Disease (HD) to those with Huntington Disease Like-2 (HDL2), which were both compared to matched control samples. The DF was scored in terms of the number of correct designs produced in Condition 1, Condition 2 and Condition 3. Additionally, the researchers calculated the percentage of accuracy, which is the ratio of the total number of attempted designs to the total number of correct designs. The study demonstrated that the DF is appropriate for use with typical South Africans (Ferreira-Correia et al., 2020).

In addition to measuring task-switching, the DF was used as an additional indicator of divergent thinking in the present study. The DF consists of three conditions (*basic*, *filter* and *switch)* where participants are given 60 seconds per trial to produce as many different designs as possible by connecting the dots using four straight lines (Delis et al., 2001). The basic condition (Condition 1) comprised of filled (black) dots and required individuals to draw designs by connecting the filled dots. The filter condition (Condition 2) comprised of filled and unfilled (white) dots and required participants to draw designs using only the unfilled dots. The switch condition (Condition 3) comprised of both filled and unfilled dots and required participants to draw designs by alternating between connecting filled and unfilled dots (Baldo et al., 2001).

Participants were instructed to draw as many different designs as possible within the given time limit using only four, straight lines. They were informed that it was unnecessary for designs to be drawn from one continuous stroke, that each line was required to be in contact with at least one other line at a dot and that the lines were allowed to intersect each other. Before beginning each trial, participants were permitted to practice drawing three designs, which the researcher provided feedback on and corrected any errors. The participants were then provided with a page with 35 squares, which had an identical configuration of dots that were illustrated in the practice sheet, and the instructions discussed in the practice stage were repeated (Delis et al., 2001).

The DF was scored in terms of correct, set-loss[10], repeated designs and the number of attempted designs produced in each trail (Delis et al., 2001). Suchy et al. (2010) adopted this approach to interpreting the test results. They recommended considering condition 3 (i.e., switch trial) as a separate construct to Condition 1 and Condition 2 as their study suggested that the third trial elicits a construct that is both separate from generative fluency as well as more reliant on executive processes (Suchy et al., 2010). Therefore, the DF was examined in terms of *non-switch* (Condition 1 and 2) and *switch* (Condition 3) trails in order to isolate the fluency construct (Suchy et al., 2010). Conditions 1 and 2 were used together with the AUT as indicators of divergent thinking. Condition 3 was examined separately and used as an indicator of task-switching in the structural equation model.

3.7.9. Shortened Version of Raven Standard Progressive Matrices (SPM)

Raven's Standard Progressive Matrices (SPM) is a non-verbal estimate of reasoning and fluid intelligence that was designed by Raven et al. (1998) for the general population between the ages of 6 and 80 years. The full version of the SPM comprises of five sets (A-E) of 12 items per set (Tang et al., 2018). Moreover, the test has favourable psychometric

[10] A set-loss design refers to a design that reflects one or more violations for the stipulated rule for the trial (Delis et al., 2001).

properties, including good test-retest reliability, which ranged between .8 and .9 (Rushton & Skuy, 2000).

The SPM has various notable advantages that make it both appropriate for and applicable to this study's research sample, namely elderly South African participants. Firstly, the SPM is not highly dependent on auditory perception or verbal and manipulative capabilities, which makes it well suited for a range of practical settings. Secondly, due to the nonverbal nature of the instrument, it is a test that is relatively free from the influence of verbal fluency and language, and avoids culturally loaded content (Van der Elst et al., 2013). Lastly, since completion of matrices requires minimum motor skills, it is an appropriate instrument to assess an elderly sample (Zhu et al., 2004). Indeed, a study conducted by Rushton et al. (2004) demonstrated that, within a South African context, this measure has favourable internal and external validity scores. Specifically, when administered to a demographically diverse South African sample, Rushton et al. (2004) demonstrated that the SPM had excellent internal consistency reliability (α = .86). Additionally, the researchers demonstrated that the SPM significantly correlate with an English Comprehension Test (r = .29), the similarities subscale of the South African WAIS (r = .14) and the participants' high school GPA (r = .22), thereby demonstrating that this test has good concurrent validity (Rushton et al., 2004).

Nevertheless, a disadvantage of the full version of the SPM is that the administration time is relatively long as it takes approximately 40 to 60 minutes to complete (Van der Elst et al., 2013). Inclusion of the full version of the SPM would, therefore, significantly increase the duration of the testing procedure for each participant. A lengthy testing procedure would be problematic for the current study as an elderly sample is often prone to fatigue during cognitive assessments (Bayard et al., 2011; Troyer et al., 2006). Therefore, the current study used a shortened version of the SPM, validated by Van der Elst et al. (2013) using IRT models. This version of the test comprises of three sets of 12 items taken from the original SPM (sets B, C and D). The respective sets contained 12 multiple choice items (i.e., B1-12; C1-12; and D1-12). Participants were presented with a set of abstract black and white designs with a missing piece from one. They were then instructed to select, from among 6 (Set B) or 8 (Set C and D) response options, the design that adhered to and continued the given design in the missing space. Participants received 1 point for each correct response and 0 for incorrect responses. The total score was calculated according to the number of correct answers provided by the participants, with zero being the lowest score in which a participant could achieve and 36 points being the total possible score. It took the participants between 16 and 30 minutes to complete the entire test, which was approximately 40% less than the amount of time required to complete the original SPM (Van der Elst et al., 2013).

3.7.10. Victoria Stroop (VS) Test

The Stroop Test is used to assess various cognitive functions, including response interference, cognitive control and inhibition (Strauss et al., 2006). A variation of the original test, namely the Victoria Stroop (VS) test, was used in this study as it has several noteworthy strengths (Troyer et al., 2006). Firstly, the VS is both brief and easy to administer, making it an effective test to include in test batteries, as well as an instrument that is particularly appropriate for an elderly sample which, as above-mentioned, is often prone to fatigue during cognitive assessments (Bayard et al., 2011; Troyer et al., 2006). Furthermore, the VS demonstrates sound psychometric properties, including both reliability and validity (Troyer et al., 2006). Malek and Amiri (2013) obtained a high test-retest coefficient of the VS. In particular, for reaction times on each test condition, the researchers obtained coefficients of .86 (Dots), .86 (Words), .93 (Colour) and .64 (reaction time interference). Additionally, for errors made on each test condition, the researchers obtained coefficients of .67 (Dots), .37 (Words), .81 (Colour) and .75 (error interference; Malek & Amiri, 2013). These results (Malek & Amiri, 2013). indicate that the VS has good internal reliability, which is congruent with findings from other studies (Bayard et al., 2011; Homack & Riccio, 2004; Troyer et al., 2006). The VS also has good ecological validity as it is sensitive to frontal lobe dysfunction (Troyer et al., 2006).

The VS comprises of three parts that each take approximately five minutes to complete (Strauss et al., 2006). During each stage, the participants viewed a card that illustrated four rows of six items, each of which was presented in one of the following colours: blue, green, yellow or red. For each task, participants examined the items and read the name of the colour that the object was presented in as quickly and accurately as possible. The first condition (D) comprised of coloured dots, the second condition (W) included neutral words (hard, over, but, when) that were presented in coloured ink and the last condition (C) comprised of colour names that were also printed in coloured ink which was incongruent with the written names. During the administration of the test, the researcher interrupted the participant if they made a mistake in naming, after which the participant was required to correct themselves and continue. Any errors that the participant spontaneously corrected were not counted as an error (Troyer et al., 2006).

A review of the literature shows that there are various scoring methods available. While multiple studies score performance solely in terms of speed, the parameters of both speed and accuracy should be considered in order to accurately detect the Stroop effect (Scarpina & Tagini, 2017). Therefore, the current study applied the scoring method used by Caffarra et al. (2002), who compared D, W and C conditions and used two equations, presented below, to calculate speed and accuracy independently. Equation ((*1*) was used to first calculate the participants' performance in terms of the speed.

$$TI = CT - \frac{(WT + DT)}{2} \tag{1}$$

The above equation calculated the time interference score (TI), where CT represents the time taken to complete the name-colour condition, WT represents the time taken to complete the neutral word condition, and DT represents the time taken to complete the dot condition (Caffarra et al., 2002). In addition to speed, the current study calculated response accuracy using the equation demonstrated in (2).

$$EI = CE - \frac{(WE + DE)}{2} \tag{2}$$

The above formula provided an Error Interference (EI) score, where CE represents the errors made in the name-colour condition, WE represents the errors made in the neutral word condition, and DE represents the number of errors made in the dots condition (Caffarra et al., 2002). Errors were defined as mistakes that were not spontaneously corrected (Strauss et al., 2006; Troyer et al., 2006).

Lastly, within a South African context, the Stroop test appears sensitive to executive dysfunction as a result of HIV infection, as HIV+ individuals have demonstrated a greater difficulty at inhibiting automatic responses on the test compared to their HIV- counterparts (Rice et al., 2014). However, while the Stroop test is widely used in South Africa, it is influenced by various demographic factors, including language, SES and culture, which therefore need to be taken into consideration when interpreting results (Rice et al., 2014).

In summary, the current research used a battery of measures that gathered information pertaining to the participants' demographics, creative ability, higher-order functions, and linguistic experience. In particular, information about the sample was collected using a demographic questionnaire, as well as the LEAP-Q, which was used to assess the participants' language proficiency. The IADLs and MoCA version 7.2 were used as cognitive screens to evaluate whether the participants fell within the exclusion criteria. Creative ability was tested using the AUT and Condition 1 and 2 of the DF (divergent thinking, the RAT (convergent thinking) as well as the letter and category fluency test (associative thinking). Finally, higher-order functions were assessed using Condition 3 of the DF (task-switching), the SPM (fluid intelligence) and the VS test (inhibition). The raw data from the cognitive tests were used to formulate the indicators of the SEM model and used in the group-difference analysis, which is discussed further in the subsequent sections.

3.8. Procedure

The following sections describe the procedures adopted in the current study. In particular, it describes the training process, the pilot study, data collection procedures, statistical analysis techniques and ethical considerations.

3.8.1. Training

Before the data was collected, Dr Ferreira-Correia (research supervisor/registered clinical psychologist and neuropsychologist) trained the researcher to administer the cognitive tests used in this study correctly. The training ensured that the researcher administered the tests competently, accurately and ethically in order to safeguard the integrity of the study.

3.8.2. Pilot Study

The researcher conducted a pilot study (see Chapter 4) to investigate the feasibility of the methods and instruments intended for the ensuing large-scale study. Ten participants from the target population were recruited using the same sampling strategies proposed for the large-scale study. The participants in the pilot study followed the procedures outlined in the Methods sections above, including exclusion criteria, instruments, administration procedures, as well as scoring methods (Lancaster et al., 2004). They were then asked to comment on the clarity of information disclosed in the information and consent sheets, as well as the comprehensibility of instructions and test items. Additionally, the format, the time taken to complete the battery and any other comments made by the participants were all taken into consideration (Hassan et al., 2006). Based on the participants' responses, any errors or deficiencies identified, such as lengthy administration time and inappropriate content in the RAT, were amended, and the necessary alterations were made.

3.8.3. Data Collection

The data collection phase involved the precise and systematic gleaning of data and information relevant to the purpose of the study. Firstly, participants were provided with an information sheet that disclosed relevant information about the research, as well as an informed consent sheet, which they completed before the study began. The researcher first administered the demographic questionnaire and the LEAP-Q to collected information regarding the participants' demographics and language proficiency, respectively. This was followed by the administration of the IADL and the MoCA to assess the participants' ability to undertake the ensuing cognitive tests. Once the signed consent sheet was submitted, the terms of the study agreed upon, and the inclusion criteria met, the assessment stage of the research began. The battery of cognitive tests was administered to the participants under standardised conditions in order to minimise the influence of external factors on test performance. Specifically, environmental factors were controlled by conducting the assessment in a quiet, sufficiently lit and well-ventilated area to minimise potential distractions or interferences and to ensure the participants' comfort (Rust et al., 2014). The two creativity tests were first administered, namely the AUT and the RAT, followed by the two verbal fluency tests, including the letter and the category fluency tests. Participants were then given a 15-minute break. Finally, the research administered the DF test, SPM and the VS test. The testing procedure for each participant took approximately 60-90 minutes.

The second phase of the data collection process involved the organisation and refinement of the raw data. The data were collected and managed using Research Electronic Data Capture (REDCap) hosted at the University of the Witwatersrand (Harris et al., 2019; Harris et al., 2009). REDCap is a secure web-based software platform that supports data capture for research studies. This software offers an intuitive interface for validated data capture and audit trails that track the manipulation of data and export procedures. Additionally, it provides automated export procures that enable coherent data downloads to common statistical packages, as well as procedures for data integration and interoperability with external sources.

The data was first coded by converting nominal categories into numerical indicators, including factors that did not have a numerical value, such as the variables of gender, level of education and SES. Once identity numbers were assigned, the raw data was cleaned, whereby any errors in entering data were located and corrected or eliminated. Possible-code cleaning checked whether only specific assigned identity numbers or codes were present. Additionally, contingency cleaning was used to inspect whether variables that were expected to have corresponding data possessed such data. The data cleaning process was a necessary step as the results were dependent on the reliability of the data on which they were based (Jarausch & Hardy, 2016).

3.8.4. Statistical Analysis

The statistical analysis phase of the study included three stages. The first stage involved the descriptive analyses, which quantitatively described and aggregated information about the variables in the dataset. The data was described in terms of both measures of central tendency, including means and medians, as well as measures of variability, including standard deviations (SD), minimum, maximum, interquartile ranges (IR), skewness, and kurtosis. The second and third stages of the statistical analysis involve the inferential analyses, which drew conclusions that could not be derived from the descriptive statistics (Marshall & Jonker, 2010). Specifically, inferential statistics were used alongside hypothesis testing to answer the research questions. In the current research, two inferential analysis techniques were used to address the two main aims of the study, respectively. In particular, the first aim of the study was addresses using a multivariate statistical analyses technique, namely structural equation modelling (SEM). Additionally, the second aim of the study was address using a combination of group-difference analyses, namely *t*-tests one-way analysis of variances (ANOVAs) depending on the number of categorical groups.

The two inferential statistical techniques used in the current study are discussed in detail below. In terms of SEM, an overview and a brief rationale for the choice of this statistical technique is first provided. The rationale discusses the advantages associated with SEM in light of the current study, including its ability to simultaneously assess measurement models (relationships between latent variables and their indicators) and structural models (relationships between constructs), as well as its capacity to analyse complex models (Tarka, 2018). The statistical assumptions related to SEM, which are necessary to evaluate to ensure that the researcher makes accurate inferences and conclusions, are then discussed and the data assessed to determine whether it met these assumptions. The main assumptions associated with SEM evaluated included sample size, multivariate normality, multivariate outliers, and multicollinearity. Firstly, the adequacy of this study's sample size was evaluated using the *N:*q ratio, which is a widely used rule-of-thumb. Multivariate normality was then evaluated by calculating the squared-Mahalanobis distances (MD) and plotting them against the quantiles of a Chi-square distribution (Field, 2013). The calculated MDs were then interpreted using $p < .001$ and corresponding χ^2 values with 12 degrees of freedom (df; the number of variables included in the final model) to identify any multivariate outliers (Newton & Rudestam, 2013). Lastly, multicollinearity was assessed by measuring the variance inflation factor (VIF) and tolerance (Bowen & Guo, 2012).

A breakdown of the five-step guide to SEM analysis described by Crockett (2012) used in the current study is then provided. As previously discussed, the first step of SEM analysis involved the specification of the theoretical model. This step entails the development of a theoretical model of creative cognition by examining existing research and related theory in order to identify the cognitive processes underpinning creativity and the relationships among them (Crockett, 2012). The researcher completed this step in the review of the literature (see Chapter 2).

The next step of the SEM analysis involved the model identification, which assessed whether the developed theoretical model was able to produce actual results that can be estimated using SEM. Model identification applies to both the measurement and structural models. Briefly, SEM comprises of two main components, namely the measurement model and structural model. The measurement model demonstrates the relationships between the latent variables and their comprising indicators, whereas the structural model demonstrates the relationships between independent (exogenous) and dependent (endogenous) variables (Tarka, 2018). The measurement model was first identified using the single indicator rule, as certain constructs had only one indicator, as well as by assessing whether indicators loaded appropriately onto each variable (Kenny et al., 1998). The structural model was then identified using *t*-rule for identification, which stipulates that the number of unique elements in the covariance matrix must be greater or equal to the number of unknown parameters that are to be estimated (Crockett, 2012).

After identifying the measurement model and the structural model, the next step in the SEM analysis involved model estimation. This step entails obtaining estimates for the parameters specified in the theoretical model that generate the Σ matrix, in such a manner that the theoretical parameters produce a matrix as close as possible to the observed covariance S matrix (Crockett, 2012). While SEM analysis programs offer various fitting functions to minimise the differences between Σ and S, the current study used maximum likelihood (ML) due to notable advantages associated with this technique (Schumacker & Lomax, 2010).

The last two stages of SEM are then discussed, namely model testing (stage four) and model modification (stage five). The researcher combined these stages due to the approach taken in model testing. Specifically, the approach involved deconstructing the hypothesised theoretical model developed in the model specification stage and individually testing the comprising components. Modifications to the model were then made, depending on the result obtained in the analysis, before testing the next model. The final model comprised of the accepted and modified models. The last SEM analysis involved assessing the final theoretical model. This assessment ultimately tested the degree to which the data supported the final, modified structural model of creativity. The criteria used to test the SEM models is also provided in this section. These criteria included model fit indices, as well as absolute, relative and non-centrality based indices, regression weights (β) and mediation effects.

Following the description of the SEM analysis process, the second inferential analysis technique used in the current study, namely group-difference analysis, is then discussed. This section includes a discussion of the statistical assumptions assessed, namely the assumptions of normal distribution and homogeneity of variance. The results revealed that the assumption of normality was violated, but only on certain tests and that the assumption of homogeneity of variance was violated for the majority of the instruments. Therefore, Welch's *t*-test and Welch's ANOVA were used as alternative statistical analysis techniques, since they are more reliable in instances where the assumption of homogeneity of variance has been violated (Field, 2013). Subsequently, a discussion of the method of both exploring differences between multiple groups means and determining the size of a found effect is provided, namely the Games-Howell post hoc test and Cohen's *d*, respectively.

Finally, in terms of the software used to analyse the data, both the descriptive statistics and group-difference analyses (used in the third stage) were calculated using IBM SPSS Statistics for Windows Version 24 (Corp., 2016) and SEM (used in the second stage) was run using IBM SPSS Statistics Amos Version 26 (Corp., 2020).

3.8.4.1. Structural Equation Modelling (SEM). SEM is a multivariate statistical methodology that combines three statistical techniques, including path analysis, multiple regression, and factor analysis. In general, SEM comprises of two distinct yet interconnected models, namely the measurement model and the structural model. The focus of the measurement model is to assess the degree to which the indicators (e.g., DF Condition 1, DF Condition 2 and the AUT) effectively capture the constructs included in the model (e.g., divergent thinking). The measurement model is based on factor analysis, a statistical technique that analyses the patterns within a set of measures in order to identify their underlying structure (Mancha & Leung, 2010).

In contrast, the structural model aims to test all of the links between the constructs simultaneously, that is, the causal relationships included in the overall model (e.g., the relationship between fluid intelligence and divergent thinking). The structural model aspect of SEM is based on path analysis, which enables complex relationships between multiple variables to be assessed and presents them visually in a path diagram. Moreover, path analysis estimates the fit of the collected data to the hypothesised model by comparing the regression weights obtained from the hypothesised model to the correlations obtained from the data. However, unlike path analysis, SEM enables all causal relationships in the model to be simultaneously estimated. Finally, SEM incorporates multiple regression to obtain information regarding the relationship between exogenous and endogenous latent variables. Exogenous latent variables correspond to the IV in multiple regression as their cause is external to the model and they are, therefore, not influenced by other latent variables in the model. In contrast, endogenous latent variables correspond to the DV in multiple regression as they are dependent on, or caused by, other latent variables in the model. SEM differs from multiple regression analysis in that it enables endogenous latent variables to function simultaneously as both independent and dependent constructs (Mancha & Leung, 2010).

In the context of the present study, fluid intelligence was specified as the exogenous latent variable, whereas task-switching, inhibition, divergent, convergent, and associative thinking were all identified as endogenous latent variables. In addition, task-switching, inhibition, and associative thinking served as both independent and dependent constructs. Table 3 provides a summary of the latent variables included in the model, their corresponding indicators and the labels of the higher-order constructs.

Table 3

Summary of Higher-order Constructs, First-order Variables, and Indicators

Higher-order construct	First-order latent variable	Indicators
Creativity	Divergent Thinking	Alternative Uses Test (AUT) total score
		Design Fluency test (DF) Condition 1 and 2 total correct score
	Convergent Thinking	Remote Associates Test (RAT) total score
	Associative Thinking	Letter Fluency total correct responses
		Category Fluency total correct responses
Executive Functions	Fluid Intelligence	Shortened version of Raven's Standard Progressive Matrices (SPM) score for set B, C and D
	Task-switching	Design Fluency (DF) condition 3 total correct score
	Inhibition	Victoria Stroop (VS) test time interference score and error interference score

Moreover, the indicators presented in Table 3 were constructed using item parceling strategies. In SEM, parceling refers to the grouping or aggregation of test items into one or more "parcels", which are then used as the indicator(s) of the target latent variable rather than the individual items. For example, when given a measure such as the 6-item AUT, parcels can be formed by generating aggregate scores by combining two or more items (e.g., two 3-item parcels), which is referred to as subset-item parceling, or aggregating all six items into one composite score, referred to as all-item parceling, rather than using individual scores from the six test items (Matsunaga, 2008). The current study used a combination of the sub-set item and all-item parcel approaches. In particular, sub-set item parceling was used on the SPM (i.e., the indicator of fluid intelligence was made up of the items Set B, Set C and Set D), the VS test (i.e., the indicator of inhibition was formed using the items Error Interference and Time Interference), the verbal fluency test (i.e., the indicator of associative thinking was made up of the items letter fluency and category fluency) and the DF test, with items from this test aggregated to form indicators of both task-switching (Condition 3) and divergent thinking (Condition 1 and 2). In addition, the current study made use of all-item parceling on the AUT and the RAT, which involved aggregating all the respective test items (i.e., six items on the AUT and 30 items on the RAT) into one composite score. It is important to note that the use of this all-item approach require a particular type of manipulation as specifying a latent variable with only one indicator results in underidentification, and underidentified models are unable to computed (Matsunaga, 2008). Nevertheless, the manipulation undertaken in this study is described in the discussion of model identification.

The researcher chose to use parceling strategies in the current study as there are various psychometric and modelling benefits. In terms of psychometric benefits, the Principle of Aggregation stipulates that each parcel has a greater reliability than any individual test item (Little et al., 2013). As a consequence, any given parcel tends to have a higher proportion of true-score variance to unique variance than the individual items used to create the parcel (Matsunaga, 2008). Moreover, a higher indicator-level reliability also increases the factor loadings (enhanced communality), thereby refining the common elements among the group items (i.e., the underlying latent factor) and enabling the target construct to be formed more adequately. In addition to enhancing the communality, higher indicator-level reliability also reduces the residual variances and, as a result, increases the ratio of common-to-unique factor variance (Little et al., 2013; Matsunaga, 2008). Together, these three related features improve the psychometric properties of the data that are fit in the SEM model developed in this study.

In terms of the modelling benefits, the use of parceling leads to the estimation of fewer model parameters. As a consequence, this not only lowers the variable to sample size ratio (*N*;q) and results in more stable parameter estimate, especially with small samples, but because fewer indicators are use, parceling also reduces the amount of measurement error (Bandalos, 2002; Little et al., 2013; Matsunaga, 2008). Therefore, parceling is particularly beneficial in the context of the current study as, if the individual items for the various cognitive tests were used in the measurement model, a larger sample would have been required and the amount of measurement error would have increased.

Taken together, the above sections provided an overview of SEM and a brief introduction of the overall structure of the model. In particular, a summary of the higher-order constructs, exogenous and endogenous latent variables, and the indicators used in the current study is provided. Additionally, the above section describes the item parceling strategy used to form the indicators included in the model, as well as the psychometric and modelling benefits of using these parceling strategies. The next section provides the rationale for using SEM as an analysis technique.

3.8.4.2.1. Rationale. As a data analysis procedure, SEM is not only useful when variables, or measures, have a particular causal structure, but it also offers a level of precision that is not readily available to alternative statistical approaches for analysing multivariate causal relationships (Fan et al., 2016). SEM has several advantageous features that make it well suited to the aims of the present study. Firstly, the ability to separate measurement models and structural models is a key advantage of SEM, particularly in the context of psychological research (Meyers et al., 2016). Since SEM models include latent factors, part of what this technique evaluates is the degree to which the measured indicator variables represent the factor (the measurement model). Additionally, SEM assesses the strength of the directional paths between constructs (the structural model). Hence, a desirable feature of SEM for the present study was that, in addition to estimating the relationships between constructs, the quality, or psychometric properties, of measures were simultaneously assessed (Tomarken & Waller, 2005).

Another notable strength of SEM is that it enables more complex models to be tested than multiple regressions and alternative path models (Coursey, 2007). Procedures, such as multiple regression, often used in place of SEM to test models, provide separate, small scale tests of the models' components, which are calculated on an equation-by-equation basis. In contrast, due to measures of global fit, SEM provides a summary evaluation of complex models that include multiple linear equations (Tomarken & Waller, 2005). Unlike traditional path analysis, SEM allows for both the simultaneous estimation of all model parameters, as well as direct model representation of measurement error. That is, while regression-based path analysis produces factors and subsequently discarding the reliabilities, SEM considered these using the path estimations (Coursey, 2007). Additionally, through the use of model fit indices, the fit of possible alternative models that differ in terms of their complexity are evaluated. Through these processes, SEM supports a model comparison approach to data analysis (Tomarken & Waller, 2005).

The nature of the current research meant that SEM was the most appropriate data analysis approach as the primary aim of this study was to directly test a hypothesised theoretical model of creative cognition. While this study considered the measurement model, it focused predominantly on the structural model and assessed the validity of the hypothesised structural model. To ensure that accurate inferences were drawn from the SEM analysis, specific underlying assumptions were first considered (Kaplan, 2009).

3.8.4.2.2. Assumptions. Before performing the statistical analysis, the data were evaluated to determine whether they propitiated the underlying assumptions of SEM (Hoekstra et al., 2012). These assumptions are a set of conditions that must be met in order for a test to yield accurate results (Rosenthal & Rosenthal, 2011). The main assumptions associated with SEM evaluated were sample size, multivariate normality, multivariate outliers, and multicollinearity.

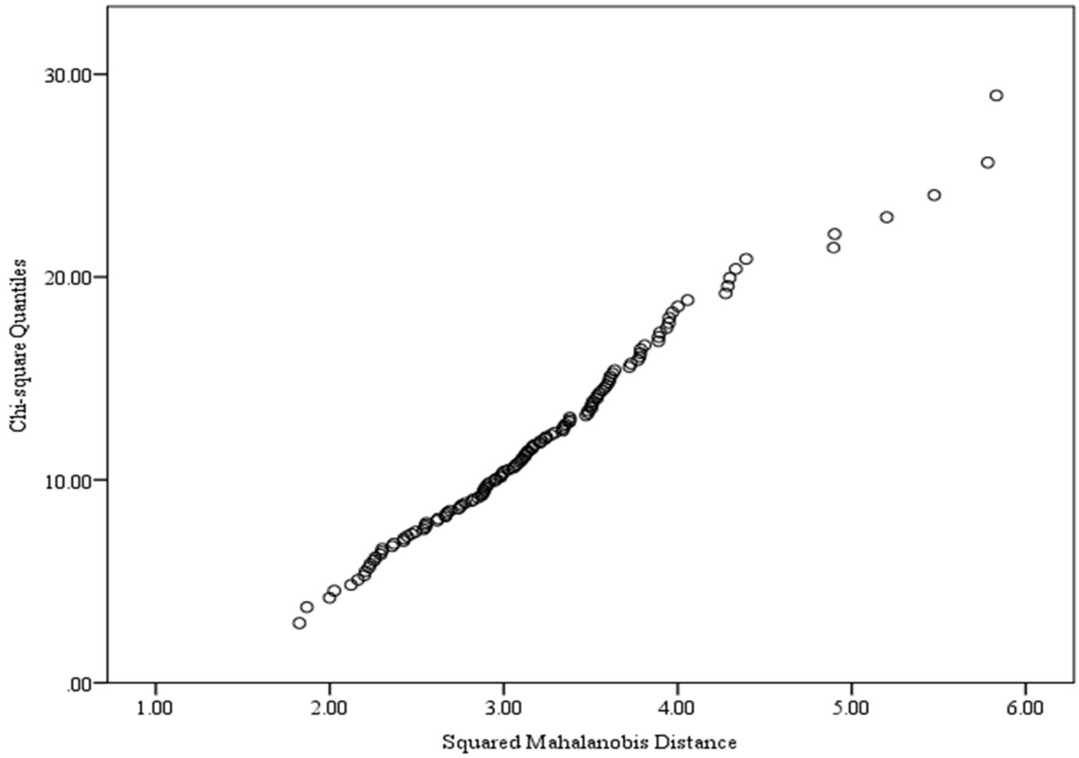
The first assumption evaluated was the sample size as is affects the stability of parameter estimates (Schreiber et al., 2006). SEM is a large sample size technique, with ≥ 300 cases being considered ideal (Tabachnick & Fidell, 2013). An alternative benchmark for determining the appropriate number of cases to include in the study is the *N*:q ratio, which involves assessing sample size (N) with regards to the number of observed variables (q). A widely used rule of thumb for setting a lower bound for an acceptable sample size is 10 participants per observed variable (Wang & Wang, 2012). The participant to item ratio for the current analysis was approximately 10 to 1, where the sample size was 125, and the number of observed variables included in the final model was 12. Based on the *N*:q ratio rule-of-thumb, the given sample size is therefore sufficient for SEM.

The underlying assumption of multivariate normality requires the data upon which SEM is applied to be normally distributed (Kaplan, 2009). This assumption was evaluated by calculating the squared-Mahalanobis distances (MD)[11] and plotting them against the quantiles of a Chi-square distribution (Field, 2013). Figure 13 presents the scatterplot of MD versus the Chi-square distribution. Normality can be assumed if the points form a relatively straight line (Holgersson, 2006). Since the majority of the points formed a relatively straight line with minimal irregularities, normality of the study data was assumed.

[11] A multivariate metric that measures the distance between a set of scores for a single participant and the sample means for all variables (Bowen & Guo, 2012).

Figure 13

Mahalanobis Distance Scatterplot Testing Multivariate Normality for the Current Study Data.



Multivariate outliers refer to cases that have an unusual combination of values on two or more variables. They are essential to detect before performing SEM as they may negatively affect fit indices (Kline, 2016). In order to identify influential points in the data, the calculated MDs were interpreted using $p < .001$ and corresponding χ^2 values with 12 degrees of freedom (df), which was equal to the number of variables to be included in the final model (Newton & Rudestam, 2013). The analysis detected two outliers. The researcher ran the model with and without the outliers' scores to determine whether or not to exclude them from the final SEM analysis (Warner, 2013). The results revealed that the inclusion of the outliers made no significant difference to the outcome of the SEM analysis. Therefore, the researcher decided to include the outliers to prevent the violation of the sample size assumption.

Although it was essential for the variables included in the model to be correlated with each other for them to be considered suitable for factorisation, variables that are too highly correlated are problematic in SEM (Kline, 2016). Therefore, multicollinearity was assessed by measuring the variance inflation factor (VIF) and tolerance (Bowen & Guo, 2012). VIFs that exceed 5 and, simultaneously, tolerance values that are less than .2 indicate that the regression coefficients are poorly estimated due to multicollinearity (Kutner et al., 2005). Any variables that are too highly correlated would be either integrated as a composite variable or removed from the analysis (Kline, 2016). The multicollinearity diagnostics yielded no VIF values > 5 or tolerance values < .2, suggesting that there was no multicollinearity in the data.

After the statistical assumptions of SEM were analysed and found to be met satisfactorily, the next stage entailed the SEM analysis. The organisation of the SEM analysis followed the five-step process outlined by Crockett (2012), which includes: (1.) model specification, (2.) model identification, (3.) model estimation, (4.) model testing, and (5.) model modification. As previously discussed, the first step of SEM analysis (model specification), which involved developing the hypothesised theoretical model of creativity, was conducted in the initial stages of the study, before data collection and analysis. Therefore, this step is omitted from the methods chapter, with the next section beginning with the second step of SEM analysis.

3.8.4.2.3. Model Identification. Before the models were estimated and evaluated against the data, the parameters of the estimated model were identified. Model identification involves determining whether a unique solution to the hypothesised model, initially specified in the first step, can be generated (Crockett, 2012). That is, it is necessary to ensure that there is no indeterminacy or no possibility of the data fitting more than one implied theoretical model equally well (Schumacker & Lomax, 2010). An identified model first needs to be theoretically possible for a unique estimate for each parameter to be established (Crockett, 2012). Additionally, the model identification is contingent on the specification of parameters as free (i.e., an unknown parameter that needs to be estimated), fixed (i.e., a parameter that has been fixed to a specific value, which is typically set at 0 or 1), or constrained (i.e., an unknown parameter that is equivalent or constrained to one or multiple other parameters; Schumacker & Lomax, 2010).

Model identification applies to both the measurement and structural aspects of the SEM model. Researchers must first identify the measurement model for the overall SEM model (Crockett, 2012). An adequately identified measurement model meets one of two sets of criteria. Firstly, the measurement model is likely to be identified if it comprises of at least two latent variables, each of which have three or more indicators that load onto it, with no significant correlations between the errors of these indicators, and each indicator loads onto only one latent variable. Secondly, the measurement model is also likely to be identified if the model comprises of at least two latent variables, but one of the latent variables must only have two indicators that load onto it, with no significant correlations between the errors of these indicators, each indicator must load onto only one latent variable, and the variances or covariances between the factors must be zero (O'Brien, 1994). In terms of loading thresholds, values equal to or exceeding .70 represent that the indicator loads sufficiently onto the factor (Nunnally & Bernstein, 1994). However, factor loadings equal to or exceeding .60 are also deemed to be adequate (Bagozzi & Yi, 1988).

Therefore, the measurement model for the overall SEM model was identified as it had six latent variables with indicators that loaded appropriately onto each factor. The results section of the analysis (see Chapter 4) demonstrates the factor loadings of the measurement model. Additionally, the errors of the indicators were not significantly correlated, and each indicator loaded onto only one latent variable. However, the measurement model of the overall SEM model violated the criterion which stipulated that each latent variable should have three or more indicators load onto it. As discussed in the introduction to SEM, the specified theoretical model in this study contained single indicator constructs and, therefore, required significant manipulation. In particular, this issue was addressed by fixing the loadings of these factors to one, forcing their errors to zero and leaving their variances free to be estimated (Kenny et al., 1998).

Next, the overall structural model was identified using the t-rule for identification. This rule stipulates that the number of non-redundant, or unique, elements in the covariance matrix must be greater or equal to the number of unknown parameters that are to be estimated. In other words, in order to find unique solutions, the model must be comprised of more known than unknown pieces of information. The number of known and unknown pieces of information were compared to each other to identify whether the model met this condition. The number of unknown pieces of information corresponds to the number of free parameters estimated in the model. These free parameters comprise of the factor loadings, relationships between exogenous and endogenous variables, as well as relationships among endogenous variables, errors in equations and the variance/covariance of the exogenous variables. The number of non-redundant (known information) elements in the covariance matrix was calculated using the equation seen in (3), where p is equal to the number of observed variables (Crockett, 2012).

$$\frac{p(p+1)}{2} \tag{3}$$

The final SEM model in the present study comprised of 12 observed variables; therefore, the number of non-redundant elements calculated was equal to 78. The number of free parameters to be estimated in the model was 40. Given that the number of non-redundant elements exceeded the free parameters in the model, the final model in this study was over-identified (Schumacker & Lomax, 2010).

SEM models can be either under-identified, just-identified or over-identified. Under-identified models provide insufficient information for the model parameters to be distinctively estimated and, consequently, fail to produce a unique solution. In contrast, a model is just-identified if the parameters are uniquely determined due to the matrix S having just enough information. Over-identified models have enough information in the matrix S to be able to establish the parameter/s in multiple ways (Schumacker & Lomax, 2010). A model is identified if it is either just- or over-identified. However, while just-identified models yield only one solution, over-identified models produce several potential solutions (Crockett, 2012). Given that there are multiple sources of error in the covariation matrix (e.g., sampling and measurement error), over-identified models are the ideal (Kelloway, 1988). Therefore, based on the *t*-rule criteria, the overall SEM in this study was considered to be identified.

3.8.4.2.4. Model Estimation. The third step of the SEM analysis, model estimation, entails obtaining estimates for the parameters specified in the theoretical model that generate the Σ matrix, in such a manner that the theoretical parameters produce a matrix as close as possible to the observed S matrix (Crockett, 2012). This stage involves calculating the χ^2 test statistic to assess the appropriateness of a structural equation model. A perfect model fit occurs when the differences between elements of the matrices Σ and S are equal to 0 ($S - \Sigma = 0$). Iterative methods, or fitting functions, are used to obtain estimates of parameters that result in the "best fit" of the model to the data and therefore minimise the difference between matrix Σ and matrix S (Schumacker & Lomax, 2010).

SEM analysis programs offer various fitting functions, such as maximum likelihood (ML), ordinary least squares (OLS), and generalised least squares (GLS). While both ML and GLS are similar to the OLS estimation used in multiple regression, the former two estimation methods differ from, and have several advantages over, the latter method. For example, OLS is scale-dependent and, as a result, alterations in the observed variable scale produce a different set of estimates. Additionally, both ML and GLS have desirable asymptotic properties, or large sample properties, including low variance (i.e., least effected by sampling error) and unbiasedness. Lastly, unlike OLS, ML, and GLS estimate all of the parameters in the model simultaneously in order to generate a full estimation model (Schumacker & Lomax, 2010).

Therefore, ML was selected as the model estimation technique to minimise the differences between matrix Σ and matrix S.

4.2.2.5. Model Testing and Modification. After obtaining parameter estimates for the specified theoretical model of creative cognition, the researcher progressed to the next phase (stages four and five) of the SEM analysis. The researcher decided to combine stages four (model testing) and five (model modification) due to the approach used in model testing. This approach involved deconstructing the hypothesised theoretical model developed in the model specification stage and individually testing its comprising features. Modifications to the model were then made, depending on the result obtained in the analysis, before testing the next model. The final theoretical model comprised of the accepted and modified models. The last SEM analysis involved assessing the final theoretical model of creative cognition. The models were evaluated in terms of: (1.) model fit indices, namely absolute and comparative fit indices, (2.) regression weights (β) to assess the strength of the relationships between variables and (3.) mediation effects. The following sections discuss these criteria in further detail.

4.2.2.5.1. Model Fit Indices. The first step of the model testing stage involved the deconstruction of the hypothesised model and the individual assessment of its subcomponents. Each SEM model was evaluated using various global fit measures, which were employed to establish whether the initially developed theoretical model adequately fitted the sample data (Crockett, 2012).

The types of indices analysed in this study included absolute and comparative model fit indices. Absolute fit indices focus on the ability of the structural model to reproduce the sample S matrix (Cangur & Ercan, 2015). That is, absolute fit tests are concerned with how well the interrelationships demonstrated in the theoretical model match those between the actual or observed interrelationships (Meyers et al., 2016). Commonly used absolute fit indices include the χ^2 goodness of fit test, the ratio of minimum discrepancy to the degree of freedom (χ^2/df), and the root mean square error of approximation (RMSEA; Meyers et al., 2016). In terms of the χ^2 test, a non-significant statistic, which was conducted at a significance level, $\alpha = .05$, indicates that the matrix Σ is similar to matrix S and, hence, that the theoretical model fits the data well. In addition to the χ^2 test, the current study considered the χ^2/df ratio to determine the goodness of fit. For correct models, the ratio should be close to 1; however, values ≤ 2 are generally also accepted as indicators of a good fit (Hooper et al., 2008).

In conjunction with the tests mentioned above, an additional absolute fit index considered in this study was RMSEA. This test is a badness of fit index that quantifies the degree of approximate fit, instead of a perfect fit in the χ^2 test. RMSEA examines whether the theoretical model exceeds an adequate level of close fit to the data and, hence, indicates misfit. The index values range from .00 to 1.00, with lower values signifying a better fit of the model to the data (Crockett, 2012). In particular, while RMSEA values below .05 demonstrate close fit, values ≤ .10 are indicative of an adequately fitting model (MacCallum et al., 1996). This section considered the absolute fit indices alongside additional global measures of fit, namely comparative fit indices.

Unlike the previously discussed absolute fit indices, which contrast the theoretical model to a model that perfectly fits the data, comparative fit indices compare the theoretical model to a standard model that poorly fits the data. Comparative fit indices are incremental tests that identify where the model fit lies on a continuum that ranges from worst fit, whereby there is no relationships present in the data set, to a perfectly fitting model (Crockett, 2012). The comparative fit indices used in this study included the comparative fit index (CFI) and the Tucker-Lewis index (TLI). Both of these fit indices range from 0 to 1, with values ≥ .90 indicating that the model fits the data adequately, and values ≥ .95 signifying an excellent model fit (Hooper et al., 2008).

Once the overall global fit was established for the comprising model, as well as for the final model, the next step of the model testing stage was to evaluate the fit of individual model parameters. This step considered whether the regression weights of each parameter was statistically significant from zero. This criterion is discussed further in the following section.

4.2.2.5.2. Regression Weights. Together with the goodness of fit assessment, an evaluation of the statistical significance of estimated parameters was conducted. Each of the models comprised of parameters, i.e., path coefficients (regression weights). The models included two types of regression weights that were tested and evaluated, namely the regression weight between both observed and unobserved variables (loading factor) and the regression weights between the dependent and independent constructs, that is the path coefficient (β).

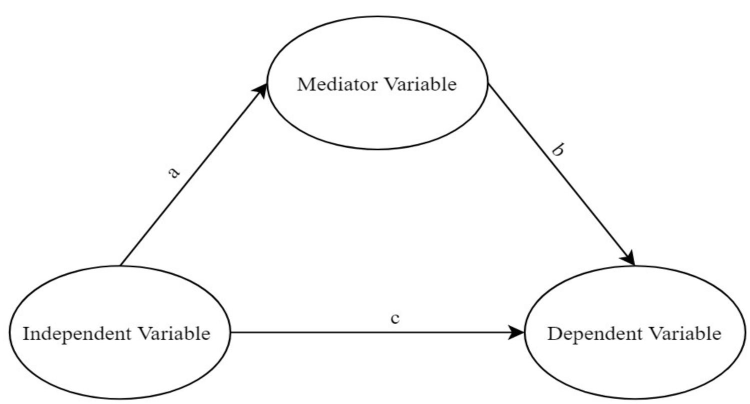
In order to determine the statistical significance of regression weights, the critical ratio (CR) was considered, which uses the ratio between parameter estimates (regression weights) and its standard error (SE) to derive a z-statistic. A CR > 1.96 indicates a regression coefficient that is statistically different from zero based on a .05 level of significance. That is, a regression weight with a CR > 1.96 indicates that the path is significant at a .05 level of significance (Widaman & Grimm, 2014). Lastly, in addition to evaluating whether the regression weights were significant, it is important to assess whether these pathways run in the expected direction and can be meaningfully interpreted (Crockett, 2012). In addition to the criteria discussed above, the current study evaluated the mediation effects. The next section discusses the method of assessing mediation.

4.2.2.5.3. Mediation Effect. A variable functions as a mediator if it explains the relationship between a predictor (IV) and a criterion (DV) (Baron & Kenny, 1986). Figure 14 demonstrates an example of how a mediator variable functions in a three-variable relationship. In this model, the DV results from two causal paths, namely the direct effect of the IV (path c) and the indirect effect of the mediator variable (path b). In addition, there is a path that feeds into the mediator from the IV (path a). A variable functions as a mediator if it meets all of the following criteria:

1. A change in the level of the IV significantly accounts for a change in the mediator (path a).
2. A change in the presumed mediator significantly accounts for a change in the DV (path b).
3. When both path a and path b have been controlled, the previously significant relationship between the IV and the DV becomes non-significant (Baron & Kenny, 1986).

Figure 14

Basic causal chain involved in mediation.



In order to test for mediation in each of the models, the following regression equations were estimated: the mediator variable was first regressed on the IV; the DV was subsequently regressed on the IV; and lastly, the DV was regressed on both on the IV and the mediator variable. Separate regression coefficients for each of the above equations were estimated and tested. Mediation was established if the following criteria were met: (1.) the IV influenced the mediator in the first regression equation, (2.) the IV directly influenced the DV in the second regression equation, (3.) the mediator influenced the DV in the third regression equation. If all of these criteria were met, and if they were in the predicted direction, then the influence of the IV on the DV had to be less in the third equation compared to the effect in the second equation. Moreover, since the IV is presumed to cause the mediator, these two variables were expected to correlate significantly with each other (Baron & Kenny, 1986).

The current research used Sobel's (1982) test, illustrated in(4), to evaluate the significance of the indirect effect of the IV on the DV via the mediator. In Figure 14, *a* represents the regression coefficient for the relationship between the IV and the mediator variable. The regression coefficient for the relationship between the mediator variable and the DV is represented by *b*. The variable Se_a represents the SE of the relationship between the IV and the mediator. Finally, SE_b signifies the SE of the relationship between the mediator and the DV.

$$z = \frac{ab}{\sqrt{(b^2 {SE_a}^2) + (a^2 {SE_b}^2)}} \tag{4}$$

The present study made use of the three-stage approach discussed by Gunzler et al. (2013) and Zhao et al. (2010) to identify the presence and type of mediation in each of the analysed models. The first stage of evaluating mediation assessed the initial relationship between the IV and the DV in the absence of the mediator. The second stage assessed the relationship between the mediator and both the IV and DV. These analyses determined the presence or absence of mediation. If both relationships were significant, then some form of mediation occurred. However, if any of these two relationships were non-significant, then no mediation occurred. Additionally, if the relationship analysed in step one was significant, the IV directly predicted the DV and, thus, no mediation occurred. However, if none of the relationships mentioned above were significant, neither mediation nor a direct effect occurred (Gunzler et al., 2013; Zhao et al., 2010). Stage three evaluated the relationship between the IV and DV in the presence of the mediator. This determined not only the presence but also the type of mediation, which are listed below:

1. If there was initially a significant relationship between the IV and DV in the first stage and, subsequently, a non-significant relationship between these two variables

once the mediator was introduced, then it was concluded that full mediation occurred.

2. If there initially was a significant relationship between the IV and DV in the first stage and, subsequently, a significant relationship between these two variables once the mediator was introduced, then it was concluded that partial mediation occurred.
3. If there was initially a non-significant relationship between the IV and DV in the first stage and, subsequently, a significant relationship between these two variables once the mediator was introduced, then it was concluded that an indirect effect occurred through the mediator.
4. If there was initially a non-significant relationship between the IV and DV in the first stage and, subsequently, a non-significant relationship between these two variables once the mediator was introduced, then it was concluded that no mediation occurred and that there was no significant relationship between the IV and DV (Gunzler et al., 2013; Zhao et al., 2010).

In addition to determining the type of mediation, the present study evaluated a continuously graded statistic, namely the effect ratio (P_M), to identify the percentage of mediation that occurred. P_M, presented in (5), is the ratio of the indirect effect to the total effect (Woody, 2011).

$$P_M = \frac{IE}{TE} \tag{5}$$

In terms of Figure 14, the formula is demonstrated in (6):

$$P_M = \frac{ab}{ab + c} \tag{6}$$

In summary, the above sections provide the rationale for using SEM in the current study, the assessment of whether the data propitiated the underlying assumptions of SEM, as well as a description of the five-step guide to SEM analysis (Crockett, 2012) employed in the current research. Additionally, the criteria used to evaluate the adequacy of the models tested in this study were outlined in the previous sections. These criteria included global model fit indices, namely absolute and comparative fit indices, the fit of individual parameters (regression weights), as well as mediation effects. The next section describes the second inferential analysis technique used to address the second aim on the study, namely group-difference analysis.

3.8.4.2. Group-difference Analysis.. As previously discussed, the second aim of the current study was to investigate whether particular demographic variables, namely age, multilingualism, SES, level of education and gender, predicted any of the individual cognitive processes included in the model of creative cognition. An effective SEM method of evaluating whether there are significant differences in test scores across pre-defined data groups is multi-group analysis. This statistical technique assesses the extent to which moderator variables, such as demographic factors, affect the strength and direction of the relationship between IVs and DVs(Henseler & Fassott, 2010). However, although the *N*:q ratio discussed in the previous sections indicates that 125 participants is sufficient to conduct SEM, the sample of the current study is not large enough to conduct multi-group analysis. In particular, for multi-group analysis, a general rule of thumb stipulates that there should be 100 participants in each data group (Kline, 2016; Wang & Wang, 2012). Multi-group analysis, in the context of the current research, would require a much larger sample size due to the fact that the theoretical model would need to be fit to data for each sub-group of all the demographic variables.

Consequently, a combination of group-difference analyses techniques was selected as the statistical analysis method to assess the differences in test performance based on different groups of demographic variables. The number of groups in the categorical variable determined whether a *t*-test or a one-way analysis of variance (ANOVA) was used. Differences in test performance on demographic variables comprised of two categorical groups, namely level of education and gender, were analysed with an independent *t*-test as both variables comprised of unrelated groups. In contrast, demographic variables comprised of more than two categorical groups, namely age, multilingualism and SES, were analysed with a one-way ANOVA (Abbott, 2016). Similar to SEM, certain statistical assumptions are required to be met before conducting group-difference analyses, such as the assumptions of normality and homogeneity, which are discussed further below. In addition, the method of identifying differences between multiple groups, namely the Games-Howell post hoc test, as well as the test used to explore the size of any effect found, namely Cohen's *d*, are discussed in the subsequent sections.

3.8.4.2.1. Assumptions. As previously mentioned, most statistical analysis procedures assume certain characteristics about the data. In particular, parametric tests require the data to meet the assumptions of normality and homogeneity of variance. Violations of these assumptions can significantly affect the interpretation of results and the research conclusions (Marshall & Jonker, 2010). This stage of the research, therefore, included the Shapiro-Wilk test to determine whether test scores for each instrument were normally distributed for each demographic category. Shapiro-Wilk test *p*-values greater than .05 indicates a normally distributed data set (Razali & Wah, 2011). In addition, this stage of the research analysis included Levene's test, which assessed the assumption of homogeneity of variance. For the assumption of homogeneity of variance to be met, *p*-values needed to be non-significant based on an alpha value of .05 (Abbott, 2016). The results revealed that the assumption of normality was violated, but only on certain tests, and that the assumption of homogeneity of variance was violated for the majority of the instruments. Therefore, Welch's *t*-test and Welch's ANOVA were used as alternative statistical analysis techniques, since they are more reliable in instances where the assumption of homogeneity of variance has been violated (Field, 2013). All *t*-tests were two-tailed with the probability of rejecting the null hypothesis when it is accurate set at a .05 level of significance, which ensured a 95% certainty that any significant differences did not occur by chance. The ANOVAs applied the F-test to determine if there were any significant differences at a significance level, $\alpha = .05$.

3.8.4.2.1. Post Hoc and Effect Size. It is important to note that when using an ANOVA to assess the equality of three or more group means, statistically significant results only indicate that not all group means are equal. That is, ANOVA results do not reveal which particular differences between group means are significant. Therefore, if the ANOVA yielded significant group-differences, a Games-Howell post hoc test was used to explore differences between multiple groups means. This post hoc test was selected as it does not assume equal variances and sample sizes (Abbott, 2016). In addition, both the *t*-test and the ANOVA yielded significant results, Cohen's *d* was calculated using the equation depicted in (7).

$$d = \frac{\mu_1 - \mu_2}{S_p} \tag{7}$$

Cohen's *d* values reflect the effect size of the standardised difference between two means (μ_1 & μ_2; Field, 2013). The pooled estimated population standard deviation (S_p) was first calculated and subsequently substituted into the above equation. The formula for S_p is demonstrated in (8).

$$S_p = \sqrt{\frac{(N_1 - 1).{S_1}^2 + (N_2 - 1).{S_2}^2}{N_1 + N_2 - 2}} \tag{8}$$

In terms of interpreting Cohen's *d,* values ≤ .20 indicate a small effect size, values ranging between .20 and .50 indicate a small to medium effect size, values between .50 and .80 indicate a medium to large effect size, and values ≥ .80 indicate a very large effect size (Warne, 2017).

To summarise, the previous section discusses the group-difference analyses used in the current study. In particular, the assumption associated with this statistical analysis is first discussed followed by the grounds for selecting particular group-difference analysis techniques based on the analysis of these assumptions. Specifically, the current study used Welch's *t*-test and Welch's ANOVA, as well as the Games-Howell post hoc test as the data were found to violate the assumption of homogeneity of variance. Additionally, the method of evaluating the size of a found effect, namely Cohen's *d*, was discussed. The final section of the research methods chapter discussed the ethical considerations undertaken in the current study.

3.8.5. Ethical Considerations

There are numerous challenges associated with including an elderly sample that need to be considered and addressed. These include practical challenges in undertaking geriatric research, difficulties in administering specific measures and research procedures, inconvenience, age-related impairments that may hinder the elderly from providing informed consent, cost, as well as social and cultural barriers that obstruct access to the population. Additionally, research often excludes elderly samples, which is typically motivated by the desire to abide by the ethical principle of autonomy delineated in the Belmont report. However, in doing so, researchers violate the ethical principle of justice, thus preventing this sector of the population from reaping the benefits of research (İlgili et al., 2014). Moreover, exclusion of the elderly on the premises of the autonomy principle is problematic as it portrays the elderly as a homogenous population who all have impaired decision-making capabilities and are, as a consequence, disregarded as free, self-governing agents (Sherwin & Winsby, 2011). Although there are several challenges associated with including an elderly research sample, the exclusion of individuals on age grounds without scientific justification presents greater ethical problems for researchers (İlgili et al., 2014). The present study needed to abide by the accepted guidelines and standards for moral conduct that governs research. These standards ensure that others are considered as moral equals and that the researchers' actions were well-intended and premediated. The ethical considerations for this research were based on the principles mentioned above, including autonomy and beneficence, which both ensured that participants were treated equally and fairly (Tangwa, 2009).

Firstly, the present study adhered to the principle of autonomy by valuing the judgment of participants, which ensured that unwanted decisions were not imposed on them. The practice of informed consent is based on this fundamental principle, whereby a capable participant, or a representative who has been legally authorised, is permitted to make a cognizant decision whether or not to participate in the research (Owonikoko, 2013). Therefore, the participants were informed that their participation in the current research was entirely voluntary and that they were not obliged to do so. Moreover, participants were permitted to withdraw from the study at any point and had the option to not answer any of the questions without a given reason or fear of negative consequences.

The study's protocol was disclosed to the participants, including its purpose and aims as well as the estimated duration of assessment. Additionally, the participants were notified about aspects of the research that could influence their willingness to participate, such as any anticipated risks of distress (Michie, 2008). These included the possibility of experiencing emotional distress, frustration or test anxiety due to the perceived difficulty of the research instruments. All participants were provided with information about a free counselling service, which was notified about the study before it began. Participants could contact this service if they experienced any distress as a result of the research. Finally, this study ultimately adhered to the principle of autonomy, and the related practice of informed consent, by making it mandatory for participants to sign an informed consent sheet (see Appendix F) once they had read the information sheet (see Appendix G), which disclosed the information as mentioned earlier.

The disclosure of the above-mentioned potential risk factors and the availability of counselling services is related to the ethical principles of beneficence and non-maleficence. These principles refer to the obligation to maximise research benefits and to minimise harm to the participants (Tangwa, 2009). They entail protecting participants' identity through confidentiality and anonymity (Pollock, 2012). Although anonymity and confidentiality are related procedures, there are significant differences between them that were made clear to the participants to ensure that they did not confuse or misunderstand the techniques. Since the researcher administered the questionnaires and cognitive tests, this study involved face-to-face interactions between the participants and the researcher. Therefore, complete anonymity could not be guaranteed (Coffelt, 2017).

Nevertheless, the researcher took measures to ensure that all obtained information remains confidential both during and after the course of the study. These included assigning each participant an identification number and using an identification file to link the participants' names to their identification number in the event of information being misplaced or inconsistent. The identification file and data records are stored on a password-protected computer, and test protocols are stored in a locked filing cabinet, which remain private with access restricted to the individuals involved in the research. Therefore, participants were notified that, although the researcher could not guarantee anonymity, confidentiality was ensured throughout the course of the research, as well as during the dissemination of results and findings. Finally, before this study proceeded to the data collection stage, the research proposal was reviewed and approved by the Human Research Ethics Committee (medical) of the University of Witwatersrand (protocol number: M180726, see Appendix H).

3.9. Summary

This chapter outlined the methods used to address the research questions. A discussion of the rationale identified four areas to which the study makes a potential contribution, namely theoretical, methodological, applied, and social significance. The two main research questions of the study were (1.) is matrix S equal to matrix Σ? and (2.) are there statistically significant differences on fluid intelligence, inhibition and task-switching, divergent, convergent and associative thinking by age, multilingualism, SES, education, and gender on the relationship? This chapter provided a hypothesised theoretical model of creativity, as well as statistical hypotheses for the research questions. The research design, which was quantitative, correlational, and cross-sectional, provided an appropriate framework for the current study.

A discussion of the sample, instruments and procedure outlined the specifics of the overall study. It described who took part in the study, how they were recruited and tested, and how the study, in general, was conducted. Specifically, 125 individuals above the age of 64 were recruited using both convenience and snowball sampling strategies. Participants completed various questionnaires that obtained information about their demographics, capacity to live independently and language proficiency. Additionally, participants completed a battery of cognitive tests to assess the cognitive functions of interest in the current study. These included executive functions, namely task-switching, inhibition, and fluid intelligence, as well as components of creativity, namely divergent, convergent and associative thinking.

The discussion of procedures indicated the overall process flow of the current study. It outlined procedures leading up to data collection, including the training that the researcher underwent, and the pilot study conducted to assess the feasibility of the large-scale study. A two-step approach to data collection was subsequently provided, which first involved a description of the data gleaning process followed by a description of the data cleaning process. Additionally, the statistical analyses techniques were discussed. This included an in-depth description of SEM analysis techniques, which were used to address the first research aim, as well as group-difference analysis techniques, which were used to address the second aim of the study. Lastly, this chapter outlined the potential ethical issues of the current study and the procedures used to address them. The ethical considerations for this research were based on the principles of autonomy and beneficence. This study abided by the principle of autonomy through the practice of informed consent, and it complied with the principle of beneficence by ensuring that all collected information remained confidential. The subsequent chapters of this thesis present the results obtained once the data were analysed. In particular, the goal of the next chapter is to describe and present the findings from both the pilot and large-scale studies.

Chapter 4: Results

This chapter presents and reports the findings from the current study and is organised into two main sections. The first section describes the pilot study, including the rationale, as well as methods, instruments and procedures used. Additionally, it presents the results from the pilot study, including the changes made to the large-scale, such as the inclusion of breaks during the administration and the adjustment of inappropriate RAT items. The second section of this chapter reports the results from the large-scale study and comprises of three sections. The first section comprises of the descriptive analysis and the second and third sections include the inferential analyses. The two sections of the inferential analysis include the results from the SEM and the group-difference analysis, respectively. In the SEM stage of the analysis, seven deconstructed models are presented including the results from their analysis as well as any modifications made to each model. The final theoretical model of creative cognition is then presented. This model was made up of a combination of the deconstructed models that not only had the best fit but also contained only significant pathways. The results from the analysis of the final theoretical model are then provided, including the analysis of model fit, regressions, and mediation effects. Together, these results were used to address the first aim of the current study. Next, the results from the group-difference analysis are presented. This stage of the analysis is comprised of five subsections, each of which are dedicated to presenting the results from the analysis of each demographic variable, namely age, multilingualism, SES, level of education and gender. Together the results from this stage of the analysis were used to address the second aim of the current study.

4.1. Pilot Study

A pilot study is a crucial step in the research process and can be used in two different ways. Firstly, it can be used as a feasibility study, which refer to scaled-down versions of a larger study, or trial runs, that are undertaken in preparation for the final, full-scale study (van Teijlingen & Hundley, 2002). A pilot study can also be used as a pre-test or the 'trying out' of a particular research approach, including research methods, procedures and resources intended for a large-scale study. Unlike the large-scale study, research does not use a pilot study for hypothesis testing. Instead, it primarily serves as an earlier-phase developmental function that increases the likelihood of success in the larger ensuing study (Leon et al., 2011). Therefore, in preparation for the full-scale study, a pilot study was conducted, which served as a feasibility study and a pre-test of the final study's processes, methods and resources. This section first provides a rationale for conducting a pilot study, followed by a brief overview of the sample recruited, as well as the methods and instruments used.

4.1.1. Rationale

The rationale for including a pilot study in the present research was that it presented various benefits and advantages, which can be subsumed under different classifications, including process, resources and management. In terms of process, the pilot study enabled the feasibility of the steps to be taken in the full-scale study to be evaluated (Thabane et al., 2010). The pilot study enabled the researcher to evaluate whether the research protocol, described in Chapter 3, was realistic and workable. Additionally, it enabled the likelihood of success of proposed recruitment strategies, the effectiveness of the sampling frame and technique, as well as the sufficiency of the proposed eligibility criteria to be evaluated (Thabane et al., 2010; van Teijlingen & Hundley, 2002).

The advantages that a pilot study confers on research resources are its ability to assess the appropriateness and adequacy of data collection instruments and to uncover issues regarding time and budget that may occur in the main study (Thabane et al., 2010). The total duration of the testing procedure was particularly important to evaluate since the current study included multiple cognitive assessments and a sample that was prone to fatigue. Furthermore, it was essential to pre-test the instruments with this population since, to the researcher's awareness, some of the measures (AUT and the RAT) had yet to be applied in the South African context. Finally, the pilot study enabled the data-capturing software and data analysis techniques to be pre-tested to uncover unanticipated factors that could pose significant problems in the large scale study (Thabane et al., 2010; van Teijlingen & Hundley, 2002).

Lastly, the pilot study helped to identify potential issues relating to human or data management, such as issues associated with entering and storing data. It also provided the researcher with an opportunity to gain experience and familiarity with the various elements of the research process before undertaking the main study. Therefore, the researcher included a pilot study as it presented multiple advantages. The aim of the pilot study in the present research was to provide an advanced warning regarding areas where the main study could potentially fail, to indicate areas where deviations from protocols might occur and to provide any information that could promote the efficiency and accuracy and, therefore, the success of the main study (van Teijlingen & Hundley, 2002)

4.1.2. Sample

The researcher conducted the pilot study on a small subsample of the target population, including ten elderly participants above the age of 64 years. The participants were recruited using the same sampling strategies employed in the main study, namely convenience and snowball sampling. The pilot study also used the same selection criteria as the large-scale study. These included prospective participants being sufficiently fluent in English, capable of independent daily living and an absence of any cognitive impairments that may affect their performance on the cognitive tests. The study took place at a date and time that was suitable for the participants and took place at their place of residence as it proved to be the most convenient location for the participants.

The pilot sample comprised of 4 male and 6 female participants (n = 10), with a mean age of 72.5 years (SD = 6.654) and an average of 14.8 years of education. All the participants who took part in the pilot study spoke English as their home language. Like the large-scale study, the participants in the pilot study were categorised in SES groups based on the scores obtained on the LSM (Haupt, 2006), with 8 participants residing in the high SES group and two participants falling within the upper socio-economic bracket. Additionally, the pilot sample was categorised according to the number of languages they reported being able to speak. The sample comprised of two monolinguals, three bilinguals and five multilinguals (individuals who spoke three languages and more).

4.1.3. Instruments

To ensure that accurate and optimal measurements were collected, the pilot study entailed pre-testing all questionnaires and data collection tools included in the full-scale study. Chapter 3 provides a full description of these measures. Briefly, the instruments that were pre-tested included the demographic questionnaire, which gathered information regarding participants' age, gender, level of education, home language and living standards. Additionally, two screening tools were evaluated, including the IADL, which assess participants' independent living skills, and the MoCA, which was used as a rapid screening assessment to detect mild cognitive impairment. The inclusion of participants was conditional on their ability to execute all activities presented in the IADL and their MoCA score. Instruments that investigated particular aspects of creativity included the AUT (Guilford et al., 1978), which assessed divergent thinking, the RAT (Mednick, 1962), which tested convergent thinking, and two verbal fluency tests, namely the letter and animal category fluency. Higher-level cognitive functions were assessed via the SPM, which served as a measure of fluid intelligence and the VS, which evaluated inhibition. Additional instruments included the DF, which served as an additional indicator of divergent thinking (Condition 1 & 2) and task-switching (Condition 3), as well as the LEAP-Q, which established a comprehensive profile of the extent of multilingualism.

4.1.4. Procedure

The pilot study used the same data collection methods intended for the main study, including the first and second phases. Chapter 3 provides a full description of the research procedures. Briefly, the first phase of data collection included the disclosure of relevant information about the study and the signing of the informed consent sheet. Participants were then assessed to determine whether or not they met the inclusion criteria. The cognitive tests were then administered to the participants using the same administration techniques and research conditions as intended for the main study.

Additional procedures were included in the first phase of data collection process that were unique to the pilot study, including behaviour coding, cognitive interviews, and individual debriefing. Behaviour coding entailed the researcher watching and taking notes of participants' behaviours as they progressed through the various tests to identify possible problems with the questionnaires and instruments, such as confusion, hesitation or frustration. For the cognitive interviews, the researcher encouraged participants to think out loud or narrate their thought processes while they took the tests. Once the participants had completed the battery of tests, the researcher individually debriefed them in order to explicitly gather information and feedback about instructions, specific questions, the design of each test and the research process. Together, these processes were used to identified problem areas, provide information on how to reduce both measurement error and respondent burden, as well as to determine whether or not instructions and questions were correctly understood and interpreted by the participants (Ruel et al., 2015).

In addition, the pilot study provided raw data to evaluate the second phase of the data collection process, including the methods of organising and refining data, as well as data entry and data processing procedures. The preliminary coding and analyses of data were undertaken to investigate the capability and accuracy of data capturing and analysis programs. This process of the pilot study identified whether the initial coding, entry and management of data was executed effectively and precisely in a timely manner, and enabled any prevalent issues to be corrected (Ruel et al., 2015).

4.1.5. Findings

Analysis of performance and participants' feedback from the pilot study revealed several minor problems, such as unclear instructions and test content, as well as issues associated with data capturing and test format, that were rapidly rectified. However, more crucial problems were encountered in the pilot study that converged on some common themes, which the next sections discuss further.

4.1.5.1. Administration Time. The total duration of the study for each participant was initially estimated to be between 50 to 60 minutes. However, participants in the pilot study took longer than this to complete the entire test battery. Total administration time ranged between 80 and 90 minutes per person.

The discrepancy between proposed and actual administration times may have been due to additional factors, such as providing instructions for each test, as well as clarifying or answering questions regarding test instructions, that were initially overlooked. Moreover, the researcher initially underestimated the duration of untimed tests such as the SPM, which typically takes between 16 and 24 minutes to complete (Van der Elst et al., 2013). Since participants had an unlimited time frame in which to complete the SPM, this test became relatively time-consuming as participants often became preoccupied with providing the correct answer and, therefore, took their time to consider items. Additional factors that were unrelated to research procedures also contributed to the overall duration of administration. These included the participants' desire to discuss the study or particular instruments during the testing procedure, as well as environmental distractors, such as disturbances from visitors, family members, pets or telephone calls. However, the researcher found that an effective strategy to minimise the effect of these factors was to first prepare participants for the nature of the experience. This included requesting to hold questions for the break or the end of the study, as well as to eliminate potential interruptions.

The main concern related to the long administration time was respondent fatigue, which occurs when participants become tired of research tasks, resulting in a deterioration in the quality of data (Ben-Nun, 2008). Respondent fatigue was an essential factor to consider in the present research as the elderly are particularly prone to fatigue (Klienpell & Mick, 2009). However, the researcher found particular measures, such as pacing test administration and allowing for breaks, to be effective in minimising respondent fatigue.

4.1.5.2. Inappropriate Content. The RAT used included the 30 items selected and evaluated by Lee et al. (2014). They obtained these items from Bowden and Jung-Beeman's (2003) bank of 144 remote associate problems. Although this 30-item version was validated (Lee et al., 2014), the pilot study revealed that certain items were inappropriate for a South African population. In particular, when each RAT problem was analysed with regards to its corresponding solution, the researcher discovered that participants were at times unfamiliar with some of the compound words or phrases generated when the cues were combined with the solution word. As a consequence, the participants were unable to identify suitable associate words. The researcher identified these inappropriate RAT items and obtained suitable replacements by revising Lee and colleagues' (2014) original 30 items and shortlisting potential replacement items from Bowden and Jung-Beeman's (2003) RAT bank. The researcher then checked whether the participants were familiar with the answers to the potential replacement items. If the majority of the participants were familiar with the generated compound words or phrases, then the item was suitably replaced. Table 4 presents the inappropriate problems and replacement items.

Table 4

Inappropriate and Replacement RAT problems

Inappropriate Items		Replacement Items	
Cue Words	Solution	Cue Words	Solution
Nuclear/feud/album	Family	Rocking/wheel/high	Chair
Carpet/alert/ink	Red	Flower/friend/scout	Girl
Main/sweeper/light	Street	Health/taker/less	Care
Basket/eight/snow	Eight	Cover/arm/wear	Under
Show/life/row	Boat	Control/place/rate	Birth
Loser/throat/spot	Sore	Cross/rain/tie	Bow
Sense/courtesy/place	Common	Home/sea/bed	Sick
Preserve/range/tropical	Forest	Wise/work/tower	Clock
Flake/mobile/cone	Snow	Force/line/mail	Air
Fountain/baking/pop	Soda	Man/glue/star	Super
Duck/fold/dollar	Bill	Pea/shell/chest	Nut

In summary, the pilot study enabled crucial problems, such as extensive administration time and inappropriate content to be identified and rectified. Moreover, it demonstrated that the main study was feasible with these modifications and close monitoring. Therefore, the researcher administered the main procedure described in Chapter 3 to a full sample. This included providing participants with the information and informed consent sheet, the administration of the battery of cognitive tests, as well as the organisation and refinement of the raw data. The next sections present the results in the full-scale study and discuss them with reference to the two main research aims.

4.2. Large-scale Study

This section reports the findings from the large-scale study and comprises of three main sections. The first section presents the results from the descriptive analyses, which quantitatively describe and aggregate information about the variables in the dataset. The data is described in terms of both measures of central tendency, including means and medians, as well as measures of variability, including standard deviations (SD), minimum, maximum, interquartile ranges (IR), skewness, and kurtosis. The second and third sections involve the inferential analyses, which drew conclusions that could not be derived from the descriptive statistics (Marshall & Jonker, 2010). Specifically, inferential statistics were used alongside hypothesis testing to answer the research questions. Therefore, the second and third sections of this chapter present the results that address the two main aims of the current research.

The second section addresses the first aim of the study, which was to develop a coherent theoretical model of creativity. In order to address this aim, multivariate statistical analyses were used to identify, describe and explore the relationships between executive functions, including fluid intelligence, task-switching and inhibition, and components of creative thinking, namely divergent, convergent and associative thinking. Specifically, structural equation modelling (SEM) was used to investigate whether the empirical data supported the theoretical model of creative cognition developed in the initial stages of this research (see Figure 12). As previously mentions, the current study made use of the five-step guide to SEM analysis described by Crockett (2012), which included (1.) model specification, (2) model identification, (3.) model estimation, (4.) model testing, and (5.) model modification. The first step of the analysis (model specification) was undertaken during the review of the literature (see Chapter 2). Moreover, the findings from stage two (model identification) and stage three (model estimation) are presented in Chapter 3. The following sections present the results from the last two stages of SEM analysis, namely model testing (stage four) and model modification (stage five). The researcher combined these stages due to the approach taken in model testing.

Specifically, the approach involved deconstructing the hypothesised theoretical model developed in the model specification stage and individually testing the comprising components. Modifications to the model were then made, depending on the result obtained in the analysis, before testing the next model. The final model comprised of the accepted and modified models. The last SEM analysis involved assessing the final theoretical model. This assessment ultimately tested the degree to which the data supported the final, modified structural model of creativity.

The third section presents the results from the next stage of the inferential analysis, which addressed the second aim of this study. Specifically, the second aim of the study was to investigate whether certain demographic variables, such as age, the number of spoken languages, SES, level of education, and gender, predicted any of the individual functions included on the theoretical model of creative cognition. Group-difference analyses, namely a Welch's *t*-test (used for demographic variables with two categorical groups) or a Welch's one-way analysis of variance (ANOVA; used for demographic variables with more than two categorical groups), were used to explore the effects of the above-mentioned demographic variables on measures of creativity (divergent, convergent thinking and associative thinking) and executive functions (fluid intelligence, inhibition and task-switching). This section is, therefore, comprised of five subsections, each of which presents the analysis for the respective demographic variables. As previously mentioned, the Welch's *t*-test and Welch's ANOVA were used as alternative statistical analysis techniques, since they are more reliable in instances where the assumption of homogeneity of variance has been violated (Field, 2013). The *t*-statistic (*t*-test) and the *f*-statistic (ANOVA) were calculated to determine whether there were any significant differences between demographic groups (e.g., males and females) at a significance level of $\alpha = .05$. If significant group effects occurred, Cohen's *d* was subsequently calculated to indicate the size of the effect. In addition, if the ANOVA yielded significant group-differences, a Games-Howell post hoc test explored differences between multiple groups means. This post hoc test was selected as it does not assume equal variances and sample sizes (Abbott, 2016).

4.2.1. Descriptive Statistics

The descriptive statistics were calculated to summarise and provide basic information about the dataset. The descriptive statistics also provided information about the variability of the data, as well as indicated unexpected patterns and observations. For the present study, the following descriptive statistics were calculated and analysed: measures of central tendency, including mean (M) and median (x̃), and measures of variability, including standard deviation (SD), minimum, maximum, interquartile range (IR), skewness and kurtosis. Table 5 summarises and systematically organises the results from the descriptive analyses.

Table 5

Summary of Descriptive Statistics for Observed Variables

Variable	Mean	Median	SD	Min	Max	IR	Skewness	Kurtosis
1. AUT	10.94	10	6.89	0	29	10	.47	-.36
2. RAT	5.59	3	5.63	0	21	9	.88	-.27
3. Letter Fluency	12.38	12	5.08	3	24	8	.12	-.84
4. Category Fluency	15.42	16	6.05	2	33	8	.25	.203
6. DF Condition 1	7.39	7	3.25	1	19	5	.71	.83
7. DF Condition 2	7.81	8	3.21	2	20	5	.68	1.06
8. DF Condition 3	5.12	5	2.54	0	12	4	-.05	-.35
9. Set B	7.54	8	2.82	1	12	5	-.39	-.77
10. Set C	6.22	7	2.87	0	12	4	-.30	-.75
11. Set D	6.63	7	3.41	0	12	6	-.27	-1.07
12. VS Time Interference	16.86	15	9.40	4.5	56.5	9.5	1.62	3.45
13. VS Error Interference	.98	0	1.59	-1	8	1.5	1.95	4.49

Note. SD = Standard Deviation. Min = Minimum Score. Max = Maximum score. IR = Interquartile Range. AUT = Alternative Uses Test. RAT = Remote Associates Test. DF = Design Fluency. VS = Victoria Stroop

An analysis of the descriptive statistics indicated notable patterns in the dataset. For example, most of the mean and median values are similar, indicating that the distribution of the data is approximately symmetrical (Marshall & Jonker, 2010). However, there is a notable discrepancy between the mean and median values of the RAT (M = 5.59, x̃ = 3), as well as for the VS, namely time interference (M = 16.86, x̃ = 15) and error interference (M = .98, x̃ = 0). These results suggest that extreme values or high leverage data points for the respective indicators influence the mean values (Cooksey, 2020). Specifically, since the mean values for the RAT, VS time interference and error interference are greater than their respective median values, there is a positive skew in the data distribution, which is confirmed by the skewness values of each test. This indicates that a few participants obtained RAT and VS (time and error interference) scores that were markedly higher than the mean or median scores obtained by the majority of the sample.

Considering the RAT in greater detail, the SD for this test (σ =5.63) indicates that the values in the dataset are relatively close to the mean (Miller & Lovler, 2016). It is worth noting that, as mentioned in Chapter 3, the RAT comprised of 30 items. Therefore, considering the mean and SD values with regards to the number of items included in the test, it is evident that the majority of the sample scored exceedingly low on this test. This suggests the presence of floor effects, which occur when the level of difficulty of test items is so high that participants fail to perform well on even the least challenging items on the test (Banks, 2011). The discrepancy between the mean and median values mentioned above supports this interpretation. In particular, the positive skew indicates that few participants obtained RAT scores that were markedly higher than the mean score.

While these floor effects could be attributed to a variety of factors, in the context of the current research, inappropriate content or language bias may cause this effect. In particular, the RAT used in the present study may contain material that is unfamiliar to certain demographic groups. Therefore, low scores may not necessarily indicate poor convergent thinking abilities, but rather unfamiliarity with the content of the test. Moreover, the RAT is heavily dependent on language as test performance relies on one's ability to form compound words in English. Hence, the RAT favours English-language proficiency skills and, as a consequence, participants whose first language was not English may not have fared as well.

In terms of the VS scores (time and error interference), the positive skew observed in both indicators possibly demonstrates extraneous data or outliers who performed comparatively worse than the majority of the sample. Higher time interference scores indicate slower performance, whereas higher error interference indicates less accurate performance (Caffarra et al., 2002). The presence of outliers is supported when the minimum and maximum values for both indicators are taken into consideration. For instance, there is a large discrepancy between the minimum and maximum values for the time interference scores (4.5, 56.5) and error interference scores (-1, 8). The possibility of outliers in the data needs to be taken into account as they have significant implications for SEM. Outliers have the potential to distort the results of SEM seriously and, therefore, affect the model significance (Kline, 2016). The subsequent section presents the results from the fourth (model testing) and fifth (model modification) stage of the SEM analysis.

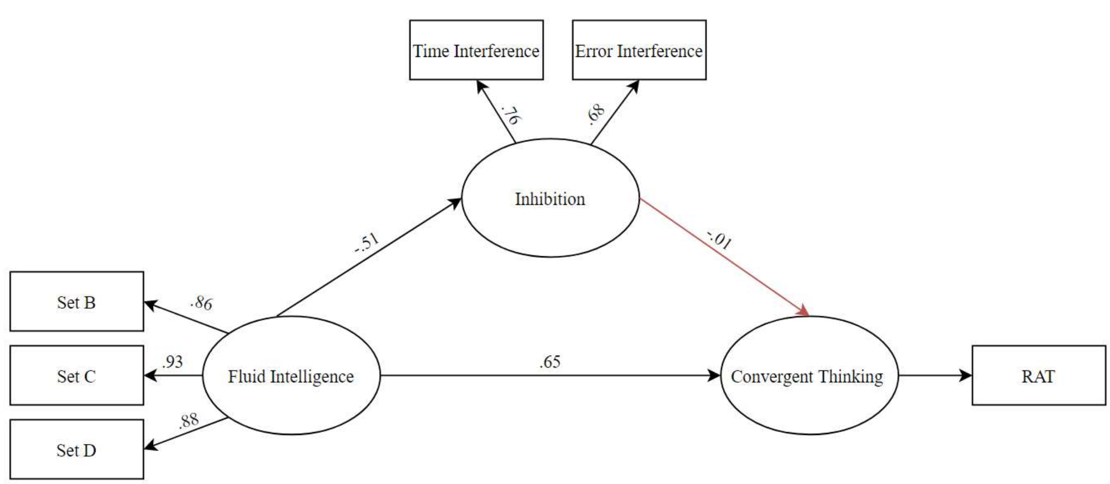
4.2.2. Results from Structural Equation Modelling (SEM).

This section presents the results from the SEM analysis of the theoretical model of creativity. As previously mentioned, the researcher deconstructed the overall hypothesised theoretical model into smaller models and individually tested them according to the criteria discussed in Chapter 3. These criteria included global fit indices, regression weights and mediation effects. In particular, all statistically significant regression weights and mediation paths, including full, partial and indirect paths, in each of these models were considered to be adequate indicators. Modifications to the model were then made, depending on the result obtained in the analysis, before testing the next model. Modifications involved the elimination of any non-significant paths that were considered trivial (Byrne, 2001). Therefore, models that met the global goodness of fit criteria and had adequate indicators were incorporated in the final structural model. The final model was then analysed as a whole according to the same criteria.

4.2.2.1. Model 1: The Relationship between Fluid Intelligence, Inhibition and Convergent Thinking. This analysis assessed the relationship between fluid intelligence, inhibition and convergent thinking. Fluid intelligence was specified as the exogenous variable, whereas inhibition and convergent thinking were specified as the endogenous variables. Additionally, inhibition was specified as the variable that mediated the relationship between fluid intelligence and convergent thinking. The model was embedded in the diagram is presented in Figure 15. The standardised factor loadings for the indicators of each latent variable were as follows: Set B (.86), Set C (.93), Set D (.88), Time Interference (.76) and Error Interference (.68), $p < .001$. As demonstrated, most of these loadings exceed the .70 cut-off value. Although the loading for Error Interference falls slightly below this cut-off, factor loadings above .60 are considered to be adequate (Bagozzi & Yi, 1988). These results demonstrate that all the indicators sufficiently load onto their respective factors.

Figure 15

Relationship between Fluid Intelligence, Inhibition and Convergent Thinking.



Regarding the first criterion to analyse the models, namely global measures of model fit, the model fit indices demonstrated that the model sufficiently fit the data (χ^2 = 2.724, *df* = 7, *p* = .909, χ^2/df = .389, RMSEA = .000, CFI = 1.0, TLI = 1.034). In terms of the next criterion of analysis, namely the respective regression weights, fluid intelligence significantly predicted both inhibition (β = -.51, *z* = -4.334, $p < .001$) and convergent thinking (β = .65, *z* = 6.842, $p < .001$). The finding that fluid intelligence significantly predicts inhibition supports H1 in the hypothesised theoretical model (see Figure 12). It is worth noting that the negative relationship between fluid intelligence and inhibition can be meaningfully interpreted. In particular, higher time and error interference scores are indicative of poorer performance on inhibitory control tasks. It is, therefore, tenable that an increase in fluid intelligence corresponds with an increase in inhibitory control (i.e., lower time and error interference scores).

A non-significant, negative relationship was observed between inhibition and convergent thinking (β = -.01, *z* = -.069, *p* = .945), which rejects H2. This negative relationship can also be meaningfully interpreted as higher scores on measures of convergent thinking presumably correspond with better inhibitory control; however, the relationship was non-significant. Although the researcher did not initially anticipate these results, the non-significant relationship could be attributed to inhibitory control functioning as a generalised characteristic of executive control, rather than a separable factor that independently influences aspects of creativity, namely convergent thinking. Lastly, these results demonstrate that mediation is not supported in this model, as the conditions for mediation were not met. Specifically, the mediator (inhibition) did not significantly predict the DV (convergent thinking).

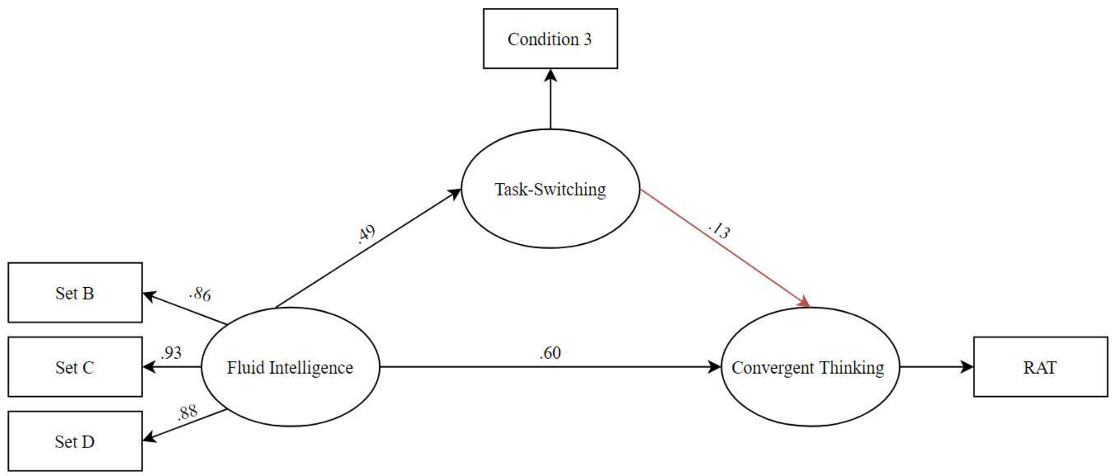
In summary, significant pathways were observed between fluid intelligence and inhibition, as well as between fluid intelligence and convergent thinking, which were both analysed further in subsequent models. Contrarily, a non-significant path occurred between inhibition and convergent thinking, indicated by the red arrow in Figure 15. This path was, therefore, removed and not included in subsequent models.

4.2.2.2. Model 2: The Relationship between Fluid Intelligence, Convergent Thinking and Task-switching. The next model analysed investigated the relationship between fluid intelligence, convergent thinking and task-switching. Fluid intelligence is specified as the exogenous variable, whereas task-switching and convergent thinking are specified as the endogenous variables. The model was embedded in the diagram in Figure 16.

The standardised factor loadings for the indicators of each latent variable were as follows: Set B (.86), Set C (.93) and Set D (.88), $p < .001$. These loadings exceed the .70 cut-off value, which demonstrates that all of the indicators sufficiently load onto their respective factors.

Figure 16

Relationship between Fluid Intelligence, Task-Switching and Convergent Thinking.



Regarding the first criterion used to analyse the models, namely global measures of model fit, the model fit indices demonstrated that the model sufficiently fit the data (χ^2 = , *df* = 4, *p* = , χ^2/df = .430, RMSEA = .000, CFI = 1.0, TLI = 1.024). In terms of the next criterion of analysis, namely the respective regression weights, fluid intelligence significantly predicted both task-switching (β = .49, z = 5.662, p < .001) and convergent thinking (β = .60, z = 6.834, p < .001). The results demonstrating that fluid intelligence significantly predicts task-switching supports H3 in the hypothesised theoretical model.

Task-switching did not significantly predict convergent thinking (β = .13, z = 1.552, p = .121), which rejects H4. Although the researcher did not initially expect this non-significant relationship between task-switching and convergent thinking, these results may be attributed to the notion that when creative tasks, such as the RAT, reside closer to the convergent thinking pole of the creativity continuum, they rely less on the ability to flexibly switch concepts. Instead, these tasks possibly rely on the ability to maintain focus on a current task and to systematically explore potential creative products to find a final solution (De Dreu et al., 2012). This idea is explored further in the subsequent, Discussion chapter.

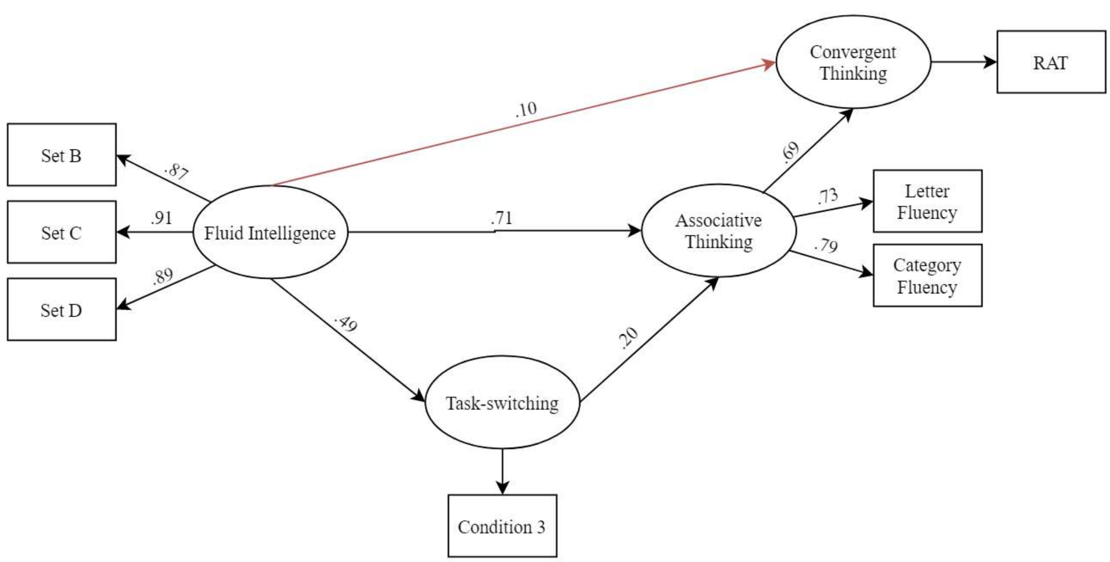
Based on the above results, mediation is not supported in this model as the conditions for mediation were not met. In particular, the mediator (task-switching) did not significantly predict the DV (convergent thinking). The insignificant path between task-switching and convergent thinking, indicated in red, was removed from the model.

In summary, significant pathways were observed between fluid intelligence and task-switching, as well as between fluid intelligence and convergent thinking, which were both analysed further in subsequent models. However, a non-significant path occurred between task-switching and convergent thinking, indicated by the red arrow in Figure 16. This direct path was, therefore, removed and not included in subsequent models.

4.2.2.3. Model 3a: The Relationship between Fluid Intelligence, Convergent Thinking, Task-switching and Associative Thinking. The model depicted and analysed in the previous section was expanded in the model assessed in this section. Specifically, associative thinking was included in the analysis of the relationship between fluid intelligence, convergent thinking and task-switching. Based on the results obtained in the above analysis, the direct pathway between task-switching and convergent thinking was removed in the model depicted in Figure 17. As in the previous model, fluid intelligence was specified as the exogenous variable, whereas task-switching, associative thinking and convergent thinking were specified as the endogenous variables. The standardised factor loadings for the indicators of each latent variable were as follows: Set B (.87), Set C (.91), Set D (.89), Letter Fluency (.73) and Category Fluency (.79), $p < .001$. These loadings exceed the .70 cut-off value, which demonstrates that all of the indicators sufficiently load onto their respective factors.

Figure 17

First Proposed Relationship between Fluid Intelligence, Task-Switching, Associative Thinking and Convergent Thinking.



Regarding the first criterion used to analyse the models, namely global measures of model fit, the model fit indices demonstrated that the model sufficiently fit the data (χ^2 = , *df* = 11, *p* = , χ^2/df = 1.265, RMSEA = .046, CFI = .994, TLI = .985). In terms of the next criterion of analysis, namely the respective regression weights, fluid intelligence significantly predicted both task-switching ($\beta = .49$, $z = 5.655$, $p < .001$) and associative thinking ($\beta = .71$, $z = 6.472$, $p < .001$). The results demonstrating that fluid intelligence significantly predicts task-switching support H3 in the hypothesised theoretical model. Task-switching significantly predicts associative thinking ($\beta = .20$, $z = 2.349$, $p < .05$), which supports H5. Associative thinking also significantly predicts convergent thinking ($\beta = .69$, $z = 3.416$, $p < .001$), which supports H7. Lastly, unlike Model 1 and Model 2, fluid intelligence did not significantly predict convergent thinking in the current model ($\beta = .10$, $z = .553$, $p = .581$), which introduced associative thinking.

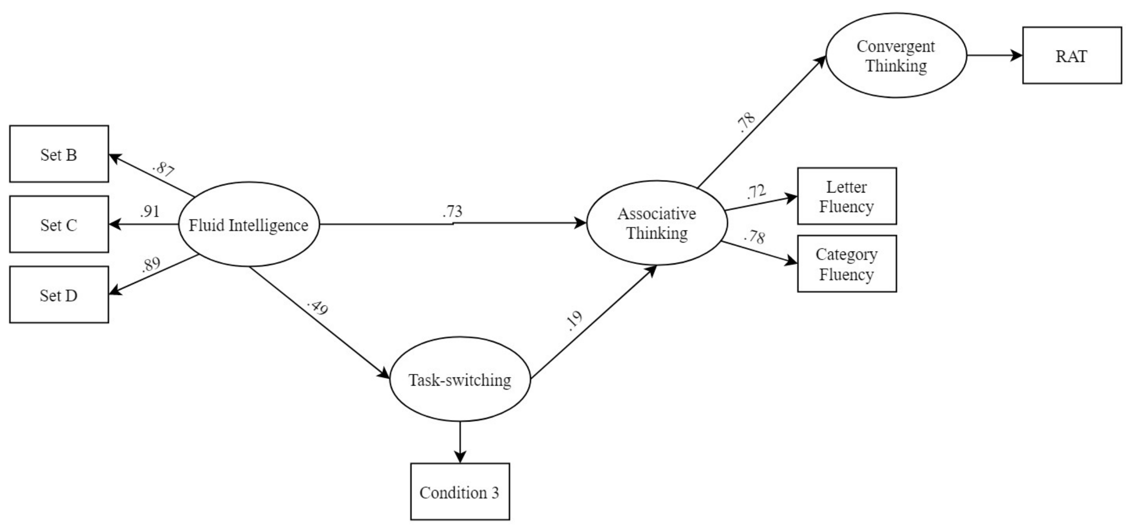
These findings suggest that mediation occurred. Therefore, the significance of the mediation effect was evaluated using the SE of the path between fluid intelligence and associative thinking (*SE* = .135) and the path between associative thinking and convergent thinking (*SE* = .307) alongside their regression weights. There was a significant mediation effect ($z = 2.07$, $p < .05$) of fluid intelligence on convergent thinking through associative thinking. Since the direct relationship between fluid intelligence and convergent thinking was significant in the previous models, and subsequently become non-significant when the mediator associative thinking was introduced, full mediation occurred.

In summary, significant pathways were observed between fluid intelligence and task-switching, as well as between fluid intelligence and associative thinking. Additionally, task-switching significantly predicted associative thinking, and convergent thinking was also significantly predicted by associative thinking. These significant pathways were all analysed further in subsequent models. However, unlike the previous models, fluid intelligence did not predict convergent thinking, which suggested that mediation occurred. Associative thinking fully mediated the relationship between fluid intelligence and convergent thinking. The now non-significant, direct path between fluid intelligence and convergent thinking, indicated by the red arrow in Figure 17, was removed and the model was re-run. The next section presents the results obtained from re-running the modified model.

4.2.2.4. Model 3b: The Relationship between Fluid Intelligence, Task-switching, Associative Thinking and Convergent Thinking. A modified version of the previous model is presented and analysed in this section. Specifically, associative thinking was included in the analysis of the relationship between fluid intelligence, convergent thinking and task-switching. Based on the results obtained in the previous analysis, the direct pathway between fluid intelligence and convergent thinking was removed in the model depicted in Figure 18. As in the previous model, fluid intelligence was specified as the exogenous variable, whereas task-switching, associative thinking and convergent thinking were specified as the endogenous variables. The standardised factor loadings for the indicators of each latent variable were as follows: Set B (.87), Set C (.91), Set D (.89), Letter Fluency (.72) and Category Fluency (.78), $p < .001$. These loadings exceed the .70 cut-off value, which demonstrates that all of the indicators sufficiently load onto their respective factors.

Figure 18

Relationship between Fluid Intelligence, Task-Switching, Associative Thinking and Convergent Thinking with Non-significant Pathways Removed.



Regarding the first criterion used to analyse the models, namely global measures of model fit, the model fit indices demonstrated that the model sufficiently fit the data (χ^2 = , df = 12, p = , χ^2/df = 1.183, RMSEA = .038, CFI = .996, TLI = .990). It is worth noting that the goodness of fit indices indicated that the current model fits the data better than Model 3a, therefore justifying the modifications to the model. In terms of the next criterion of analysis, namely the respective regression weights, fluid intelligence significantly predicted both associative thinking ($\beta = .73$, $z = 6.833$, $p < .001$) and task-switching ($\beta = .49$, $z = 5.663$, $p < .001$). The results demonstrating that fluid intelligence significantly predicts task-switching support H3 in the hypothesised theoretical model. Additionally, task-switching predicted associative thinking ($\beta = .19$, $z = 2.343$, $p < .05$), which supports H5. Associative thinking also significantly predicted convergent thinking ($\beta = .78$, $z = 7.946$, $p < .001$), which supports H7.

The mediation effect of task-switching on the relationship between fluid intelligence and associative thinking was also assessed. Since the relationship between fluid intelligence (IV) and associative thinking (DV) remained significant once the mediator task-switching was introduced, partial mediation occurred, which the significance of the mediation effect analysis confirmed ($z = 2.16$, $p < .05$). The effect ratio was subsequently calculated to evaluate the percentage of the mediation effect. The results revealed that there was 11.26% partial mediation of task-switching on associative thinking from fluid intelligence.

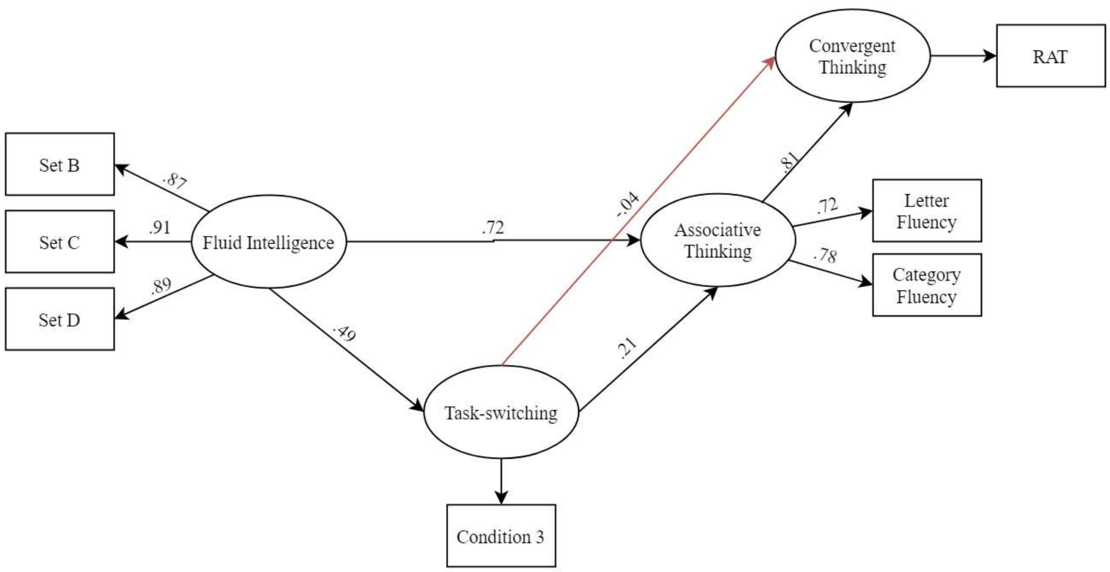
In summary, significant pathways were observed between fluid intelligence and task-switching, as well as between fluid intelligence and associative thinking. Additionally, task-switching significantly predicted associative thinking, and associative thinking significantly predicted convergent thinking. These significant pathways were all analysed further in subsequent models. Although the relationship between fluid intelligence and associative thinking remained significant once the mediator task-switching was introduced, partial mediation could still have occurred. This idea was supported by analysing the significance of the mediation effect. Specifically, the analysis demonstrated an 11.26% partial mediation of task-switching on associative thinking from fluid intelligence was found. Lastly, to assess whether task-switching, in addition to associative thinking, functions as a mediator of convergent thinking, the direct relationship between the two variables was assessed in the subsequent model.

4.2.2.5. Model 3c: The Relationship between Fluid Intelligence, Task-switching, Associative Thinking and Convergent Thinking. Although task-switching did not significantly predict convergent thinking in the analysis of Model 2, the purpose of the current analysis was to evaluate whether the relationship between task-switching and convergent was affected by the presence of associative thinking. Therefore, this section reanalysed the relationships among fluid intelligence, convergent thinking, associative thinking and task-switching.

The model depicted in Figure 19 resembles the previous model; however, the researcher modified the model by reintroducing the direct pathway. As in the previous model, fluid intelligence was specified as the exogenous variable, whereas task-switching, associative thinking and convergent thinking were specified as the endogenous variables. The standardised factor loadings for the indicators of each latent variable were as follows: Set B (.87), Set C (.91), Set D (.89), Letter Fluency (.72) and Category Fluency (.78), $p < .001$. These loadings exceed the .70 cut-off value, which demonstrates that all the indicators sufficiently load onto their respective factors.

Figure 19

Second Proposed Relationship between Fluid Intelligence, Task-Switching, Associative Thinking and Convergent Thinking.



Regarding the first criterion used to analyse the models, namely global measures of model fit, the model fit indices demonstrated that the model sufficiently fit the data ($\chi^2 =$ $df = 11$, $p =$, $\chi^2/df = 1.272$, RMSEA = .047, CFI = .994, TLI = .985). In terms of the next criterion of analysis, namely the respective regression weights, fluid intelligence significantly predicted both associative thinking ($\beta = .72$, $z = 6.647$, $p < .001$) and task-switching ($\beta = .49$, $z = 5.653$, $p < .001$). The results demonstrating that fluid intelligence significantly predicts task-switching support H3 in the hypothesised theoretical model. Task-switching significantly predicted associative thinking ($\beta = .21$, $z = 2.320$, $p < .05$), which supports H5. Associative thinking also significantly predicted convergent thinking ($\beta = .81$, $z = 6.679$, $p < .001$), thereby supporting H7.

As for the results obtained in the analysis of Model 2, a direct effect of task-switching on convergent thinking was non-significant in the current model (β = -.04, z = -.443, p = .658). However, this non-significant result in the context of mediation could signify full mediation effects. Therefore, the potential mediation effect of associative thinking on the relationship between task-switching and convergent thinking was investigated. The results revealed full mediation of associative thinking on convergent thinking from task-switching (z = 2.19, p < .05).

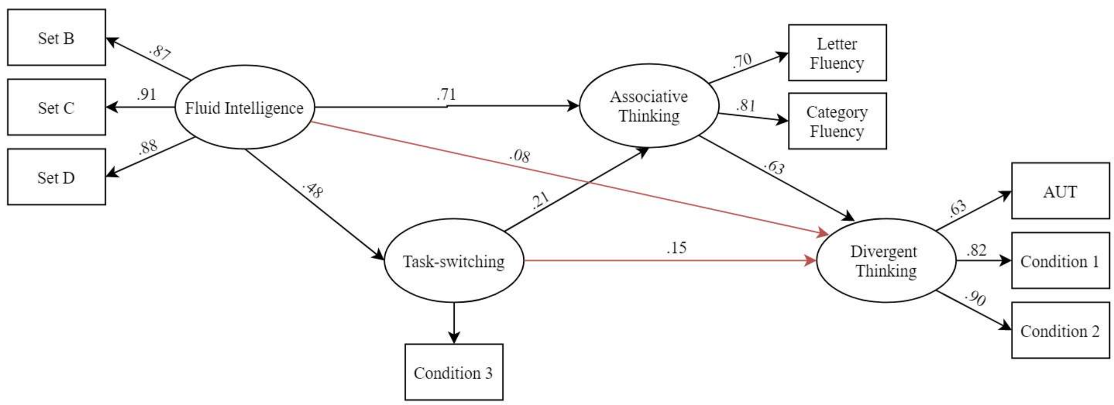
In summary, significant pathways were observed between fluid intelligence and task-switching, as well as between fluid intelligence and associative thinking. Additionally, task-switching predicted associative thinking significantly, and associative thinking significantly predicted by convergent thinking. These significant pathways were all analysed further in subsequent models. A non-significant relationship occurred between task-switching and convergent thinking. However, this non-significant path signified that full mediation of associative thinking on convergent thinking from task-switching occurred, which was confirmed by the analysis of mediation. The non-significant direct path between task-switching and convergent thinking, indicated by the red arrow, was removed from the model. The previous sections (Model 1 – Model 3c) focused on analysing the processes implicated in one aspect of creativity, namely convergent thinking. The subsequent sections, therefore, analysed the processes implicated in the other aspect of creativity, that is, divergent thinking.

4.2.2.6. Model 4a: The Relationship between Fluid Intelligence, Task-switching, Associative Thinking and Divergent Thinking. As mentioned above, the purpose of the current section is to assess the processes implicated in divergent thinking. Since the previous sections established the relationships among fluid intelligence, associative thinking and task-switching, the researcher merely included divergent thinking in the model depicted Figure 20.

Therefore, this section assesses the relationship between fluid intelligence, task-switching, associative thinking, and divergent thinking. Fluid intelligence was specified as the exogenous variable, whereas task-switching, associative thinking and divergent thinking were specified as the endogenous variables. The standardised factor loadings for the indicators of each latent variable were as follows: Set B (.87), Set C (.91), Set D (.88), Letter Fluency (.70), Category Fluency (.81), AUT (.63), Condition 1 (.82) and Condition 2 (.90), p < .001. As demonstrated, most of these loadings exceed the .70 cut-off value. Although the loading for the AUT falls below this cut-off, factor loadings above .60 are considered to be adequate (Bagozzi & Yi, 1988). These results demonstrate that all of the indicators sufficiently load onto their respective factors.

Figure 20

The Relationship between Fluid Intelligence, Task-switching, Associative Thinking and Divergent Thinking.



Regarding the first criterion used to analyse the models, namely global measures of model fit, the model fit indices demonstrated that the model sufficiently fit the data (χ^2 = , *df* = 22, *p* = .000, χ^2/df = 3.002, RMSEA = .127, CFI = .935, TLI = .868). In terms of the next criterion of analysis, namely the respective regression weights, fluid intelligence significantly predicted both associative thinking (β = .71, z = 6.197, $p < .001$) and task-switching (β = .48, z = 5.591, $p < .001$), but not divergent thinking (β = .08, z = .398, p = .690). The results demonstrating that relationship between fluid intelligence and task-switching support H3. Task-switching predicted associative thinking (β = .21, z = 2.377, $p < .05$), which supports H5, but not divergent thinking (β = .15, z = 1.502, p = .133), which rejects H6. Lastly, associative thinking significantly predicted divergent thinking (β = .63, z = 2.573, $p < .05$). These findings, therefore, support H8.

Although the influence of fluid intelligence and task-switching on divergent thinking were both non-significant, this could indicate full mediation. Firstly, the mediation effect of associative thinking on the relationship between fluid intelligence and divergent thinking was investigated. The results revealed that associative thinking fully mediated the relationship between fluid intelligence and divergent thinking (z = 2.38, $p < .05$). Next, the mediation effect of associative thinking on the relationship between task-switching and divergent thinking was investigated. The results from this analysis indicated that associative thinking also fully mediated the relationship between fluid task-switching and divergent thinking (z = 2.38, $p < .05$). Lastly, as demonstrated in the analysis of Model 3b, task-switching partially mediated the relationship between fluid intelligence and associative thinking (11.26%). Therefore, this mediation effect was also assessed in the current model. Similar to Model 3b, the effect of fluid intelligence on associative thinking remained significant once the mediator task-switching was introduced in the current model. These findings suggest that partial mediation could have occurred. The results obtained from the analysis of mediation in the current model corresponded to the results obtained when Model 3b was analysed. That is, task-switching partially mediated the relationship between fluid intelligence and associative thinking ($z = 2.19$, $p < .05$). The effect ratio was subsequently calculated to evaluate the percentage of the mediation effect. The results revealed that there was 12.73% partial mediation of task-switching on associative thinking from fluid intelligence, which closely corresponded to the results obtained when the same effect was analysed in Model 3b.

In summary, significant pathways were observed between fluid intelligence and task-switching, as well as between fluid intelligence and associative thinking. Additionally, task-switching significantly predicted associative thinking, and divergent thinking was also significantly predicted by associative thinking. These significant pathways were all analysed further in subsequent models. A non-significant relationship was observed between task-switching and divergent thinking, as well as between fluid intelligence and divergent thinking. However, these non-significant paths signified that full mediation occurred, which was confirmed by mediation analysis. In particular, associative thinking fully mediated the relationship between divergent thinking and task-switching.

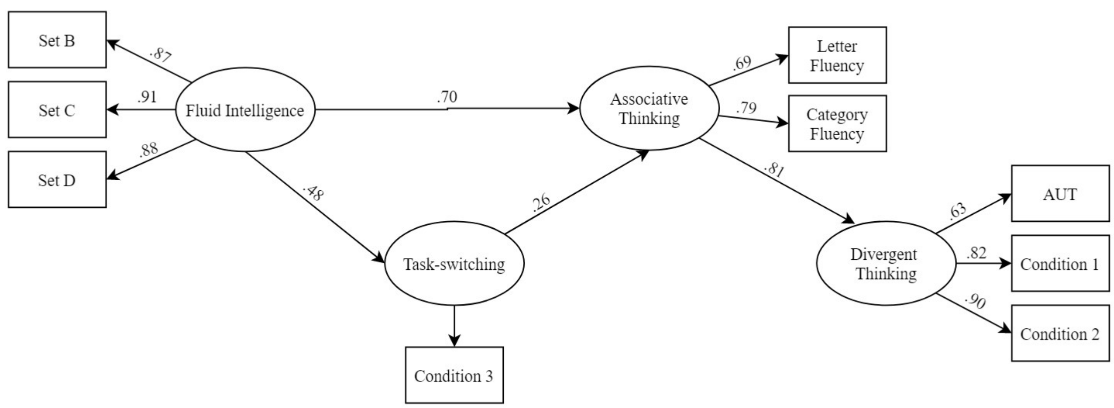
Similarly, associative thinking also mediated the relationship between fluid intelligence and divergent thinking. Lastly and similar to the findings obtained in Model 3b analysis, task-switching partially mediated the relationship between fluid intelligence and associative thinking. The non-significant direct paths, indicated by the red arrows, were removed from the model. After removing these non-significant paths, the researcher re-ran the model to assess whether this modified model adequately fit the data. The subsequent section presents the results obtained from this analysis.

4.2.2.7. Model 4b: The Relationship between Fluid Intelligence, Task-switching, Associative Thinking and Divergent Thinking. This section assesses the final subcomponent of the hypothesised theoretical model. The model depicted in Figure 21 the previous model; however, the researcher modified the model in the current section by excluding the non-significant pathways. As in the previous model, the current section evaluated the relationships among fluid intelligence, associative thinking, task-switching and divergent thinking.

Fluid intelligence was specified as the exogenous variable, whereas task-switching, associative thinking and divergent thinking were specified as the endogenous variables. The standardised factor loadings for the indicators of each latent variable were as follows: Set B (.87), Set C (.91), Set D (.88), Letter Fluency (.69), Category Fluency (.79), AUT (.63), Condition 1 (.82) and Condition 2 (.90), $p < .001$. Although the loadings for the AUT and Letter Fluency fall below this cut-off, factor loadings above .60 are considered to be adequate (Bagozzi & Yi, 1988). These results demonstrate that all of the indicators sufficiently load onto their respective factors.

Figure 21

The Relationship between Fluid Intelligence, Task-switching, Associative Thinking and Divergent Thinking with Non-significant Pathway Removed.



Regarding the first criterion used to analyse the models, namely global measures of model fit, the model fit indices demonstrated that the model sufficiently fit the data ($\chi^2 = 68.050$, $df = 24$, p = .000, $\chi^2/df = 2.835$, RMSEA = .121, CFI = .935, TLI = .879). It is worth noting that the goodness of fit indices of the structural model demonstrated that the current model fit the data slightly better than Model 4a, therefore justifying the modifications to the model. In terms of the next criterion of analysis, namely the respective regression weights, fluid intelligence significantly predicted both associative thinking ($\beta = .70$, z = 6.428, $p < .001$) and task-switching ($\beta = .48$, $z = 5.594$, $p < .001$). he results demonstrate a significant relationship between fluid intelligence and task-switching, supporting H3. There was a significant relationship between task-switching and associative thinking ($\beta = .26$, $z = 3.185$, $p < .05$), supporting H5, and between associative thinking and divergent thinking ($\beta = .81$, $z = 5.577$, $p < .001$). These findings support H8.

The mediation effects of task-switching and associative thinking were also reassessed. The mediation effect of task-switching on the relationship between fluid intelligence and associative thinking was first assessed to establish whether its effect was still present in this model. The mediation effect of associative thinking on the relationship between task switching and divergent thinking was also reassessed. As demonstrated in both Model 3b and Model 4a, task-switching partially mediated the relationship between fluid intelligence and associative thinking in the current model ($z = 2.12$, $p < .05$). The effect ratio was subsequently calculated to evaluate the percentage of the mediation effect. There was 15.43% partial mediation of task-switching on associative thinking from fluid intelligence. The mediation effect of associative thinking on the relationship between fluid intelligence and divergent thinking was then investigated. The results revealed that associative thinking fully mediated the relationship between fluid intelligence and divergent thinking ($z = 3.52$, $p < .001$). Lastly, the mediation effect of associative thinking on the relationship between task-switching and divergent thinking was investigated. The results from this analysis indicated that associative thinking also fully mediated the relationship between fluid task-switching and divergent thinking ($z = 2.01$, $p < .05$).

In summary, significant pathways were observed between fluid intelligence and task-switching, as well as between fluid intelligence and associative thinking. Additionally, task-switching significantly predicted associative thinking, and divergent thinking was also significantly predicted by associative thinking. These significant pathways were all analysed further in the final model. Associative thinking mediated the relationship between divergent thinking and task-switching fully. Similarly, associative thinking also mediated the relationship between fluid intelligence and divergent thinking. Lastly, similar to the findings obtained in the Model 3b and Model 4a analyses, task-switching partially mediated the relationship between fluid intelligence and associative thinking.

The previous sections presented, analysed and modified the subcomponents of the overall hypothesised theoretical model developed in the earlier stages of the research (see Figure 12). Components of creativity, divergent and convergent thinking were first separated and analysed in terms of the relationships between additional processes theorised to be implicated in each aspect of creativity. In particular, Model 1- Model 3c assessed the processes implicated in convergent thinking, whereas Model 4a and Model 4b evaluated the processes implicated in divergent thinking. The researcher compared the goodness of fit indices for each model presented in the previous sections to evaluate which models to incorporate into the final model of creative cognition. While the goodness of fit criteria for various fit indices were discussed earlier in the chapter, Table 6 reiterates the indices used in the current study as well as their respective cut-off criteria to remind the reader of how the goodness of fit was identified.

Table 6.

Summary of Goodness of Fit Index and Cut-off Values.

Index	Shorthand	Cut-off Criteria
Chi-square	$\chi2$	Non-significant statistic
Chi-square associated p-value	p	$\geq .05$
Ratio of minimum discrepancy to the degree of freedom	$\chi2/df$	≤ 2
Root mean square error of approximation	RMSEA	$\leq .05$; good $\leq .10$; adequate
Comparative fit index	CFI	$.90 \leq$ value $< .95$; adequate $\geq .95$; excellent
Tucker-Lewis index	TLI	$.90 \leq$ value $< .95$; adequate $\geq .95$; excellent

A summary of the goodness of fit indices for each model is provided in Table 7. In order to decide which models to include in the final theoretical model of creative cognition, the researcher compared Model 3a – Model 3c to identify the convergent thinking component, as well as compared Model 4a and Model 4b to each other to identify the divergent thinking component. Regarding the convergent thinking, while Model 3a – Model 3c all demonstrate a good model fit, Model 3a had slightly better model fit values. However, as demonstrated in the previous section, this model contained non-significant pathways that needed to be removed. Therefore, the researcher selected Model 3c as the convergent thinking component included in the final model. In terms of the divergent thinking component, the researcher selected Model 4b to include in the final model as it not only had the best goodness of fit values but also all non-significant paths were removed from this model. Therefore, the final theoretical model comprised of a combination of Model 3c and Model 4b. It is worth noting that although the goodness of fit values of the divergent thinking component (Model 4b) were adequate, they were not as good as those achieved in the convergent thinking component (Model 3c). This discrepancy has important implications for the goodness of fit measure of the final model. The next section presents the findings from the analysis of the final theoretical model.

Table 7

Summary of Goodness of Fit Indices for Models Tested.

	Goodness of Fit Indices						
Model	*χ2*	*df*	*p*	*χ2/df*	RMSEA	CFI	TLI
1	2.724	7	.909	.389	.000	1.0	1.034
2	1.721	4	.787	.430	.000	1.0	1.024
3a	13.920	11	.237	1.265	.046	.994	.985
3b	14.192	12	.289	1.183	.038	.996	.990
3c	13.992	11	.233	1.272	.047	.994	.985
4a	66.036	22	.000	3.002	.127	.935	.868
4b	68.050	24	.000	2.835	.121	.935	.879

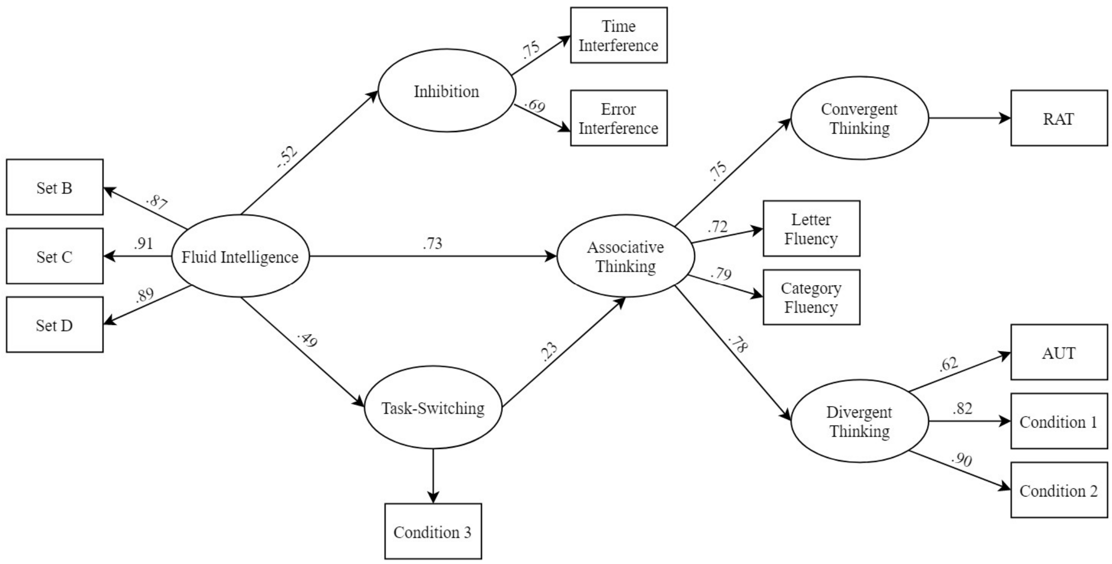
Note. χ^2 = Chi-square goodness of fit test. *df* = degree of freedom. χ^2/df = ratio of minimum discrepancy to the degree of freedom. RMSEA = root mean square error of approximation. CFI = comparative fit index. TLI = Tucker-Lewis index.

4.2.2.8. Final Model. This section presents a detailed assessment of the full theoretical model of creative cognition. This model was based on the theoretical model initially developed in the earlier stages of this study. The researcher deconstructed the hypothesised model into smaller subcomponents, which were analysed and modified in the previous sections. The two subcomponents that had the best fit and only contained significant pathways, namely Model 3c and Model 4b, were combined to develop the final theoretical model of creativity.

The last stage of the SEM analysis involves assessing the final theoretical model, presented in Figure 22, using similar procedures undertaken in the previous sections. In particular, the final model was first evaluated in terms of various global measures of model fit, including χ^2 goodness of fit test, χ^2/df ratio, RMSEA, CFI and TLI. The next stage of the analysis assessed two types of regression weights. The first included the regression weight between both observed and unobserved variables, that is, the loading factor. The second regression weights that were analysed included those between the dependent and independent constructs, that is the path coefficient (*β*). Lastly, the mediation effects of particular variables were evaluated. The subsequent sections present the results from the analysis.

Figure 22

Final SEM Model Depicting the Relationship between Fluid Intelligence, Inhibition, Task-Switching, Associative Thinking, Divergent Thinking and Convergent Thinking.



4.2.2.8.1. Model Fit. The analysis of the final model included the assessment of both absolute and comparative fit indices. Absolute indices included χ^2 goodness of fit test, the χ^2/df ratio, and RMSEA, whereas comparative fit indices included CFI and TLI. Table.8 provides a summary of the goodness of fit values for the final model.

Table.8

Fit Indices for the Final SEM model

	Goodness of Fit Indices				
Model	χ^2	χ^2/df	RMSEA	TLI	CFI
Final	95.926	1.919	.086	.913	.944

Note. χ^2 = Chi-square goodness of fit test. χ^2/df = ratio of minimum discrepancy to the degree of freedom. RMSEA = root mean square error of approximation. CFI = comparative fit index. TLI = Tucker-Lewis index.

The χ^2 goodness of fit test, which was conducted at a significance level of, $\alpha = .05$, a χ^2 is suggestive of an adequately fitting model (Hooper et al., 2008). As demonstrated in Table.8, the χ^2 value is non-significant ($\chi^2 = 95.926$) demonstrating that the model fit the data well. However, the χ^2 goodness of fit measure is often not considered to be very useful as it is affected by several factors, including sample size, model size and complexity, as well as the distribution of variables (West et al., 2012). Therefore, additional absolute model fit indices were considered, such as the χ^2/df ration and RMSEA. In the case of both of these model fit indices, lower values signify a better fitting model, with $\chi^2/df \leq 2$ indicating good fit, whereas RMSEA values ≤ .10 signify adequate fit models and RMSEA values ≤.08 indicate excellent fit (Hooper et al., 2008). An analysis of the goodness of fit measures indicates a good fit between the model and the data (χ^2/df = 1.919, RMSEA = .086). Lastly, the model was evaluated in terms of comparative fit indices, namely TLI and CFI. For CFI and TLI, values ≥ .90 suggest that the model fits the data adequately, while values ≥ .95 signify a good model fit (Hooper et al., 2008). The values for the comparative fit indices suggest that there was an acceptable model fit (TLI = .913, CFI = .944). Together, the global measures of model fit suggest that the final model adequately fits the data. The next section presents the results from the analysis of the second criterion, namely the fit of individual parameters (regression weights).

4.2.2.8.2. Analysis of Regressions. This section presents the results obtained from analysing two types of regression weights. The first included the regression weight between both observed and unobserved variables (loading factor). The second regression weights analysed included those between the dependent and independent constructs (β). Table 9 presents a summary of all standardised and unstandardised regression weights.

Table 9

Unstandardised Regression Weights (Standard Errors), Standardised Regression Weights, and Significance Levels for Each Parameter in the Final SEM Model (N = 125).

			Unstandardised	Standardised	*p*
Task-switching	<---	Fluid Intelligence	.408(.072)	.490	< .001
Associative Thinking	<---	Fluid Intelligence	.879(.125)	.729	< .001
Associative Thinking	<---	Task-switching	.332(.111)	.230	.003
Divergent Thinking	<---	Associative Thinking	.916(.163)	.776	< .001
Inhibition	<---	Fluid Intelligence	-1.209(.275)	-.518	< .001
Set D	<---	Fluid Intelligence	1.000	.885	< .001
Set C	<---	Fluid Intelligence	.868(.059)	.912	< .001
Set B	<---	Fluid Intelligence	.815(.060)	.873	< .001
Letter Fluency	<---	Associative Thinking	1.000	.715	< .001
Category Fluency	<---	Associative Thinking	1.310(.162)	.788	< .001
AUT	<---	Divergent Thinking	1.000	.622	< .001
Condition 1	<---	Divergent Thinking	.618(.087)	.823	< .001
Condition 2	<---	Divergent Thinking	.667(.091)	.895	< .001
Convergent Thinking	<---	Associative Thinking	1.163(.150)	.751	< .001
Time Interference	<---	Inhibition	1.000	.749	< .001
Error Interference	<---	Inhibition	.156(.038)	.693	< .001

Regarding the regression weight between both observed and unobserved variables, the standardised factor loadings for the indicators of each latent variable were as follows: Set B (.87), Set C (.91), Set D (.89), Letter Fluency (.72), Category Fluency (.79), AUT (.62), Condition 1 (.82), Condition 2 (.90), Time Interference (.75) and Error Interference (.69), *p* <

.001. As discussed previously, loading values equal to or exceeding .70 represent that the indicator loads sufficiently onto the factor (Nunnally & Bernstein, 1994). As demonstrated in Table 9, most of these loadings exceed the .70 cut-off value. Although the loading for the AUT and Error Interference fall slightly below this cut-off, factor loadings above .60 are considered to be adequate (Bagozzi & Yi, 1988). These results demonstrate that all of the indicators load sufficiently onto their respective factors.

Next, the regression weights between the dependent and independent constructs, that is, the path coefficient (β) were analysed. The critical ratio (CR) that corresponded with these regression weights was examined based on an alpha value of .05. The results revealed that fluid intelligence significantly predicted inhibition (β = -.52, z = -4.405, $p < .001$), indicating that a one-unit standard deviation increase in fluid intelligence decreased inhibition by .52 standard deviations and the probability of achieving a CR as large as 4.405 in absolute value was less than .001. That is, the regression weight for fluid intelligence in predicting inhibition was significantly different from zero at a .001 level of significance (two-tailed). These findings support the H1 pathway demonstrated in the hypothesised theoretical model of creative cognition (see Figure 12).

Fluid intelligence significantly predicted task-switching (β = .49, z = 5.691, $p < .001$) and associative thinking (β = .73, z = 7.035, $p < .001$). These findings indicate that a one-unit standard deviation increase in fluid intelligence corresponded to .49 and .73 increases in standard deviations for task-switching and associative thinking, respectively. The probability of achieving a CR as large as 5.691 (task-switching) and 7.035 (associative thinking) in absolute value was less than .001. That is, the regression weight for fluid intelligence in predicting both task-switching and associative thinking was significantly different from zero at a .001 level of significance (two-tailed). The results demonstrating that fluid intelligence predicts task-switching support H3. However, the researcher did not initially model fluid intelligence as a direct predictor of associative thinking in the hypothesised model and this was, therefore, an unexpected finding.

Additional findings include task-switching significantly predicting associative thinking (β = .23, z = 2.994, $p < .05$), which indicates that a one-unit standard deviation increase in task-switching increased associative thinking by .23 standard deviations and the probability of achieving a CR as large as 2.994 in absolute value was less than .05. That is, the regression weight for task-switching in predicting associative thinking was significantly different from zero at a .05 level of significance (two-tailed). These findings support the H5 pathway presented in the hypothesised model.

Lastly, associative thinking significantly predicted both divergent thinking (β = .78, z = 5.617, p < .001) and convergent thinking (β = .75, z = 7.754, p < .001), which supports H8 and H7, respectively. These findings indicate that a one-unit standard deviation increase in associative thinking corresponds to .78 and .75 increases standard deviations for divergent thinking and convergent thinking, respectively. The probability of achieving a CR as large as 5.617 (divergent thinking) and 7.754 (convergent thinking) in absolute value was less than .001. That is, the regression weight for associative thinking in predicting both divergent thinking and convergent thinking was significantly different from zero at a .001 level of significance (two-tailed).

In summary, fluid intelligence predicted inhibition, task-switching and associative thinking directly. Additionally, task-switching significantly predicted associative thinking, and associative thinking significantly predicted both divergent and convergent thinking. After evaluating the direct relationships among the variables included in the model, the next section assesses the mediation effects of several processes.

4.2.2.8.3. Analysis of Mediation. The model illustrated in Figure 22, task-switching and associative thinking were identified as mediators. Therefore, the researcher conducted tests of mediation to determine whether or not these two variables influenced any of the relationship pathways demonstrated in the model. Sobel's (1982) test evaluated the significance of the mediation effect, using an alpha of .05.

The mediation effects of associative thinking on the relationship between fluid intelligence and both components of creativity were analysed. Firstly, the analysis evaluated the mediation effect of associative thinking on the relationship between fluid intelligence and convergent thinking. The results revealed a significant mediation effect (z = 3,79, p < .001) of fluid intelligence on convergent thinking through associative thinking. Since the direct relationship between fluid intelligence and convergent thinking was significant in the models assessed in the previous sections (Model 1 and Model 2), which subsequently became non-significant when the mediator associative thinking was introduced, full mediation occurred. Next, a test of mediation was conducted to determine whether associative thinking mediated the relationship between fluid intelligence and divergent thinking. The analysis revealed a significant mediation effect (z = 3,7, p < .001) of fluid intelligence on divergent thinking through associative thinking. Since the direct relationship between fluid intelligence and divergent thinking was non-significant when the mediator associative thinking was introduced, full mediation occurred. Based on the above results, associative thinking appears to play an important role in facilitating the relationship between higher-order cognitive functions, namely fluid intelligence, and both aspects of creativity, including divergent and convergent thinking.

Next, the mediation effect of associative thinking on the relationship between task-switching and both divergent and convergent thinking, respectively, was investigated. The results revealed that associative thinking did not function as a mediator in the relationship between task switching and divergent thinking ($z = 1.90$, $p = .057$), as well as in the relationship between task-switching and convergent thinking ($z = 1.91$, $p = .056$). These results differed from those obtained in the analysis of the small-scale models (Model 3c, Model 4a and Model 4b) and are possibly attributed to the fact that the final model is more complex than the previously analysed models.

Lastly, the analysis investigated the mediation effects of task-switching on the relationship between fluid intelligence and associative thinking. It revealed a significant mediation effect ($z = 1.98$, $p < .05$) of fluid intelligence on associative thinking through task-switching. Since the direct relationship between fluid intelligence and associative thinking remained significant ($\beta = .73$, $z = 7.035$, $p < .001$) when the mediator associative thinking was introduced, it was concluded that partial mediation occurred. The effect ratio was subsequently calculated to evaluate the percentage of the mediation effect. The results revealed that there was 16.15% mediation through task-switching from fluid intelligence on associative thinking.

4.2.2.9. Summary. The above sections constitute the second stage of the analysis of the results. As previously mentioned, this stage addressed the first aim of the current research, which was to develop a coherent theoretical model of creative cognition. The current study used SEM to explore the relationships between executive functions, including fluid intelligence, task-switching and inhibition, and components of creative thinking, namely divergent, convergent and associative thinking. The researcher deconstructed the hypothesised theoretical model developed in the initial stages of the research into subcomponents and assessed them individually. The models that yielded the best goodness of fit values and comprised of significant regression weights were incorporated into a final theoretical model of creativity which was analysed as a whole.

The results obtained from the analysis of the final model demonstrated that this model fit the data adequately. Furthermore, this model bore several similarities to the hypothesised model; that is, the findings supported some of the pathways depicted in the hypothesised model. For example, fluid intelligence significantly predicted inhibition and task-switching, which supports H1 and H3, respectively. In addition, task-switching predicted associative thinking, which supports H5. Lastly, associative thinking predicted both divergent and convergent thinking, which supports H7 and H8, respectively.

Nevertheless, there are also significant discrepancies between the hypothesised and final theoretical models of creativity. In particular, inhibition did not predict convergent thinking, which rejects H2. Additionally, task-switching predicted neither convergent nor divergent thinking, which rejects both H4 and H6, respectively. Lastly, the analyses yielded an unexpected direct relationship between fluid intelligence and associative thinking, which the researcher did not initially plot onto the hypothesised theoretical model.

Finally, in terms of mediation effects, associative thinking fully mediated the relationship between fluid intelligence and both divergent and convergent thinking, respectively. Moreover, task-switching partially mediated the relationship between fluid intelligence and associative thinking. After developing and analysing the theoretical model of creativity, the next section investigates whether particular demographic variables predict the individual cognitive processes included in the theoretical model developed in the previous sections.

4.2.3. Results from the Group-difference Analyses.

The following sections present the results obtained in the third stage of the analyses. As previously mentioned, this stage addressed the second aim of the study, which was to investigate whether the individual cognitive processes included in the theoretical model of creativity were influenced by the demographic variables of age, multilingualism, SES, level of education and gender, affected the processes in the theoretical model of creativity. This section is, therefore, comprised of five subsections, each of which presents the analysis for the respective demographic variables.

4.2.3.1. Age. Participants were stratified into five age groups, namely 65-70, 71-75, 76-80, 81-85, and 86-90. Since the age variable comprised of more than two groups, an ANOVA was used to investigate the effect of age on the cognitive processes included in the model. Specifically, a Welch's ANOVA determined whether there were significant differences in test performance between the five age groups. The following sections present the results from the analyses, and Table 10 illustrates the sum of squares (*SS*) and mean square (MS), which were used to calculate the F ratio.

Table 10

Sum of Squares and Mean Square values for Test Scores by Age on each Instrument.

		SS	*MS*
AUT	Between Groups	208.716	52.179
	Within Groups	5687.892	47.399
RAT	Between Groups	187.605	46.901
	Within Groups	3742.587	31.188
Letter Fluency	Between Groups	60.077	15.019
	Within Groups	3141.491	26.179
Category Fluency	Between Groups	100.817	25.204
	Within Groups	4429.711	36.914
Condition 1	Between Groups	35.954	8.989
	Within Groups	1269.838	10.582
Condition 2	Between Groups	37.409	9.352
	Within Groups	1237.983	10.317
Correct Condition 3	Between Groups	78.739	19.685
	Within Groups	718.461	5.987
Set B	Between Groups	49.335	12.334
	Within Groups	933.673	7.781
Set C	Between Groups	31.604	7.901
	Within Groups	989.564	8.246
Set D	Between Groups	25.622	6.406
	Within Groups	1413.450	11.779
Time Interference	Between Groups	158.799	39.700
	Within Groups	10806.609	90.055
Error Interference	Between Groups	14.694	3.673
	Within Groups	297.234	2.477

In order to test whether the means of between the age groups differed significantly, the Welch's F-statistic was calculated. Table 11 shows the Welch's F-statistic, as well as df and p-values.

Table 11

Welch Test of Equality of Means for Age.

	Statistic[a]	*df1*	*df2*	*p*
AUT	1.036	4	24.632	.409
RAT	2.240	4	25.266	.093
Letter Fluency	.465	4	24.803	.761
Category Fluency	.768	4	24.536	.557
Condition 1	.773	4	23.858	.554
Condition 2	.839	4	28.244	.512
Condition 3	2.948	4	23.449	.041
Set B	1.735	4	25.331	.173
Set C	1.606	4	30.993	.198
Set D	.535	4	24.655	.712
Time Interference	.435	4	23.329	.782
Error Interference	1.269	4	22.586	.311

a. Asymptotically F distributed.

The ANOVA was examined based on an alpha value of .05. The results revealed non-significant age group-differences on the AUT, $F(24.632) = .084$, $p = 1.036$; RAT, $F(4, 25.266) = 2.240$, $p = .093$; Letter Fluency, $F(4, 24.803) = .465$, $p = .761$; Category Fluency, $F(4, 24.536) = .768$, $p = .557$; Condition 1, $F(4, 23.858) = .773$, $p = .554$; Condition 2, $F(4, 28.244) = .425$, $p = .512$; Set B, $F(4, 25.331) = 1.735$, $p = .173$; Set C, $F(4, 30.993) = 1.606$, $p = .198$; Set D, $F(4, 24.655) = .535$, $p = .712$; Time Interference, $F(4, 23.329) = .435$, $p = .782$; and Error Interference, $F(4, 22.586) = 1.269$, $p = .311$, scores.

Significant age group-differences were found on Condition 3, $F(4, 23.449) = 2.948$, $p < .05$. A Games-Howell post hoc explored the differences between age groups on Condition 3 based on an alpha of .05. The results revealed that there were significant differences in Condition 3 scores between individuals aged 71-75 and individuals aged 76-80 (MD = 2.269), $p < .05$, with the mean Condition 3 score for the 76-80 age group ($M = 3.58$, $SD = 2.501$) significantly smaller than that for the 71-75 age group ($M = 5.85$, $SD = 2.397$). Cohen's *d* value for this difference was .927, which is a large effect size. These findings suggest that the 71-75 age group significantly outperformed the 76-80 age group in task-switching.

In general, age did not affect the processes included in the theoretical model of creativity. These findings were unexpected because age was hypothesised to have both positive and negative effects on the processes included in the model depending on the extent to which they relied on higher-order executive functions. This hypothesis was based on age-related decline in functionality of the PFC (Amer et al., 2016; Leon et al., 2014). In particular, the researcher initially expected age to negatively affect all of the higher-order functions included in the model (i.e., task-switching, inhibition and fluid intelligence) and the component of creativity that presumably relies on these executive functions (i.e., convergent thinking). In addition, the researcher initially anticipated age to positively affect those aspects of creativity that are less taxing on these executive functions (i.e., divergent and associative thinking; Amer et al., 2016). As anticipated, age significantly affected performance on the executive function of task-switching (Condition 3), with the younger age group (71-75) outperforming the older age group (76-80). However, no significant differences were evident on task-switching between the other age groups, or between all age groups on the measures of fluid intelligence, inhibition, divergent, convergent and associative thinking.

4.2.3.2. Multilingualism. Participants were stratified into three language groups, including monolinguals, bilinguals, and multilinguals. Since the multilingual variable comprised of more than two categorical groups, an ANOVA investigated its effect on the cognitive processes included in the model. Specifically, a Welch's ANOVA determined whether there were significant differences in test performance between different language groups. The following sections present the results obtained from the analysis, and Table 12 illustrates the *SS* and *MS* values, which were used to calculate the F ratio.

Table 12

Sum of Squares and Mean Square values for Test Scores by Linguistic Category on each Instrument.

		SS	*MS*
AUT	Between Groups	13.895	6.948
	Within Groups	5882.713	48.219
RAT	Between Groups	24.998	12.499
	Within Groups	3905.194	32.010
Letter Fluency	Between Groups	167.492	83.746
	Within Groups	3034.076	24.869
Category Fluency	Between Groups	432.820	216.410
	Within Groups	4097.708	33.588
Condition 1	Between Groups	42.659	21.329
	Within Groups	1263.133	10.354
Condition 2	Between Groups	41.400	20.700
	Within Groups	1233.992	10.115
Condition 3	Between Groups	26.672	13.336
	Within Groups	770.528	6.316
Set D	Between Groups	28.278	14.139
	Within Groups	1410.794	11.564
Set C	Between Groups	26.207	13.103
	Within Groups	994.961	8.155
Set B	Between Groups	21.045	10.523
	Within Groups	961.963	7.885
Time Interference	Between Groups	44.724	22.362
	Within Groups	10920.684	89.514
Error Interference	Between Groups	5.045	2.522
	Within Groups	306.883	2.515

In order to test whether the means of between the linguistic groups differed significantly, the Welch's F-statistic was calculated. Table 13 shows the Welch's F-statistic, as well as df and p-values.

Table 13

Welch Test of Equality of Means for Linguistic Category on each Instrument.

	Statistic[a]	*df1*	*df2*	*p*
AUT	.103	2	15.997	.902
RAT	.39	2	17.323	.683
Letter Fluency	3.367	2	17.029	.059
Category Fluency	5.784	2	16.599	.012
Condition 1	1.997	2	19.692	.162
Condition 2	1.971	2	16.90	.17
Condition 3	2.056	2	17.347	.158
Set B	1.259	2	16.154	.31
Set C	1.541	2	16.873	.243
Set D	1.204	2	16.122	.326
Time Interference	.19	2	16.32	.829
Error Interference	.824	2	16.584	.456

a. Asymptotically F distributed.

The ANOVA was examined based on an alpha value of .05. The results revealed non-significant group-differences on the AUT, $F(2, 15.997) = .103$, $p = .902$; RAT, $F(2, 17.323) = .390$, $p = .683$; Letter Fluency, $F(2, 17.029) = 3.367$, $p = .059$; Condition 1, $F(2, 19.692) = 1.997$, $p = .162$; Condition 2, $F(2, 16.90) = 1.971$, $p = .17$; Condition 3, $F(2, 17.347) = 2.056$, $p = .158$; Set B, $F(2, 16.154) = 1.259$, $p = .31$; Set C, $F(2, 16.873) = 1.541$, $p = .243$; Set D, $F(2, 16.122) = .781$, $p = .326$; Time Interference, $F(2, 16.32) = .19$, $p = .829$; Error Interference, $F(2, 16.584) = .824$, $p = .456$.

However, significant group differences were found on Category Fluency scores, $F(2, 16.599) = 1.971$, $p < .05$. A Games-Howell post hoc explored differences between monolingual, bilingual and multilingual groups on Category Fluency scores based on an alpha of .05. The results revealed that there were significant differences in Category Fluency scores between monolingual and multilingual individuals ($MD = 7.35$), $p < .05$ as well as between bilingual and multilingual individuals ($MD = 2.54$), $p < .05$. The mean Category Fluency score for multilinguals ($M = 13.79$, $SD = 5.647$) was significantly smaller than for the monolingual group ($M = 21.14$, $SD = 6.283$), with a Cohen's d value of 1.23, indicating a large effect size. The mean Category Fluency score for multilinguals was also significantly smaller than for the bilingual group ($M = 16.33$, $SD = 5.885$), with a Cohen's d value of .44, indicating a medium effect size. Therefore, both monolinguals and bilinguals significantly outperformed multilinguals in the category aspect of associative fluency.

Therefore, multilingualism did not affect most of the processes included in the theoretical model of creativity. The researcher did not expect these findings as multilingualism was initially anticipated to benefit both bottom-up and top-down processes. In particular, the architecture of multilingual memory was expected to benefit associative processes, such as associative thinking and divergent thinking (Kharkhurin, 2017). In contrast, multilinguals' high level of skill associated with the control processes was anticipated to benefit higher-order functions, executive functions, and convergent thinking (Bialystok et al., 2012; Kroll & Bialystok, 2013). Hence, the researcher expected multilingualism to positively affect all components included in the model. However, multilingualism did not affect the processes included in the model. Moreover, where a significant effect was found (Category fluency), the converse occurred whereby both monolinguals and bilinguals outperformed multilinguals.

4.2.3.3. Socio-economic Status. Participants were stratified into four SES groups, including low, middle, upper and high. Since the SES variable comprised of more than two categorical groups, an ANOVA was used to investigate the effect of multilingualism on the cognitive processes included in the model. Specifically, a Welch's ANOVA determined whether there were significant differences in test performance between the different SES groups. The following sections present the results from the analyses, and Table 14 illustrates the *SS* and *MS* values, which were used to calculate the F ratio.

Table 14

Sum of Squares and Mean Square values for Test Scores by SES on each Instrument.

		SS	*MS*
AUT	Between Groups	752.509	250.836
	Within Groups	5144.099	42.513
RAT	Between Groups	727.993	242.664
	Within Groups	3202.199	26.464
Letter Fluency	Between Groups	490.141	163.380
	Within Groups	2711.427	22.408
Category Fluency	Between Groups	747.774	249.258
	Within Groups	3782.754	31.262
Condition 1	Between Groups	123.139	41.046
	Within Groups	1182.653	9.774
Condition 2	Between Groups	209.136	69.712
	Within Groups	1066.256	8.812
Condition 3	Between Groups	122.322	40.774
	Within Groups	674.878	5.578
Set B	Between Groups	178.202	59.401
	Within Groups	858.980	7.099
Set C	Between Groups	162.188	54.063
	Within Groups	804.806	6.651
Set D	Between Groups	266.407	88.802
	Within Groups	1172.665	9.691
Time Interference	Between Groups	1030.674	343.558
	Within Groups	9934.734	82.105
Error Interference	Between Groups	16.978	5.659
	Within Groups	294.950	2.438

In order to test whether the means of between the SES groups differed significantly, the Welch’s F-statistic was calculated. Table 15 shows the Welch's F-statistic, as well as df and p-values.

Table 15

Welch Test of Equality of Means for SES.

	Statistic[a]	*df1*	*df2*	*p*
AUT	7.267	3	10.475	.006
RAT	12.244	3	13.156	.000
Letter Fluency	8.701	3	9.607	.004
Category Fluency	22.199	3	40.891	.000
Condition 1	4.083	3	9.713	.04
Condition 2	7.593	3	9.737	.007
Condition 3	7.309	3	10.073	.007
Set B	9.362	3	9.729	.003
Set C	30.890	3	18.040	.000
Set D	42.229	3	21.116	.000
Time Interference	1.457	3	9.083	.290
Error Interference	2.771	3	9.353	.101

a. Asymptotically F distributed.

The ANOVA was examined with an alpha value of .05. The results revealed non-significant group-differences on Time Interference, $F(3, 9.083) = 1.457$, $p = .290$ and Error Interference, $F(3, 9.353) = 2.771$, $p = .101$, scores. However, significant SES group-differences were found on the AUT, $F(3, 10.475) = 7.267$, $p < .05$, RAT; $F(3, 13.156) = 12.244$, $p < .01$; Letter Fluency, $F(3, 9.607) = 8.701$, $p < .01$; Category Fluency, $F(3, 40.891) = 22.199$, $p < .01$, Condition 1, $F(3, 9.713) = 4.083$, $p < .05$; Condition 2, $F(3, 9.737) = 7.593$, $p < .01$; Condition 3, $F(3, 10.073) = 7.309$, $p < .01$; Set B, $F(3, 9.729) = 9.362$, $p < .01$; Set C, $F(3, 18.040) = 30.890$, $p < .01$; Set D, $F(3, 21.116) = 42.229$, $p < .01$.

A Games-Howell post hoc was subsequently run to explore differences between low, middle, upper and high SES groups on the instruments that demonstrated significant group-differences. The results revealed significant differences in AUT scores between high and middle SES groups ($MD = 6.523$), $p < .001$, as well as between high and upper SES groups ($MD = 3.716$), $p < .05$. The mean AUT score for the high SES group ($M = 13.81$, $SD = 6.49$) was significantly higher than for the upper group ($M = 10.09$, $SD = 7.165$), with a Cohen's d value of .54, as well as significantly higher than the middle SES group ($M = 7.29$, $SD = 4.797$), with a Cohen's d value of 1.14. There were significant differences in Condition 1 scores between high and middle SES groups ($MD = 2.384$), $p < .05$. The mean Condition 1 score for the high SES group ($M = 8.57$, $SD = 3.126$) was significantly higher than for the middle SES group ($M = 6.19$, $SD = 2.804$), with a Cohen's d value of .8. There were significant differences in Condition 2 scores between high and middle SES groups ($MD = 2.886$), $p < .01$, and between high and upper SES groups (*MD* = 2.195), $p < .01$. The mean Condition 2 score for the high SES group (*M* = 9.36, *SD* = 3.11) was significantly higher than for the upper group (*M* = 7.17, *SD* = 3.058), with a Cohen's *d* value of .71, as well as significantly higher than the middle SES group (*M* = 6.48, *SD* = 2.379), with a Cohen's *d* value of 1.04. These findings suggest that individuals with a high SES generally outperformed individuals from upper and middle SES groups on multiple indicators of divergent thinking, namely the AUT, as well as Condition 1 and Condition 2 of the DF.

There were significant differences in RAT scores between high and low SES groups (*MD* = 6.801), $p < .05$, between high and middle SES groups (*MD* = 6.278), $p < .001$, as well as between high and upper SES groups (*MD* = 3.838), $p < .01$. The mean RAT score for the high SES group (*M* = 8.47, *SD* = 6.107) was significantly higher than for the upper (*M* = 4.63, *SD* = 4.946), with a Cohen's *d* value of .691. Additionally, the mean RAT score for the high SES group was significantly higher than the mean score for the middle SES group (*M* = 2.19, *SD* = 3.043), with a Cohen's *d* value of 1.302. The mean RAT score for the high SES group was also significantly higher than the low SES group (*M* = 1.67, *SD* = 1.528), with a Cohen's *d* value of 1.53. These results suggest that individuals with a high SES outperformed those from upper, middle and low SES groups on the RAT, an indicator of convergent thinking.

There were significant differences in Letter Fluency scores between upper and middle SES groups (*MD* = 2.984), $p < .05$, between high and middle SES groups (*MD* = 5.648), $p < .001$, as well as between high and upper SES groups (*MD* = 2.664), $p < .05$. The mean Letter Fluency score for the high SES group (*M* = 14.55, *SD* = 4.929) was significantly higher than that of the upper group (*M* = 11.89, *SD* = 4.982), with a Cohen's *d* value of .54, and higher than that of the middle SES group (*M* = 8.9, *SD* = 3.419), with a Cohen's *d* value of 1.33. Additionally, the mean Letter Fluency score for the upper SES group was significantly higher than that of the middle group, with a Cohen's *d* value of .7. There were significant differences in Category Fluency scores between upper and low SES groups (*MD* = 3.759), $p < .01$, between upper and middle SES groups (*MD* = 3.95), $p < .05$, between high and low SES groups (*MD* = 6.645), $p < .001$, as well as between high and middle SES groups (*MD* = 6.836), $p < .001$. The mean Category Fluency score for the upper SES group (*M* = 15.09, *SD* = 6.07) was significantly higher than that of the low SES group (*M* = 11.33, *SD* = .577), with a Cohen's *d* value of .87, and higher than that of the middle SES group (*M* = 11.14, *SD* = 4.328), with a Cohen's *d* value of .75. Additionally, the mean Category Fluency score for the high SES group (*M* = 17.98, *SD* = 5.624) was significantly higher than for the middle group, with a Cohen's *d* value of 1.36, and the low SES group, with a Cohen's *d* value of 1.66. These findings suggest that individuals with a high SES tended to perform better on both indicators of associative thinking, namely Letter Fluency and Category Fluency, than those from lower SES groups.

There were significant differences in DF Condition 3 scores between high and middle SES groups (*MD* = 2.52), $p < .01$, and between high and upper SES groups (*MD* = 1.401), $p < .05$. The mean Condition 3 score for the high SES group (*M* = 6.23, *SD* = 2.573) was significantly higher than that of the upper SES group (*M* = 4.83, *SD* = 2.23), with a Cohen's *d* value of .58, and higher than that of the middle SES group (*M* = 3.71, *SD* = 2.261), with a Cohen's *d* value of 1.04. These findings suggest that individuals with a high SES outperformed individuals within the upper and middle SES groups on Condition 3 of the DF test, an indicator of task-switching.

Significant differences in Set B scores of the SPM occurred between high and upper SES groups (*MD* = 1.807), $p < .01$, and between high and middle SES groups (*MD* = 3.127), $p < .001$. The mean Set B score for the high SES group (*M* = 8.94, *SD* = 2.316) was significantly higher than that of the upper SES group (*M* = 7.13, *SD* = 2.849), with a Cohen's *d* value of .69, as well as higher than that of the middle SES group (*M* = 5.84, *SD* = 2.442), with a Cohen's *d* value of 1.3. Similarly, there were significant differences in SPM Set C scores. In particular, differences in Set C scores occurred between the middle and low SES groups (*MD* = 2.238), $p < .05$, between upper and low SES groups (*MD* = 3.13), $p < .001$, between high and low SES groups (*MD* = 4.844), $p < .001$, between high and middle SES groups (*MD* = 2.606), $p < .01$. as well as between high and upper SES groups (*MD* = 1.714), $p < .05$. The mean score for the middle SES group (*M* = 4.9, *SD* = 2.322) on the Set C task of the SPM was significantly higher than that of the low SES group (*M* = 2.67, *SD* = .577), with a Cohen's *d* value of 1.32. The mean Set C score for the upper SES group (*M* = 5.8, *SD* = 2.942) was significantly higher than for the low SES group, which had a Cohen's *d* value of 1.48. The mean Set C score for the high SES group (*M* = 7.51, *SD* = 2.518) was significantly higher than all of the lower SES groups, including the low (*d* =1.78), middle (*d* = .98) and upper (*d* =.58) SES groups. Lastly, significant differences in Set D scores occurred between the middle and low SES groups (*MD* = 2.619), $p < .01$, between upper and low SES groups (*MD* = 3.722), $p < .001$, between high and low SES groups (*MD* = 5.986), $p < .001$, between high and middle SES groups (*MD* = 3.367), $p < .001$, as well as between high and upper SES groups (*MD* = 2.264), $p < .05$. The mean Set D score on the SPM for the middle SES group (*M* = 4.95, *SD* = 2.854) was significantly higher than that of the low SES group (*M* = 2.33, *SD* = .577), with a large effect size (*d* = 1.27). Similarly, the mean score of upper SES group (*M* = 6.06, *SD* = 3.493) on Set D was significantly higher than that of the low SES group, which also had a large effect size (*d* = 1.49). The mean Set D score for the high SES group (*M* = 8.32, *SD* = 2.806) was significantly higher than that of the lower SES groups, including the low SES (*d* = 2.9), middle (*d* = 1.19) and upper (*d* = .71) SES groups. Together, these findings suggest that individuals with a higher SES tended to outperform their lower SES peers on indicators of fluid intelligence (SPM).

Therefore, the results reveal that SES significantly predicted all cognitive processes included in the model of creativity, except for both indicators of inhibition (Time Interference and Error Interference). The general pattern that emerged was that individuals with a higher level of SES tended to outperform those from lower SES groups on indicators of divergent thinking, convergent thinking, associative thinking, task-switching and fluid intelligence. The researcher anticipated these results as it was initially proposed that SES affect processes that rely on a high and low degree of executive function.

4.2.3.4. Level of Education. Participants were stratified into two level of education groups, namely individuals with ≤12 years of education and individuals with ≥13 years of education. Since the level of education variable comprised of only two groups, a *t*-test investigated the effect of education on the cognitive processes included in the model. Specifically, a Welch's *t*-test determined whether significant differences in test performance occurred between the education groups. The following sections present the results from the analyses, and Table 16 illustrates the group statistics, including the *M*, *SD* and standard error mean for each group.

Table 16

Group Statistics for Individuals with ≤12 Years of Education and Individuals with ≥13 Years of Education.

		M	*SD*	Std. Error Mean
AUT	≤12 years	7.67	5.512	.695
	≥13 years	14.27	6.589	.837
RAT	≤12 years	3.37	4.109	.518
	≥13 years	7.85	6.078	.772
Letter Fluency	≤12 years	10.95	5.027	.633
	≥13 years	13.84	4.747	.603
Category Fluency	≤12 years	13.33	5.728	.722
	≥13 years	17.55	5.641	.716
Condition 1	≤12 years	6.03	2.759	.348
	≥13 years	8.77	3.133	.398
Condition 2	≤12 years	6.30	2.650	.334
	≥13 years	9.34	3.008	.382
Condition 3	≤12 years	4.49	2.520	.317
	≥13 years	5.76	2.407	.306
Set B	≤12 years	6.10	2.613	.329
	≥13 years	9.02	2.192	.278
Set C	≤12 years	4.78	2.732	.344
	≥13 years	7.68	2.201	.280
Set D	≤12 years	4.97	3.312	.417
	≥13 years	8.32	2.585	.328
Time Interference	≤12 years	18.952	11.6577	1.4687
	≥13 years	14.726	5.6992	.7238
Error Interference	≤12 years	1.365	1.9202	.2419
	≥13 years	.581	1.0251	.1302

As mentioned above, the Welch's *t*-test statistic was calculated to assess whether or not significant differences occurred between level of education groups. Table 17 presents the results from the *t*-test, including the *t*-test statistic, *df*, *p*-values, *MD* and standard error difference.

Table 17

Welch's t-test for Equality of Means for Level of Education.

	t	*df*	*p*	*MD*	Std. Error Difference
AUT	-6.076	118.609	.000	-6.608	1.087
RAT	-4.831	106.921	.000	-4.490	.929
Letter Fluency	-3.301	122.791	.001	-2.886	.874
Category Fluency	-4.145	123	.000	-4.215	1.017
Condition 1	-5.191	120.551	.000	-2.742	.528
Condition 2	-5.987	120.564	.000	-3.037	.507
Condition 3	-2.873	122.891	.005	-1.266	.441
Set B	-6.775	119.993	.000	-2.921	.431
Set C	-6.539	118.4	.000	-2.900	.443
Set D	-6.318	116.964	.000	-3.354	.531
Time Interference	2.581	90.355	.011	4.2266	1.6374
Error Interference	2.855	95.009	.005	.7844	.2747

The *t*-test was examined based on an alpha value of .05. The results revealed that there were significant group-differences in favour of individuals with 13 years or more of education on all instruments, including the AUT, $t(118.609) = -6.076$, $p < .01$, $d = 1.09$; RAT, $t(106.921) = -4.831$,$p < .01$, $d = .86$; Letter Fluency, $t(122.791) = -3.301$, $p < .01$, $d = .59$; Category Fluency, $t(123) = -4.145$, $p < .01$, $d = .74$, Condition 1, $t(120.551) = -5.191$, $p < .01$, $d = .93$; Condition 2, $t(120.564) = -5.987$, $p < .01$, $d = 1.07$; Condition 3, $t(122.891) = -2.873$, $p < .01$, $d = .52$; Set B, $t(119.993) = -6.775$, $p < .01$, $d = 1.21$; Set C, $t(118.4) = -6.539$, $p < .05$, $d = 1.17$; Set D, $t(116.964) = -6.318$, $p < .01$, $d = 1.13$; Time Interference, $t(90.355) = 2.581$, $p < .01$, $d = .46$; Error Interference, $t(95.009) = 2.855$, $p < .01$, $d = .51$. Together, these findings suggest that individuals with 13 or more years of education tended to perform better on all instruments included in the SEM model in comparison to those with 12 or fewer years of education.

Therefore, the results reveal that level of education significantly affected all cognitive processes included in the model of creativity. The general pattern was that individuals with a higher level of education tended to outperform their peers with a lower level of education on indicators of divergent thinking, convergent thinking, associative thinking, task-switching, inhibition and fluid intelligence. These results were expected as it was hypothesised that most of the processes included in the model would be affected by level of education. However, it was surprising that even the bottom-up processes, such as associative thinking and divergent thinking, were also significantly affected as level of education was thought to affect higher-order cognitive functions, such as fluid intelligence, task-switching, inhibition and convergent thinking to a greater degree.

4.2.3.5. Gender. The last demographic variable evaluated was gender. Since the gender variable comprised of only two groups, a *t*-test was used to investigate its effect on the cognitive processes included in the model. Specifically, a Welch's *t*-test determined whether significant differences in test performance occurred between males and females. The following sections present the results from the analysis, and Table 18 illustrates the group statistics.

Table 18

Group Statistics for Males and Females.

		M	*SD*	Std. Error Mean
AUT	Male	10.36	5.891	.888
	Female	11.26	7.401	.822
RAT	Male	5.00	5.694	.858
	Female	5.91	5.604	.623
Letter Fluency	Male	11.95	4.705	.709
	Female	12.62	5.288	.588
Category Fluency	Male	15.00	5.698	.859
	Female	15.65	6.247	.694
Condition 1	Male	6.89	2.895	.436
	Female	7.67	3.406	.378
Condition 2	Male	7.25	2.470	.372
	Female	8.11	3.521	.391
Condition 3	Male	5.25	2.729	.411
	Female	5.05	2.439	.271
Set B	Male	7.70	2.741	.413
	Female	7.46	2.868	.319
Set C	Male	6.00	2.909	.439
	Female	6.33	2.859	.318
Set D	Male	6.18	3.391	.511
	Female	6.88	3.411	.379
Time Interference	Male	17.670	9.0509	1.3645
	Female	16.414	9.6163	1.0685
Error Interference	Male	.864	1.1328	.1708
	Female	1.037	1.7885	.1987

As mentioned above, the Welch's *t*-test statistic was calculated to assess whether or not significant differences occurred between males and females. Table 19 presents the results from the *t*-test, including the *t*-test statistic, *df*, *p*-values, *MD* and standard error difference, and the results from the *t*-test.

Table 19

Welch's t-test for Equality of Means for Gender.

	t	*df*	*p*	*MD*	Std. Error Difference
AUT	-.74	106.329	.461	-.896	1.21
RAT	-.862	87.186	.391	-.914	1.06
Letter Fluency	-.72	97.566	.474	-.663	.921
Category Fluency	-.592	95.588	.555	-.654	1.104
Condition 1	-1.351	101.208	.18	-.78	.578
Condition 2	-1.594	115.021	.114	-.861	.54
Condition 3	.407	80.278	.685	.201	.493
Set B	.475	91.878	.636	.248	.522
Set C	-.615	87.069	.54	-.333	.542
Set D	-1.092	88.826	.278	-.695	.636
Time Interference	.725	93.09	.47	1.2569	1.733
Error Interference	-.662	120.013	.509	-.1734	.262

The t-test was set at an alpha value of .05. The results revealed that there were no significant gender differences on any instruments, including the AUT, $t(106.329) = -.740$, $p = .461$; RAT, $t(87.186) = -.862$, $p = .391$; Letter Fluency, $t(97.566) = -.720$, $p = .474$; Category Fluency, $t(95.588) = -.592$, $p = .555$; Condition 1, $t(101.208) = -1.351$, $p = .180$; Condition 2, $t(115.021) = -1.594$, $p = .114$; Condition 3, $t(80.278) = .407$, $p = .685$; Set B, $t(91.878) = .475$, $p = .636$; Set C, $t(87.069) = -.615$, $p = .540$; Set D, $t(88.826) = -1.092$, $p = .278$; Time Interference, $t(93.090) = .725$, $p = .470$; Error Interference, $t(120.013) = -.662$, $p = .509$.

The results reveal that gender did not significantly affect any of the cognitive processes included in the model of creativity. That is no significant group-differences between males and females occurred on the indicators of divergent thinking, convergent thinking, associative thinking, task-switching, inhibition, and fluid intelligence. Due to the inconsistencies in prior research (Abraham, 2016), the researcher did not expect gender-based differences in creative ability and, therefore, expected these results.

4.3. Summary

This chapter reported the findings from both the pilot study and the large-scale study. The current research included a pilot study to increase the likelihood of success in the main study. Ten participants from the target population took part in the pilot study and provided feedback on, the same processes, methods and measures that were included in the main study. Additionally, the pilot study involved evaluating the methods of organising and refining data, as well as data entry and data processing procedures. The results from the pilot study revealed that the main study was feasible with minor modifications and close monitoring. The issues identified included extensive administration time and inappropriate RAT content, which were rectified by including breaks during the administration procedure and replacing problematic RAT content with more appropriate items. The subsequent section of this chapter presented the results from the large-scale study, which comprised of three main sections. The first presented the results from the descriptive analyses, which summarised the data and indicated any unexpected patterns. In this sub-section, the data were analysed in terms of various measures of central tendency and variability. The analyses revealed that the distribution of the data was approximately symmetrical. However, there were notable irregularities in the dataset on the RAT and VS, particularly the Error and Time Interference scores. In terms of the RAT, these irregularities were indicative of possible floor effects. In contrast, irregularities in Error and Time Interference scores were indicative of outliers or extraneous data.

The second and third sub-sections presented the results from the inferential analyses, which were used together with hypothesis testing to address the research questions. The second sub-section addressed the first aim of the study, which was to develop a coherent theoretical model of creativity. SEM was, therefore, used to investigate the relationships between executive functions, including fluid intelligence, task-switching and inhibition, and components of creative thinking, namely divergent, convergent and associative thinking. Specifically, it assessed whether the empirical data supported the theoretical model of creative cognition developed in the initial stages of this research.

Stage four (model testing) and stage five (model modification) of SEM analysis (Crockett, 2012)were conducted together due to the approach to model testing undertaken in the current research. In particular, the researcher deconstructed the hypothesised model specified in the earlier stages of the study and individually tested the sub-components. Modifications to each model were then made based on the results obtained in the analyses. The researcher then incorporated the models consisting of the best goodness of fit values and significant regression weights into a final theoretical model and tested this model as a whole. While the final model that was analysed bore several similarities to the hypothesised model, the researcher found non-significant and unexpected significant pathways and, therefore, made some modifications to the initial model. The analyses revealed that the final model fit the data adequately and all the pathways included in the model were significant. This final model was, therefore, accepted as the theoretical model of creative cognition.

The third sub-section addressed the second aim of the study. As previously mentioned, the second aim of the study was to investigate whether various demographic variables, including age, the number of spoken languages, SES, level of education, and gender, predicted any of the individual cognitive functions identified as being implicated in the creative process. Group-differences in test performance of demographic variables were evaluated using either a *t*-test or a one-way ANOVA, depending on the number of comparisons groups. Moreover, since analysis of normality and homogeneity of variance demonstrated that a violation in these assumptions occurred (see Chapter 3), Welch's *t*-test and Welch's ANOVA were used as alternative statistical analysis techniques since they are more reliable if these assumptions have been violated (Field, 2013).

The results revealed that gender did not affect any of the processes included in the theoretical model. Additionally, while age and multilingualism, affected a few processes, SES and level of education were the most influential of the demographic variables assessed in this study. In particular, a higher level of both SES and education corresponded with better performance on the majority of cognitive tests. These findings suggest that the relationships between the variables included in the theoretical model of creative cognition may vary across SES and education levels. This idea is discussed further in the next chapter, which describes and interprets the results presented in the previous sections.

Chapter 5: Discussion

This chapter provides a critical analysis of the results with regard to the available literature and the methodological choices, with the limitations linked to the latter. The subsequent sections first provide a short overview of the study to remind the reader of the aims, objectives, research questions and framework, as well as the methodology. The goal of this study was to address two primary research aims. The first involved the development of a coherent theoretical model of creative cognition using SEM as a multivariate statistical technique to analyse the relationships between various cognitive processes implicated in creative thinking. These processes included components of creativity, namely divergent, convergent and associative thinking, and various executive functions, such as task-switching, inhibition and fluid intelligence. Specifically, since creativity relies on the generative role of divergent thinking to formulate novel output, and the analytic, evaluative role of convergent thinking to select or refine initial output into a useful idea, the present study considered both components of creativity. In addition, the model included associative thinking as it presumably forms the basis of these two components (Beaty et al., 2014b; Benedek et al., 2017; Benedek et al., 2012b; Kenett, 2018a; Lee & Therriault, 2013; Marko et al., 2019). Lastly, executive functions improve the efficiency of memory retrieval, strategy implementation and the manipulation of information, which benefits the generation of creative ideas (Benedek et al., 2017). In particular, creativity may rely on task-switching and inhibition, which operate together to optimise the retrieval of information from semantic memory and suppress strong competing, yet irrelevant information. Additionally, this study considered the role of fluid intelligence as it was assumed to facilitate the allocation of the executive functions implicated in the creative process.

The second aim of the study was to investigate whether various demographic variables, including age, the number of spoken languages, SES, level of education, and gender, predict any of the individual cognitive functions identified as being implicated in the creative process. This aim was achieved through the use of group mean difference analysis, namely Welch's *t*-test and Welch's one-way ANOVA, to evaluate whether or not there were differences in test scores for the cognitive processes included on the theoretical model developed in the first stage of the research across the above-mentioned demographic groups.

In brief, the SEM analysis revealed a good fit between the theoretical model and the observed data. While minor modifications were made based on the results of the analysis, the final theoretical model of creativity bore several similarities to the hypothesised model developed in the initial stages of the study. In terms of group-difference analysis, SES and level of education predicted the majority of the processes underlying creativity, namely divergent thinking, convergent thinking, associative thinking, task-switching, inhibition and fluid intelligence. In particular, lower levels of both SES and education corresponded with lower scores on the indicators of these functions. The subsequent sections critically examine and discuss the main findings with regards to both the existing literature and the aims of the study. The chapter concludes with a discussion of the major limitations of the study and areas of future research.

5.1. Conceptualisation the Creativity

The following section conceptualises creativity in terms of two overarching themes, namely the theoretical model of creative cognition and creativity in context. The first theme is based on the findings from the SEM analysis of the hypothesised theoretical model of creative cognition. Chapter 3 presented the model specified in the initial stages of the study (see Figure 12). This model comprised of eight hypothesised relationship pathways between the variables of interest. In particular, the model presented the following hypotheses: fluid intelligence predicts both inhibition (H1) and task-switching (H3); inhibition predicts convergent thinking (H2); task-switching predicts convergent thinking (H4), associative thinking (H5) and divergent thinking (H6); associative thinking predicts both convergent thinking (H7) and divergent thinking (H8). The SEM analysis investigated each of these hypothesised relationships and evaluated whether or not the reproduced S matrix was equal to the Σ matrix.

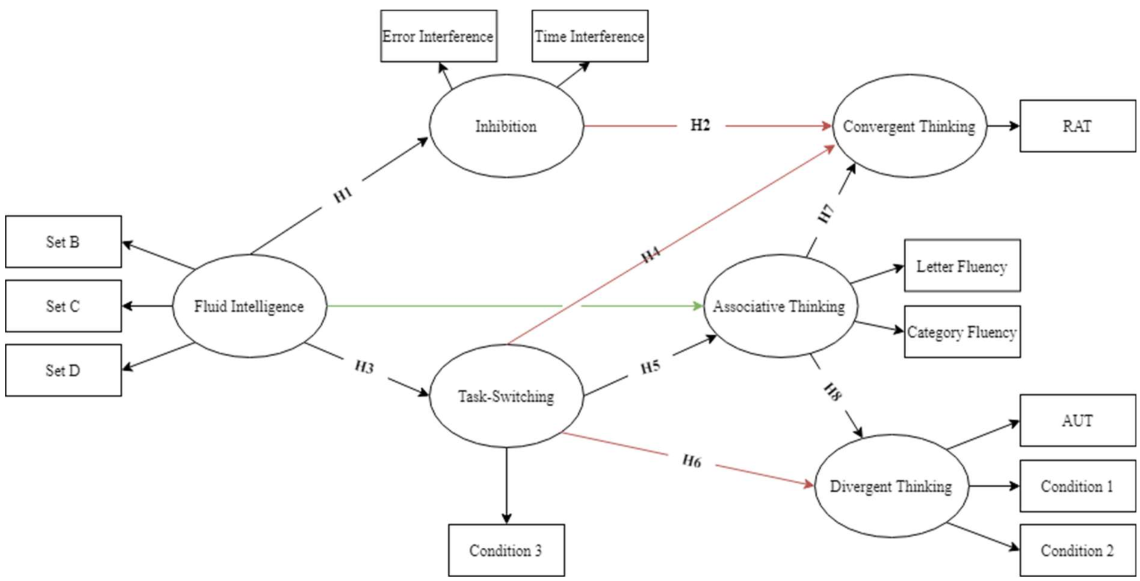
The second theme discussed is creativity in context and is based on the findings from the group-difference analysis. Specifically, this section interprets the results from the Welch's *t*-test and Welch's ANOVA, which were used to assess the demographic variables of age, multilingualism, SES, level of education and gender predicted performance on the indicators included in the model.

5.1.1. Theoretical Model of Creative Cognition

The following section aims to conceptualise creativity as a process of creative cognition. First, a hypothesised theoretical model was developed using applicable, related theory and by referring to research to identify relevant variables and the relationships between them. This hypothesised model was subsequently tested and modified to produce a final theoretical model of creative cognition. Figure 23 depicts the modifications made to the hypothesised theoretical model of creative cognition based on the results from the SEM analyses. In Figure 23, the red lines indicate the rejected hypotheses and are, therefore, the relationship pathways removed from the final model. In contrast, the green line indicates the unexpected relationship between fluid intelligence and associative thinking that the SEM analysis yielded and is, therefore, the relationship pathway included in the final model. Finally, the black lines illustrated in the hypothesised model indicate the accepted hypotheses and are, therefore, the relationship pathways that were retained in the final theoretical model of creative cognition.

Figure 23

Modifications to the Hypothesised Theoretical Model of Creative Cognition.



In brief, Figure 23 demonstrates that creativity involved the joint role of divergent and convergent thinking, and that associative thinking formed the basis of both aspects of creativity. Moreover, the analysis revealed that, in addition to bottom-up, associative processes (i.e., divergent thinking and associative thinking), creativity involved higher-order, cognitive control processes (i.e., fluid intelligence and task-switching). In particular, fluid intelligence predicted both divergent and convergent thinking via the mediator associative thinking. Additionally, fluid intelligence predicted associative thinking, and task-switching partially mediated this relationship. Lastly, inhibition did not predict any of the components of creativity. However, fluid intelligence directly predicted inhibition, suggesting that fluid intelligence concealed the effect of inhibition on creativity.

The SEM analysis of the hypothesised model elucidated the various cognitive functions that underlie and supported the creative processes, as well as the relationships between them, which contributed information about human creativity. In doing so, this analysis addressed a notable research gap, namely the tendency for studies to investigate the role of individual processes in isolation, thereby neglecting the manner in which multiple cognitive functions interact with each other and jointly influence creative performance (Reiter-Palmon, 2014). Three major findings are discussed in further detail below, before the final theoretical model of creative cognition proposed in this research is presented. The findings include: (1.) associative processes as the basis of creativity, (2.) executive functions as a second layer of information processing, and (3.) reduced inhibition facilitates remote associations.

5.1.1.1. Associative Processes as the Basis of Creativity. Creativity was operationalised in the current study in terms of three major components identified through the review of existing literature and prior research, namely divergent thinking, convergent thinking and associative thinking. In doing so, this study addressed the issue of prior research often oversimplifying the creative process by solely using tests of divergent thinking as primary psychometric measures of general creativity (Benedek et al., 2013; Simonton, 2015).

Such an approach is inadequate because there is insufficient evidence to suggest that creativity is a psychometrically unitary construct. Instead, contemporary conceptualisations maintain that a broad range of cognitive functions underlie creativity (Arden et al., 2010). While the creativity literature acknowledges the contributions of divergent, convergent and associative thinking, research tends to assess these processes in isolation. Consequently, the relationships among these processes are rarely empirically investigated (Lee & Therriault, 2013). Therefore, the present study contributed to contemporary creativity research that uses cognitive science to develop and improve our understanding of creative processes.

The final accepted theoretical model (see Figure 23) demonstrates that associative thinking predicted both divergent and convergent thinking, therefore confirming H8 (associative thinking predicts divergent thinking) and H7 (associative thinking predicts convergent thinking), respectively. A large body of literature has yielded similar results, supporting a significant relationship between associative thinking and both divergent thinking (Beaty et al., 2014a; Benedek et al., 2017; Benedek et al., 2012b) and convergent thinking (Benedek et al., 2012b; Benedek et al., 2013; Marko et al., 2019; Marko & Riečanský, 2018). Moreover, the finding that associative thinking predicted both divergent and convergent thinking corresponds with the SEM model developed by Lee and Therriault (2013), who demonstrated that associative thinking underlies both of these aspects of creative cognition.

These results support the associative theory of creativity proposed by Mednick (1962), which argues for an associative basis of creative cognition. This theory maintains that creativity relies on the ability to establish, activate and fluently retrieve associations between weakly related, remote concepts, which combine into novel and acceptable ideas (Benedek & Neubauer, 2013). Individual differences in both divergent and convergent thinking are, therefore, attributed to differences in the structure of semantic memory (Benedek et al., 2017). Hence, associative thinking is possibly a broader cognitive function that underlies, and is shared by, these two seemingly distinctive processes.

Additionally, these findings rejected the implication that divergent thinking is synonymous with creativity in general. Instead, this model demonstrates that convergent thinking plays a significant role in the creative process, despite research conceptualising this mode of creative thinking as a function that opposes creativity (Cropley, 2006). These findings suggest that creativity involves the joint role of both processes, with divergent thinking generating multiple potential solutions to a given problem, and convergent thinking subsequently evaluating these candidate solutions (Kharkhurin, 2012).

5.1.1.2. Executive Function as a Second Layer of Information Processing. Creativity is often conceptualised exclusively as a bottom-up, associative process, which implies that it is a process that occurs incidentally and operates independently of conscious control (Colzato et al., 2013). However, contemporary accounts of creativity emphasise the role of top-down, executive control during the creative process, and argue that executive processes enhance persistence and improve the efficiency of memory retrieval, strategy implementation and the manipulation of information (Benedek et al., 2017). Therefore, the current study examined the role of the executive functions of task-switching, inhibition and fluid intelligence in creative cognition.

Overall, fluid intelligence predicted all components of creativity (i.e., divergent, convergent and associative thinking), which corresponds with findings from studies that report a positive, significant relationship between the two constructs (Jauk et al., 2013; Nusbaum & Silvia, 2011). Additionally, associative thinking and task-switching both functioned as mediators that explained the relationships between fluid intelligence and aspects of creative thinking, respectively. The next section discusses the respective relationships between the executive functions of fluid intelligence and task-switching, as well as the components of creativity, namely divergent, convergent and associative thinking.

Although the researcher initially modelled task-switching as the function that mediates the relationship between fluid intelligence and all investigated components of creativity (i.e., divergent, convergent and associative thinking), the results revealed that it only mediated the relationship between fluid intelligence and associative thinking. Specifically, task-switching partially mediated the relationship between fluid intelligence and associative thinking (16.15%), and therefore accounted for some, but not all, of the relationship between these two variables. That is, the analysis revealed a significant relationship between the mediator (task-switching) and both the IV (fluid intelligence), which confirmed H3 (fluid intelligence predicts task-switching), as well as the DV (associative thinking), thus confirming H5 (task-switching predicts associative thinking). In addition, the IV also directly predicted the DV. The researcher did not initially expect fluid intelligence to predict associative thinking and, therefore, this relationship pathway constituted the first modification made to the hypothesised theoretical model.

It is important to note that the analysis of the small-scale models (Model 3c[12], Model 4a and Model 4b[13]) revealed that associative thinking mediated the relationship between task-switching and both divergent and convergent thinking, respectively. Moreover, since the IV (task-switching) did not predict either DV (divergent thinking and convergent thinking), thereby rejecting H6 and H4 respectively, it was concluded that associative thinking fully mediated both relationship pathways in those initial models. The researcher removed H6 and H4 pathways from the final model, which constituted the second and third modifications made to the initial hypothesised model. Nevertheless, analysis of the final theoretical model revealed that the mediation effect of associative thinking on the relationship between task-switching and both divergent thinking (p = .057) and convergent thinking (p = .056) became non-significant.

This reduction in the mediation effect was possibly attributed to various factors. One factor identified by Walters (2019) is the complexity of the model. The final theoretical model analysed in this study was more complex than those assessed in the model testing stages as it

[12] Model 3c assessed the relationship between fluid intelligence, task-switching, associative thinking and convergent thinking.

[13] Model 4a and Model 4b assessed the relationship between fluid intelligence, task-switching, associative thinking and divergent thinking.

not only comprised of additional latent variables but also included, and simultaneously analysed, the effect of multiple mediators, namely associative thinking and task-switching. The amount of variation in the DV that is available to multiple mediators is often constrained. Mediators compete for this limited range of available free variance and as a consequence, the proportion of the variance that each mediator can explain decreases each time an additional mediator is included in the model (Walters, 2019). Therefore, the reduction in the mediation effect of associative thinking on the relationships between task-switching and divergent thinking and convergent thinking, respectively, was possibly attributed to the addition of multiple mediators in the final theoretical model. As such, future research should evaluate the mediation effects of task-switching in the creative process in isolation. However, as previously mentioned, a common shortfall of creativity research is that it tends to investigate the exclusive role that individual factors play in creative cognition, thereby oversimplifying the creative process (Fryer, 2012). An alternative avenue for future research in investigating the influence of multiple mediators in the creative process is to increase the statistical power and use alternative techniques of evaluating significance (Walters, 2019), both of which the next section considers.

Given how small the effects can be when including multiple mediators in a model, such as the theoretical model developed in the current study, statistical power is crucially important when conducting this type of analysis. Briefly, statistical power refers to the probability of failing to reject a false null hypothesis, thereby avoiding a Type II error (β). One of the best methods of improving the statistical power of an analysis is to increase the sample size of the study to reduce the standard error of the mediation effect and narrow the distribution of the test statistic (Walters, 2019).

The method used in the current study to detect significant mediation effects, namely the Sobel test, is often criticised for being overly conservative as it assumes that the sampling distribution of the mediation effect is normal (Neiheisel, 2017; Walters, 2019). Consequently, results from mediation analysis using the Sobel test may fail to achieve significance (Walters, 2019). Alternative approaches to evaluating the significance of mediation effects can, therefore, be used, such as the M-test or bootstrapping procedures. Unlike the Sobel test, these techniques are non-parametric and, therefore, do not assume normality (Neiheisel, 2017). Therefore, the indirect effect of task-switching on the different components of creative cognition (i.e., divergent and convergent thinking) through associative thinking can be reviewed in future research using a larger sample size and less conservative techniques to evaluate significance.

The results also demonstrated that associative thinking mediated the relationship between fluid intelligence and both divergent and convergent thinking. In particular, since the relationship between the IV (fluid intelligence) and the respective DVs (divergent and convergent thinking) became non-significant when the mediator (associative thinking) was introduced, full mediation occurred in both cases. These findings are similar to those obtained by Lee and Therriault (2013), who found that intelligence, which was specified using measures of both fluid intelligence and crystallised intelligence, indirectly affected divergent and convergent thinking through associative fluency. Moreover, these results are in line with the findings obtained in Benedek and colleagues' (2012b) study, which supported the overarching role of associative processes in both divergent thinking and measures of intelligence. The current study extends Benedek et al.'s (2012b) findings by demonstrating that, like divergent thinking, associative processes are central to convergent thinking.

The results showing that fluid intelligence and, to a degree, task-switching predict various aspects of creativity can be explained in terms of the two-component model of semantic exploration (Troyer et al., 1997). As discussed in the previous chapters, this model argues that two factors optimise the retrieval of information from semantic memory. These factors are the network's structural properties and task-switching (Troyer et al., 1997). Highly structured semantic networks, characteristic of individuals with high levels of fluid intelligence (Faust & Kenett, 2014; Kenett et al., 2016a), facilitate efficient and rapid retrieval of information due to concepts being organised in a strongly modular or locally clustered manner. However, overly structured semantic networks may limit the spread of activation, which may negatively affect the ability to find rare or remote paths between conceptual nodes. As a consequence, the excessive structure reduces the flexibility of the network, which may result in rigidity of thought. Therefore, task-switching is also required in the creative process to mitigate exploration limitations by enabling individuals to flexibly jump or shift to alternative semantic fields, which extends the exploration of the network and allows the spread of activation to reach more remote associations (Goñi et al., 2010).

Taken together, the results obtained from the SEM analysis have various theoretical implications. Firstly, these findings reject the conceptualisation that creativity is exclusively a bottom-up, automatic process, as executive functions, namely fluid intelligence and task-switching, played a significant role in the creative process. Instead, by demonstrating that the creative process involved both associative and higher-order cognitive functions, the present study provided evidence in support of the dual-process theory of creative cognition.

Therefore, these findings suggest that creativity relies on both associative processes during the generative stage in order to formulate novel output, as well as higher-order processes during the analytic, evaluative stage, which is required to refine initial output into a useful and valuable form (Sowden et al., 2015). Hence, both associative processes and higher-order cognitive functions are required to produce output that meets both the novelty and usefulness criteria of creativity.

Additionally, the observation that the relationship pathways proceeding from fluid intelligence, and possibly task-switching, to the components of creativity, namely divergent and convergent thinking, pass through associative thinking, suggests that associative processes function as a hub for, or are central to, creative cognition. These results support the idea that semantic network structures form the basis of creativity upon which higher-order cognitive functions operate (Kenett, 2018a), thereby supporting the dual-process theory of creative cognition. Moreover, the results from this study provide evidence to suggest that, in addition to associative processes, fluid intelligence is a common function of various components of creativity, namely associative thinking, divergent thinking and convergent thinking.

Consequently, the notion that these two processes (i.e., divergent and convergent thinking) differ in terms of their reliance on executive functions, with convergent thinking relying on a higher degree of executive function compared to divergent thinking (Colzato et al., 2013), was rejected in the current study. Instead, divergent and convergent thinking possibly draw on similar cognitive functions, such as associative thinking and fluid intelligence, an explanation that coheres with the dual-pathway model of creativity (Nijstad et al., 2010). As previously discussed, this theoretical framework diverges from other dual-process models of creativity, such as the Geneplore model, by maintaining that divergent and convergent thinking are more integrated than initially conceptualised, rather than being considered as entirely separable processes that rely on different functions (Sowden et al., 2015). This idea is considered further in the next section, which discusses the results obtained regarding the role of inhibition in convergent thinking.

5.1.1.3. The Role of Inhibition in Convergent Thinking. In addition to investigating the role of fluid intelligence and task-switching in different aspects of creativity, the present study investigated inhibition as another executive function that possibly operates on semantic structures, thereby facilitating aspects of creativity. In particular, the researcher hypothesised that inhibition directly predicts only convergent thinking aspects of creativity as it is more top-down, abstract, and rule-based than divergent thinking or associative aspects of creativity.

Inhibition was, therefore, theorised to be a possible executive function that differentiates convergent thinking from divergent thinking. This hypothesis was based on the MFH, which argues that task performance is not optimised by simply engaging a high degree of inhibitory control regardless of the task at hand. Instead, an appropriate match between the extent of control applied and the degree to which tasks require lower levels of information to be filtered is required (Chrysikou et al., 2014). In addition, the researcher modelled inhibition as the executive function that mediated the relationship between fluid intelligence and convergent thinking.

The results from the SEM analysis contradicted these hypotheses as inhibition did not significantly predict convergent thinking, therefore rejecting H2 (inhibition predicts convergent thinking). Hence, this hypothesised pathway was removed from the final model of creativity developed in this study, thereby constituting the fourth modification to the initial model. These findings correspond with those obtained by Marko et al. (2019), who demonstrated that performance on a measure of convergent thinking, namely the RAT, was related to semantic processing, but not to executive abilities, such as inhibition and task-switching. Additionally, these results suggested that inhibition did not function as a mediator in the relationship between fluid intelligence and convergent thinking as the criteria of mediation were not met. That is, although fluid intelligence significantly predicted inhibition, which confirmed H1 (fluid intelligence predicts inhibition), the hypothesised mediator (inhibition) did not predict the DV (convergent thinking).

The results demonstrating that inhibition did not predict convergent thinking suggest that the RAT reflects one's ability to coherently activate, retrieve and combine remote concepts in semantic networks without having to considerably engage executive control. Accordingly, this explanation implies that convergent thinking relies on automatic and associative processes to a greater extent that initially thought. As such, a lack of engagement of inhibitory control may improve the spread of activation in semantic memory and, consequently, enable distantly related information to enter working memory for further processing (Radel et al., 2015). This interpretation by no means suggests that inhibitory control is entirely absent when undertaking convergent thinking tasks, such as the RAT, but rather that inhibitory control does not drive individual differences in activating and combining distantly related associates.

These findings are related to the notion discussed in the previous section, namely the idea that divergent and convergent thinking aspects of creativity are considerably integrated (Sowden et al., 2015). Specifically, while tasks that engage convergent modes of processing may benefit from step-wise, analytical processes, solutions on these tasks may also emerge through unconscious, automatic and associative processes. In this sense, convergent thinking may have more in common with generative, Type-1 processing and shares similarities with divergent thinking (Sowden et al., 2015; Zhang et al., 2020). Likewise, solutions on measures of divergent thinking may emerge not only through unconscious, associative processes and step-wise analytical search, but can also be achieved through an effortful, explicit and controlled mode of thinking (Kounios & Beeman, 2014). Nevertheless, the degree to which divergent thinking engages these higher-order, executive functions, namely inhibitory control, was not considered in this study and, therefore, is an area of future research.

An alternative explanation for this lack of relationship between inhibition and convergent thinking is offered by Hommel (2015), who maintains that inhibition is a general characteristic of executive function rather than a specific, distinct component. For instance, Hommel (2015) describes that, in a situation where there are multiple conflicting response tendencies present, the inhibitory system would need to identify which response to inhibit. Such a system would, therefore, require access not only to a representation of the stimulus-response rules, but also the ability to apply these rules to identify the correct response tendency and subsequently employ that information to inhibit any inappropriate responses. In other words, this inhibitory system presumably entails some form of intelligence to identify the correct response tendencies to inhibit. Therefore, perhaps inhibition is an emergent property of other executive processes, such as fluid intelligence, task-switching or working memory rather than being an entirely separate function (Hommel, 2015). This idea is supported by Miyake and Friedman (2012), who found that inhibition correlates perfectly with a common factor shared by other executive functions, namely updating and shifting. These findings demonstrate that inhibition is a property that emerges from the interaction between different functions rather than a distinct function. Therefore, inhibition is often considered to be a general characteristic of executive function rather than a specific, distinct component comparable to updating and shifting (Miyake & Friedman, 2012). This suggests that the influence of other executive functions possibly obscures the role of inhibition in the creative process. This idea points towards additional possibilities for future research, namely investigating the role of other executive function, such as working memory, in the creative process. This avenue of research potentially has significant ramifications as working memory is thought to benefit creativity by facilitating the storing and processing of information as well as by assisting individuals in breaking away from a mental set or an ineffective approach to creative thinking (Lee & Therriault, 2013).

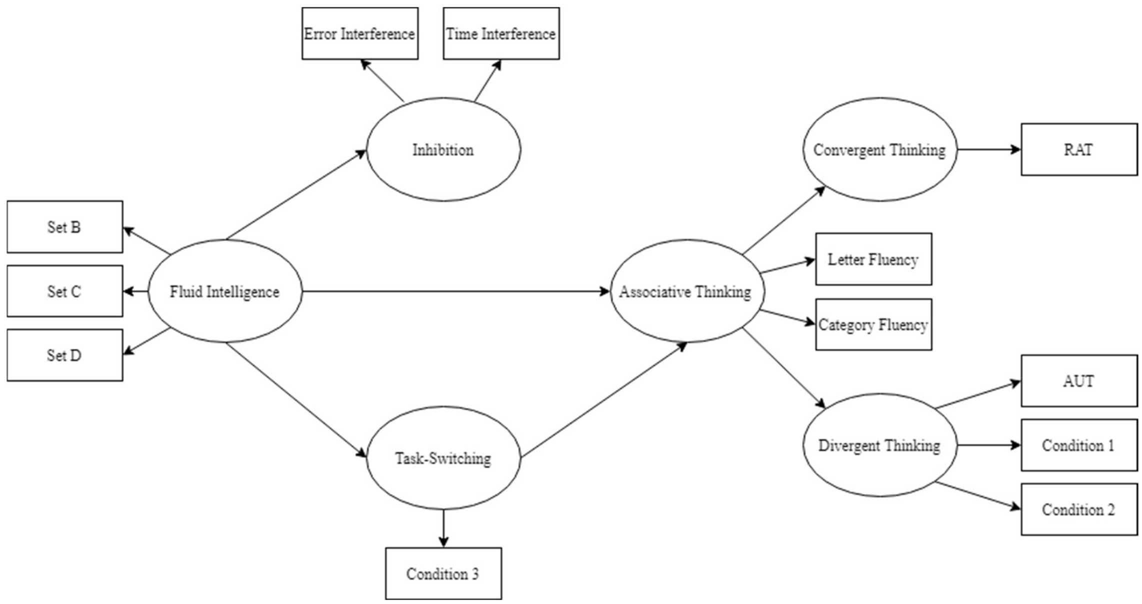
Moreover, since no significant relationship pathway was found between inhibition and convergent thinking, the current study did not identify a possible cognitive process that differentiates divergent from convergent thinking, which is, therefore, also an additional avenue for future research. Although the current research argues that divergent and convergent thinking are more integrated than initially conceptualised in prior research and existing theoretical frameworks, there are important differences between these two processes that are not accounted for in the current study. That is, the results in this study indicated the cognitive functions that were common or shared across divergent and convergent thinking, namely fluid intelligence, associative thinking and, to an extent, task-switching. However, they did not identify processes that were unique to, or implicated to a greater extent in either, divergent or convergent thinking. Therefore, future research can investigate the cognitive functions that distinguish divergent thinking from convergent thinking.

5.1.1.4. Creativity Model in Brief. The previous sections summarised and discussed the major findings in the SEM analysis of the theoretical model of creative cognition developed in the present study. Figure 24 presents the final theoretical model of creative cognition, which included minor modifications to the hypothesised model (see Figure 23).

This model indicated an acceptable fit between the S and Σ matrices. Therefore, the overall null hypothesis was accepted, which provided empirical support for the theoretical model of creative cognition. The analysis of the final theoretical model of creative cognition supports the notion that creativity consists of unique combinations of fundamental processes also engaged during non-creative tasks. In particular, creativity was found to rely on the joint role of divergent and convergent thinking, both of which were dependent on associative thinking. Hence, associative processes form the basis of creative cognition, which indicates that creativity is directly affected by the structural properties of semantic networks and, therefore, dependent on the spread of activation in semantic memory.

Figure 24

Final Theoretical Model of Creative Cognition



Additionally, the results from this phase of the study suggest that, during creative thinking, semantic memory functions as the basis upon which higher-order functions, such as fluid intelligence and, to a degree task-switching, operate. The results that demonstrated that the key components of creativity relied on both associative and higher-order functions are in line with dual-process theories (Finke et al., 1992; Nijstad et al., 2010) of creativity. Specifically, these findings cohere with the dual-pathway framework (Nijstad et al., 2010) as divergent and convergent thinking shared various cognitive functions, namely associative thinking and fluid intelligence, which indicated that these processes were integrated to a greater extent than initially thought. However, inhibition was not implicated in the creative process as it did not predict convergent aspects of creativity. Possible explanations for these results are that either convergent thinking reflects more associative and automatic processes or that other executive functions obscure the effect of inhibition.

5.1.2. Creativity in Context

The following sections discuss and interpret the main findings obtained in the second phase of the current research, the purpose of which was to investigate whether different demographic variables, including age, multilingualism, SES, level of education and gender, predicted any of the processes included in the theoretical model of creativity. In doing so, this study addressed an additional research gap, namely the tendency of creative cognitive research to focus only on internal processes, including cognition and personality, to the exclusion of other, external factors, such as contextual and environmental factors (Glăveanu, 2010). A group-difference method, including either a Welch's *t*-test or Welch's ANOVA, was used to assess differences in test performance on the indicators included in the model between two or more demographic groups. In particular, the following research question was investigated: Are there significant differences in the relative contributions of demographic variables to the contributions made by executive functions and creativity? The results from the age, multilingualism and gender group-comparisons are first discussed together as no significant group difference in test scores were found on most of the indicators included in the theoretical model across the respective groups. Subsequently, the results from the level of education and SES analyses are discussed together as significant group differences in test scores were found on the majority indicators across the respective groups.

5.1.2.1. Age, Multilingualism and Gender. As mentioned above, no significant group differences were found across age, multilingual and gender groups on the cognitive functions included in this study. Firstly, in terms of age, the sample of the current study was comprised of individuals aged 65 and above as this developmental stage is often overlooked in creativity research (Bialystok et al., 2004).

Based on the frontal lobe hypothesis, which attributes age-related cognitive decline to underlying anatomical deterioration and functional decline of the frontal cortex (Cabeza & Dennis, 2012), the researcher expected age to negatively correlate to performance on the higher-order, executive functions included in the model, namely fluid intelligence, task-switching and inhibition. Moreover, this possible decline in executive functions was expected to function as a double-edged sword for creative thinking. That is, since certain aspects of the creative processes presumably rely on a higher degree of executive functions, namely convergent thinking, this component of creativity was also expected to be negatively associated to age. In contrast, age was not expected to relate to the aspects of creativity that presumably rely less on cognitive control, such as associative thinking and divergent thinking (Amer et al., 2016).

The results obtained from this analysis revealed no significant differences between the age groups across all cognitive functions included in the model, except for task-switching. Therefore, except for task-switching, the null hypothesis was not rejected in all cases. The post hoc analysis revealed that participants from the younger age group (71-75) outperformed those from the older age group (76-80) on the measure of task-switching. Although these findings seemingly cohere with the frontal lobe hypothesis, as performance as an indicator of executive function (i.e., task-switching) appears to have been negatively associated to age, no differences across age groups were found on the indicators of other executive functions evaluated in the current study, namely fluid intelligence and inhibition.

These results are perhaps due to the indicator of task-switching used in the current study, namely the switch condition (Condition 3) of the DF test of the D-KEFS, placing greater demands on working memory. Specifically, this task relies on the ability to maintain and coordinate multiple instructions on-line, as well as to monitor progress while generating novel designs (Kramer et al., 2007). This is supported by research that has demonstrated that working memory is particularly age-sensitive (Bopp & Verhaeghen, 2007; Cansino et al., 2013; Kray & Lindenberger, 2000; Pliatsikas et al., 2019). Specifically, Kray and Lindenberger (2000) revealed that a major source of age-related differences in task-switching is attributed to the ability to organise cognitive functions in a dual or multi-task situation. That is, older adults experience a decline in working memory, including the ability to maintain multiple task rules and instructions on-line and to monitor task sequences while simultaneously switching between tasks (Kray & Lindenberger, 2000). Nevertheless, the role of working memory in the creative process, as well as the degree to which age affects this cognitive process, is beyond the scope of the present study and, as previously mentions, could be addressed in future research.

When comparing the results from this study to those of prior research, several inconsistencies become apparent. For example, unlike Leon et al. (2014), the current research did not demonstrate that age confers advantages on associative, automatic component of creativity (i.e., associative and divergent thinking). Moreover, the findings obtained in this study were different from those demonstrating that convergent aspects of creativity (Simon & Bock, 2016), as well as higher-order functions, namely fluid intelligence and inhibition (Andrés et al., 2008; Manard et al., 2014; Salthouse, 2009) are negatively affected by age. It is worth noting that these studies (Andrés et al., 2008; Leon et al., 2014; Manard et al., 2014; Salthouse, 2009; Simon & Bock, 2016) either included comparison groups that were comprised of younger adults or included a broader age range than the one used in the current study. Hence, the failure to find significant age-related differences on the majority of the variables is possibly attributed to not comparing test performance of the elderly participants included in this study to significantly younger individuals, or to the lack of variance in age.

A possible alternative explanation as to why no significant differences occurred across the different age groups for most of the tests is that the majority of participants were from either upper or high SES brackets. It is important to note that higher levels of SES may contribute to cognitive reserve by providing economic resources and environmental enrichment, as well as experiences that may increase an individual's cognitive activity and opportunities to develop various skills, which may offset the effects of age (Wilson et al., 2002; Wilson et al., 2007).

Regarding multilingualism, participants in the current study were classified into one of three groups depending on the number of languages that they reported knowing, namely monolinguals (i.e., individuals who knew one language), bilinguals (i.e., individuals who knew two languages) and multilinguals (i.e., individuals who knew three or more languages). Based on both the LMCA and the idea that multilingualism confers advantages in executive control systems, the researcher expected significant group differences across the language groups on measures of both associative aspects of creativity (i.e., associative thinking and divergent thinking), executive functions (i.e., fluid intelligence, task-switching and inhibition) and components of creativity that presumably rely on higher-order functions (convergent thinking). In particular, the researcher expected the multilingual and bilingual groups to outperform the monolingual groups on the measures mentioned above.

The results obtained from this analysis revealed no significant differences between the language groups across all cognitive functions included in the model, except for an indicator of associative thinking, namely the category fluency component of the verbal fluency test. Therefore, except for the category fluency task, the null hypothesis was not rejected in all cases. Regarding the results that indicated significant group-difference on the category fluency task, the post hoc analysis revealed that both the bilingual and monolingual groups outperformed the multilingual group on this measure. Similarly, previous studies have often reported that monolinguals outperform individuals who speak multiple languages on verbal fluency tasks, such as sematic category conditions (Gollan et al., 2002; Rosselli et al., 2000; Sandoval et al., 2010).

Although these findings seemingly contradict the LMCA framework (Kharkhurin, 2015), this theory may, in fact, explain why the multilingual group performed worse than the bilingual and monolingual groups on the category fluency task. As discussed in the previous chapters, the LMCA maintains that the architecture of multilingual memory facilitates a greater spread of activation between conceptual representations, thereby presumably stimulating associative abilities. This theory is based on the assumption that translation equivalents automatically activate each other as they share conceptual representations (Kharkhurin, 2015). However, this simultaneous activation of multiple concepts, as well as the extended production of multiple words at a time, may result in between-language interference, which was demonstrated by Sandoval et al. (2010).

Moreover, Gollan et al. (2002) argue that this interference is greater in category fluency tasks than in letter fluency tasks. This is due to the translation equivalents for semantic fluency still being in accordance with the task rules. In contrast, if translation equivalents are activated during the letter fluency task, they can be easily rejected as they often start with a different letter (Gollan et al., 2002). Therefore, the finding that multilinguals performed worse than bilinguals and monolinguals is possibly due to multilinguals experiencing more interference as they have more languages activated during the category fluency task.

Lastly, the non-significant differences between language groups in the current study contradict a large body of literature demonstrating a bilingual advantage on executive control (Bialystok et al., 2005; Costa et al., 2008; Gold et al., 2013b), conflict management and inhibition (Bialystok, 2017; Blumenfeld & Marian, 2011; Kroll & Bialystok, 2013; Lee Salvatierra & Rosselli, 2011; Singh & Mishra, 2012; Tse & Altarriba, 2012; Valian, 2015; Zied et al., 2004) as well as divergent thinking (Adi-Japha et al., 2010; Kharkhurin, 2011, 2017) and convergent thinking (Hommel et al., 2011c). However, these results are possibly attributed to the manner in which the current study conceptualised the construct of multilingualism. Specifically, by categorising individuals into multilingual, bilingual or monolingual groups, this study overlooked the complexity of multilingualism (Yang et al., 2016). In actuality, bilinguals and multilinguals differ from each other in various ways, such as age of acquisition, language proficiency and interactional contexts (de Bruin, 2019). These factors are essential to take into consideration as each may modulate the emergence, specific tuning and magnitude of the bilingual advantage in other cognitive functions (Marzecová et al., 2013). The conceptualisation of multilingualism in the current study is discussed further in the limitations and recommendations for future research section of this chapter.

Regarding the group difference across genders, due to the inconsistencies prevalent in existing research, no gender-based differences in the cognitive functions included in the model of creative were initially expected. In addition to age and language, no differences on the indicators of the various cognitive functions conceptualised as implicated in the creative process were found between males and females. As a consequence, the null hypothesis was not rejected in all cases. While these findings contradict studies that have demonstrated a male (Furnham et al., 2009; He et al., 2013; Stoltzfus et al., 2011) or female (Anwar et al., 2012; Hong et al., 2013; Kousoulas & Mega, 2009) advantage in creative performance, the results obtained in this research correspond with various other studies that failed to observe gender-based differences in creativity (Charyton, 2005; Cheung et al., 2004; Harris, 2004; Kaufman & Baer, 2004). Therefore, this study rejected not only biological and socio-cultural based theories of gender differences in creative performance, but also the idea that differences in the strategies employed by males and females translate into enhanced creative abilities (Abraham, 2016).

Taken together, these results demonstrate that there were no differences on the measure of the cognitive processes evaluated in the current study across age, multilingual and gender groups, respectively. It is, however, possible that these demographic variables may influence the cognitive functions included in the model, but that these were either obscured or overridden by other additional environmental factors, namely SES, and level of education. The subsequent sections discuss the results from this analysis in further detail.

5.1.2.2. SES and Level of Education. As demonstrated in the previous sections, no differences on indicators of the cognitive functions implicated in the creative process were found across age, multilingualism, and gender groups. In contrast, significant differences were found on the majority of the measures used in this study across both SES and education groups, respectively.

The sample of the current study was stratified into one of four SES groups, including low, middle, upper and high, based on their scores on the LSM. In addition, participants were required to stipulate the number of years of education and were subsequently categorised into one of two education groups (i.e., ≤ 12 years or ≥ 13 years). Based on findings from a large body of literature (Castillo-Vergara et al., 2018; Dai et al., 2012; Farah et al., 2006; Guerra-Carrillo et al., 2017; Kaufman et al., 2009; Kishiyama et al., 2009; Lee et al., 2010; Niu, 2007; Noble et al., 2013; Noble et al., 2007; Turrell et al., 2002; Zhang & Niu, 2013), the researcher expected a higher level of both SES and level of education to correspond with higher scores on the majority measures of the cognitive functions implicated in the creative process.

The results from this analysis demonstrated significant differences on the majority of the measures used in this study across both SES and education groups. In particular, significant differences across groups were found on all indicators in the model except for the indicators of inhibition (i.e., Time and Error Interference). Similarly, significant differences across education groups were found on all indicators used in the current study. Therefore, the null hypothesis was rejected in every case except for the influence of SES on inhibition. Additionally, post hoc analyses revealed that a higher level of both education and SES corresponded to better task performance on all measures where a significant effect occurred.

These findings correspond with a large body of existing research, which has consistently reported the beneficial effect of both higher levels of both SES and education across various cognitive domains. For example, research has demonstrated that a higher level of SES and education corresponds with better executive functions and cognitive control abilities (Farah et al., 2006; Kaufman et al., 2009; Kishiyama et al., 2009; Noble et al., 2013; Noble et al., 2007), verbal fluency, memory storage and retrieval (Turrell et al., 2002), as well as creative ability (Castillo-Vergara et al., 2018; Dai et al., 2012; Zhang & Niu, 2013).

A possible explanatory reason for these significant differences in test performance are social and environmental causes, that is, the context in which individuals are born and reside. For example, higher levels of SES and access to high-quality education influence the exposure to information, knowledge and general experiences that presumably contribute to increased learning and cognitive flexibility, as well as provide a greater context for both problem-solving and reasoning. These experiences may exercise and, therefore, improve cognitive function. In addition, the cognitive stimulation associated with higher levels of SES and higher educational attainment may translate in an elderly population to the development of compensatory cognitive strategies to mitigate or adapt more efficiently to age-related cognitive losses. Therefore, a candidate mechanism for the results from this analysis is cognitive stimulation and enrichment (Hackman et al., 2010).

Taken together, these results demonstrated significant differences on performance on the majority of the cognitive processes evaluated in the current study across both SES and education groups. These findings not only point towards the potential protective effects of a higher level of SES and educational attainment against age-related cognitive change but also demonstrate that these contextual factors cannot be ignored when investigating individual variation in cognition functioning. These factors are particularly important to take into consideration when conducting research in South Africa as there are wide discrepancies in SES, varying degrees of educational attainment and quality of education (Lucas, 2013). Finally, by linking SES and level of education to cognitive performance in the older population, these findings demonstrate the need to address community characteristics related to deprivation in order to increase or maintain cognitive reserve.

5.1.2.3. Overview of the Influence of Demographic Variables on the Creative Process. Overall, no significant differences on the indicators included on the theoretical model of creativity were found across age, multilingual and gender groups. Age-related differences were only found on the measure of task-switching and differences across language groups were only found on semantic fluency aspects of associative thinking. In contrast, significant differences on the majority of the indicators were found across SES and education groups. In particular, a higher level of education corresponded with better performance on all of the measures included in the model. Similarly, higher levels of SES corresponded with higher scores on every indicator, except the two measures of inhibition.

Taken together, these findings suggest that the theoretical model of creativity developed in the first stage of the study would not change by age, multilingual and gender groups. In contrast, the results suggest that this theoretical model possibly experiences significant changes for each SES and education group. It is important to acknowledge that the statistical analysis technique use in this stage of the research is limited in terms of its ability to assess changes in the relationship amongst the latent variables in the theoretical model of creative cognition. This shortcoming is discussed further in the subsequent limitations and recommendations for future research section.

5.2. Conclusion

Creativity is a multifaceted construct that profoundly defines and shapes the human experience (Batey, 2012). Diverse fields ranging from the arts and sciences to technological progress and economic prosperity are driven by human creativity (Paul & Kaufman, 2014). It is, therefore, unsurprising that creativity research spans disciplines as varied as cognitive sciences, neurobiology, education and the arts, among many others. Our understanding of how creativity should be defined and conceptualised, as well as nurtured and optimised remains elusive. While the concept of creativity is understood differently depending on one’s theoretical lens, it is generally accepted to be a cognitive process that leads to the generation of ideas that are novel and valuable (Runco & Jaeger, 2012; Zmigrod et al., 2015). Given the importance of creativity, this construct has not always received full attention in research. This lack of research is often attributed to problematic assumptions made by traditional conceptualisations regarding its source, which continues to shape much of the contemporary thinking about creativity (Weisberg, 2010). As a consequence, contemporary creativity research tends to adopt modern conceptualisations and approaches to investigating the construct. A prominent manifestation of such conceptualisations is found in the cognitive sciences, which considers creativity as a process of creative cognition (Glăveanu, 2010).

Although efforts to offer a better understanding of the cognitive processes underpinning creativity have been at the forefront of research in the field of creative cognition, there are also significant inconsistencies between research findings (Bowden et al., 2005; Kaufman & Sternberg, 2010). Therefore, the present study was designed and conducted to contribute to information about the cognitive functions implicated in the creative process. In particular, this study had two main research aims, the first of which was to develop a coherent theoretical model of creative cognition. The cognitive functions of interest in this study included components of creativity, namely divergent, convergent and associative thinking, as well as executive function, including fluid intelligence, task-switching and inhibition. The second aim of the study was to investigate whether certain demographic variables, including age, the number of spoken languages, SES, level of education, and gender, predicted the individual cognitive functions identified as being implicated in the creative process. The study comprised of 125 participants aged 65 years and above, which constitute an age bracket that is often overlooked in creativity research. SEM was used as a multivariate analysis technique, which involved fitting the hypothesised theoretical model of creativity to the data collected. Additionally, a group-difference analysis was used to investigate whether there were significant differences present among demographic groups.

Based on the results obtained from the analysis of the data, the current study made the following conclusions. Firstly, the creative process comprises of multiple, fundamental cognitive processes that non-creative endeavours also engage (Kharkhurin, 2012). The findings obtained in this study confirmed dual-process models of creativity as the creative process involved both associative and higher-order functions. Specifically, this study confirmed the dual-pathway model of creativity as the creative process was found to involve both divergent and convergent thinking and that these processes were integrated to a greater extent than initially conceptualised in other dual-process models. In particular, divergent and convergent thinking were related in terms of their reliance on associative thinking, fluid intelligence and, to an extent, task-switching. That is, semantic memory was directly related to both components of creativity through its structural properties (bottom-up, associative account), or indirectly by functioning as the basis upon which executive functions operate (top-down, executive account). This study also demonstrated that the cognitive processes included in the model were significantly predicted by an individual's SES and level of education. In particular, a higher level of both SES and education corresponded to better performance of the majority of the cognitive functions investigated in the present study. These findings demonstrate how particular interactions, as well as access to opportunities of cognitive stimulation, lead to individual differences in cognitive development and functioning. As a consequence, these findings could be applied to develop and improve policies that are designed to alleviate SES and education-related discrepancies prevalent in South Africa.

Finally, while the present study contributed to information regarding the cognitive processes underlying creativity, as well as what factors influence the creative process, it needs to be emphasised that this study is a work in progress both empirically and theoretically. In other words, this study constitutes a theoretical approach that is still developing rather than being a complete theory.

5.3. Limitations and Recommendations for Future Research

Several factors potentially limit the findings obtained in the present study, including limitations associated with the study sample, the methods used to study creativity, the conceptualisation of multilingualism and the statistical analysis used to evaluate the impact of demographic variables on the theoretical model of creativity. This section discusses the possible future directions of research with regards to the limitations of the current study.

With regards to the study sample, there are various limitations associated with the sample size of the study in general, the sample group sizes as well as the limited applicability or generalisability of the model developed due to the sample targeted. With regards to the sample size, it is important to note that a sample size greater than 200 is often considered to help ensure power and precision when conducting an SEM analysis (Kline, 2016). Therefore, while the *N:*q ratio indicated that 125 participants were sufficient to use SEM as a statistical analysis technique, the sample size of the current study is still relatively small. Moreover, the study included small group sizes for certain categories of demographic variables, namely the low SES group (n = 3), the 86-90 age group (n = 5), as well as the bilingual language group (n =7). However, despite small group sizes for the above-mentioned demographic groups, it is unlikely that this would have affected the outcomes or altered the pattern of findings related to these demographic variables. Nevertheless, future research can be directed at increasing the sample size, especially in the demographic categories with small group sizes, and rerun the statistical analyses. Lastly, it is important to note that, while the current research addressed the lack of representation of the elderly population in creativity research, selecting such a specified sample group potentially limits the applicability or generalisability of this model to a younger population. Therefore, future research can be directed at either rerunning the theoretical model developed in this study using data from a younger sample or developing another theoretical model that can be applied to a younger population.

In terms of the methods and instruments used to assess creativity, the AUT scoring technique used in this study may not have reflected the creative process and the language-specific rules of forming compound words on the RAT may have negatively affected the results. Firstly, as described in Chapter 3, responses on the AUT were scored as creative if the given uses for the object was original, appropriate and different from the conventional use (Guilford et al., 1978). However, responses that meet these criteria do not necessarily result from a genuinely creative process. This idea was demonstrated by Gilhooly et al. (2007), who revealed that individuals might retrieve numerous ideas that are original and unusual without actually having created them. For instance, thinking about unusual or alternative uses for automobile tyre item may prompt responses such as “swing” or “planter”, which is in accordance with the task requirements but are not necessarily new to most people. Therefore, there is a lack of clarity in the present study of whether AUT scores reflect either successful retrieval of ideas from long-term memory and, hence, do not involve the creative process, or whether responses are the result of a genuinely creative act. Future research may, therefore, benefit from adopting alternative methods of administration or scoring the AUT, such as the think-aloud techniques (Gilhooly et al., 2007) or the categorisation of responses (Benedek et al., 2014a).

The think-aloud techniques employed by Gilhooly et al. (2007) entailed participants describing their process of generating novel ideas and enable the researchers to identify the processes involved in carrying out the AUT. The categorisation of responses technique used by Benedek et al. (2014a) involved participants reviewing their responses and identifying which ideas were previously known and recalled during the experiment (old ideas) and which were previously unknown and generated for the first time during the assessment (new ideas). Both techniques can be used to evaluate whether responses entail a genuinely creative process or whether they are simply a result of successful memory recall.

The above discussion of the role of memory in creativity also highlights additional avenues for future research. In particular, future research can examine and potentially model the role of crystallised intelligence in the creative process. This area of research would be especially relevant when studying the creative abilities of the elderly population as they may experience qualitative changes in the creative process rather than an age-related decline in creative abilities (Stuart-Hamilton, 2012). Similarly, Adams-Price (1998) maintains that associating creativity with novelty and innovation is presumably more appropriate for the characteristics of youthful thinking. In contrast, creativity in the later stages of life reflects a later-life thinking style, which is based on remembering, as well as using and applying information acquired from previous experiences and education, that is, crystallised in intelligence (Adams-Price, 1998).

There are possible limitations in terms of the use of the RAT to assess convergent thinking. Firstly, as mentioned in Chapter 3, to the researcher's awareness, the RAT has not been applied to the South African population. Consequently, there is a lack of psychometric data for South Africa, particularly for the sample included in the present study, namely elderly individuals. Such data ensures that tests are used with confidence that they will provide information that is valid, reliable and meaningful, which is important for a population as complex and heterogeneous as South Africa's (Howell, 2019).

Specifically, there are limitations associated with task items included in the RAT. Although the pilot study conducted in the initial stages of this research revealed several unsuitable RAT items that the researcher replaced, the low mean score obtained in this test suggests that the presence of inappropriate test items remained. The limitations associated with the RAT are often attributed to its high demands of the English language and vocabulary and, thus, native speakers often show an advantage compared to individuals who have acquired English as an additional language (Toivainen et al., 2019). Future research can, therefore, be directed towards adapting the RAT for use in the South African context. Various approaches to test adaptation can potentially be undertaken, such as item changes, replacing RAT problems with locally appropriate examples, the omission of particularly inappropriate items or test translation of both the items and instructions. However, the adaptation of the RAT for a South African context in and of itself is fraught with difficulties, the greatest of which is the complexity and diversity of the country's population (Lucas, 2013). In particular, due to the language-specific rules of having to generate compound words, the translation of the version of the RAT used in the current study may be difficult if not impossible (Toivainen et al., 2019), especially when taking into consideration that South Africa has 11 official languages.

Given the complexity of the issue, an alternative approach could be to utilise or adapt a different version of the RAT that could better accommodate such differences. For example, a recent variation of this measure is the visual remote associates test (vRAT), which involves individuals identifying a concept that is semantically related to three images. This test may have key advantages over the original version of the RAT. Firstly, the visual stimuli of the vRAT address the constraints of language specificity for linguistic assessments. The use of the vRAT in place of the linguistic variations could, therefore, reduce the advantages of native speaks over individuals who acquired English as an additional language (Toivainen et al., 2019). In addition, Toivainen et al. (2019) maintain that using the vRAT together with the linguistic versions of the RAT may address questions regarding domain-specificity in creativity research.

An additional limitation is the manner in which the current study conceptualises multilingualism. As described in the previous sections, participants were required to complete a self-report questionnaire to assess language proficiency (i.e., LEAP-Q). Participants were subsequently stratified into one of three categories depending on the number of languages in which they were proficient. Specifically, individuals who knew only one language were categorised as monolingual, individuals who knew two languages were categorised in the bilingual group and those who knew more than two were included in the multilingual group. However, this conceptualisation provides an atomistic view of multilingualism, which is characterised by focusing on specific elementary components and by separating languages (Cenoz, 2013).

This conceptualisation bears in itself the idea of multiple discrete and clearly discernible language systems that are autonomous in nature (Blommaert et al., 2012). This perspective portrays linguistic diversity from a monolingual norm, whereby multilinguals are the sum of two monolingual individuals (Pennycook, 2009). Moreover, this approach translates into the enumeration or counting of discrete language categories and their parallel coexistence, thereby oversimplifying the multilingual experience (Blommaert et al., 2012). The atomistic view, therefore, fails to capture the complexity of actual multilingual practices, which involve the dynamic and functionally integrated use of different languages or language varieties. That is, as multilinguals' experience with language expands, they do not confine these languages strictly in discrete and clearly discernible systems (Piccardo, 2017). Instead, multilinguals develop and use a variety of linguistic strategies and discourses to which all knowledge and experience with language contribute and in which languages fluidly interact and influence each other (Cenoz, 2013; Piccardo, 2017). Multilinguals do not merely switch between one isolated language to another but rather have a linguistic repertoire that covers aspects of both languages, enabling them to use their languages together or separately, or components of one in the other, in order to accomplish the most effective form of communication depending on their context (King, 2017). Hence, the multilingual speaker cannot be considered as the sum of two or more monolinguals but, instead, as an individual with a specific linguistic profile that is characterised by the coexistence and constant interaction between two or more languages (Grosjean, 2010).

Future research should, therefore, consider the potential effects of multilingualism on creativity from a socio-linguistic framework, which considers language with regards to various social and contextual factors (Lähteenmäki et al., 2011). These factors are essential to take into consideration in creativity research as they potentially play an important role in shaping cognitive systems. This idea is proposed in a recent framework proposed by Green (2018), namely the adaptive control hypothesis. This hypothesis maintains that different contexts of multilinguals' conversational exchanges place varying demands, thereby adaptively influencing their executive control abilities, which may affect creative performance (Green & Abutalebi, 2013).

Lastly, the results reported on the role of specific demographic variables in the theoretical model of creativity developed in the present study should also be considered in light of some limitations regarding the statistical technique used. Although the group-difference analyses indicated whether there were any statistically significant differences on specific indicators included in the model, this technique did not demonstrate whether the relationships between latent variables were affected by demographic factors. Therefore, future research may further develop the findings obtained in the current study by investigating whether various demographic variable, especially SES and level of education, moderate the relationship between the cognitive processes underlying creativity. For example, future research can use multiple-group analysis to evaluate the extent to which moderator variables, such as demographic factors, affect the strength and direction of the relationship between IVs and DVs (Henseler & Fassott, 2010). This approach enables researchers to investigate whether there are differences between two identical theoretical models for different groups. In addition, a multi-group analysis provides a complete overview of potential moderators' impact on the results as focus shifts from examining its effect on specific indicators to assessing its influence on all the relationships specified in the model (Matthews, 2017). Nevertheless, the current research did not make use of multi-group analysis as the sample size was insufficient. Future research could increase the sample size and evaluate whether there are significant and meaningful differences in the theoretical model of creative cognition across demographic groups.

In summary, there are various limitations associated with the current research, which future research can potentially address. These include the limitations associated with the study sample, namely the sample size, sample group sizes and the generalisability of the model developed due to the sample targeted. Additional limitations included the measures and methods to operational creativity, namely the AUT and RAT, the oversimplification of the multilingual construct and the statistical analysis used to evaluate the impact of demographic variables on the theoretical model of creativity. These limitations are discussed with regards to possible avenues for future research, such as different methods of scoring the AUT, employing an alternative variation of the RAT, assessing multilingual creativity from a socio-linguistic framework, as well as using multi-group analysis to investigate the impact of demographic variables on the creative process. In doing so, the present study hopes to provide a sufficient basis for future research and discussion in order to enrich the creative cognition field within the South African context.

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Appendices

Appendix A: Advertisement to Recruit Participants

Seeking Volunteers for a Research Study

I am a PhD student from the University of the Witwatersrand. As part of my degree, I'm conducting a research that aims to understand how creativity is related to other cognitive process, such as flexible thinking, language and problem solving. I am looking for participants that are 65 years old or older and living independently.

The study involves taking cognitive tests for approximately an hour and a half.

Please note that if you participate you will be offered R150.00 to cover any travel or refreshment expenses.

To find out more about this study, please contact Stephanie at:

- Phone: 076 975 8467
- Email: 716976@students.wits.ac.za

Appendix B: Request for Consent to Conduct Research

THE SCHOOL OF HUMAN AND COMMUNITY DEVELOPMENT
(SHCD)

Request for Consent to Conduct Research

Dear Sir/Madam

My name is Stephanie Alcock and I am currently a PhD student in Psychology within the School of Human and Community Development, at the University of the Witwatersrand. The research that I am conducting is entitled: *Modelling the Theoretical Relationship between Creativity, Fluid Intelligence, Executive Control and the Multilingual Experience in the Elderly.* For the purpose of this study I need to assess the cognitive functions of individuals who are age 65 and above and are capable of living independently. I would like to kindly ask for your assistance with the identification of individuals who meet these criteria and grant me permission to place invitations at the institution or personally invite them to take part in the study. The participants who volunteer to participate will be provided with an information and informed consent sheet that they will be required to sign. Please note that a copy of these documents has been attached.

In order to facilitate participation for potential volunteers, I would like to kindly ask you in addition to your support with the invitations, to allow me to conduct assessment at a location and time that best suits the institution and the residents. The assessment will be composed of a demographic questionnaire and a battery of neuropsychological tests, which the participants will be invited to complete. These instruments will include various activities, such as answering questions, creative thinking tasks and problem solving, which will take approximately 60-90 minutes to complete all the tests, including a 10 to 15 minute break halfway.

Participation is entirely voluntary, anonymous and the participant may withdraw from the study without a given reason at any point. Participation is not anticipated to have risks in any manner and participants will be offered R150.00 to cover any travel and refreshment expenses. This research has received ethical clearance from the Medical Ethics Committee. Please note that a copy of the ethical clearance certificate has been attached.

Your approval to conduct this research will be greatly appreciated. To show my gratitude I would like to offer a free seminar for the residents about cognitive health or cognitive reserve. Should you have any concerns, enquiries or require further clarification regarding this research please do not hesitate to contact me: 076 975 8467 or 716976@students.wits.ac.za .You may also contact my research supervisors, Professor Kate Cockcroft on 011 717 4511/ Kate.Cockcroft@wits.ac.za or Mrs Aline Ferreira-Correia on 011 717 4527/ Aline.FerreiraCorreia@wits.ac.za. If you agree, I will require a signed letterhead that acknowledges and communicates your consent for me to invite participates and to conduct research on your premises.

Sincerely,

Stephanie Alcock

Appendix C: Demographic Questionnaire

Participant No.: | | | | |

Gender: | M | F |

Age:_________________

Home Language: ___________________________

What is your highest level of education?________________________________

Did you attend a public or private school?______________________________

Living Standards Measure:

Please answer the following questions according to your current circumstances.

Question	Answer	
1. I have the following in my household:		
TV set	TRUE	FALSE
VCR	TRUE	FALSE
DVD player	TRUE	FALSE
M-Net/DStv subscription	TRUE	FALSE
Hi-fi/music centre	TRUE	FALSE
Computer / Laptop	TRUE	FALSE
Vacuum cleaner/floor polisher	TRUE	FALSE
Dishwashing machine	TRUE	FALSE
Washing machine	TRUE	FALSE
Tumble dryer	TRUE	FALSE
Home telephone (excluding a cell)	TRUE	FALSE

Deep freezer	TRUE	FALSE
Fridge/freezer (combination)	TRUE	FALSE
Electric stove	TRUE	FALSE
Microwave oven	TRUE	FALSE
Built-in kitchen sink	TRUE	FALSE
Home security service	TRUE	FALSE
3 or more cell phones in household	TRUE	FALSE
2 cell phones in household	TRUE	FALSE
Home theatre system	TRUE	FALSE
2. I have the following amenities in my home or on the plot:		
Tap water in house/on plot	TRUE	FALSE
Hot running water from a geyser	TRUE	FALSE
Flush toilet in/outside house	TRUE	FALSE
3. There is a motor vehicle in our household	TRUE	FALSE
4. I am a city dweller	TRUE	FALSE
5. I live in a house, cluster or town house	TRUE	FALSE
6. I live in a rural area outside Gauteng	TRUE	FALSE
7. There are no radios, or only one radio (excluding car radios) in my household	TRUE	FALSE
8. There is no domestic workers or household helpers in household (both live-in & part time)	TRUE	FALSE

Appendix D: Adapted Language Experience and Proficiency Questionnaire (LEAP-Q).

Participant No._______________

The Language Experience and Proficiency Questionnaire (LEAP-Q)

1. **What languages do you know?**

   Language A: _____________________________

   Language B: _____________________________

   Language C: _____________________________

   Language D: _____________________________

   Language E: _____________________________

2. **Language A:**

   This is my ______________ (First, second, third etc.) language. All questions below refer to your knowledge of language A.

   (1) Age when you...

   Began acquiring this language: ___________

   Became fluent in this language: ___________

   Began reading in this language: ___________

   Became fluent reading in this language: ________

(2) Please circle your level of proficiency in speaking, understanding, and reading in this language:

Speaking

0 None	1 Very Low	2 Low	3 Fair	4 Slightly less than adequate	5 Adequate	6 Slightly more than adequate	7 Good	8 Very Good	9 Excellent	10 Perfect

Understanding spoken language

0 None	1 Very Low	2 Low	3 Fair	4 Slightly less than adequate	5 Adequate	6 Slightly more than adequate	7 Good	8 Very Good	9 Excellent	10 Perfect

Reading

0 None	1 Very Low	2 Low	3 Fair	4 Slightly less than adequate	5 Adequate	6 Slightly more than adequate	7 Good	8 Very Good	9 Excellent	10 Perfect

3. Language B:

This is my _______________ (First, second, third etc.) language. All questions below refer to your knowledge of language B.

(1) Age when you...

Began acquiring this language: ____________

Became fluent in this language: ____________

Began reading in this language: ___________

Became fluent reading in this language: ________

(2) Please circle your level of proficiency in speaking, understanding, and reading in this language:

Speaking

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

Understanding spoken language

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

Reading

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

4. Language C:

This is my _____________ (First, second, third etc.) language. All questions below refer to your knowledge of language C.

(1) Age when you...

Began acquiring this language: ___________

Became fluent in this language: ___________

Began reading in this language: ___________

Became fluent reading in this language: ________

(2) Please circle your level of proficiency in speaking, understanding, and reading in this language:

Speaking

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

Understanding spoken language

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

Reading

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

5. Language D:

This is my ______________ (First, second, third etc.) language. All questions below refer to your knowledge of language D.

(1) Age when you...

Began acquiring this language: ___________

Became fluent in this language: ___________

Began reading in this language: ___________

Became fluent reading in this language: ________

(2) Please circle your level of proficiency in speaking, understanding, and reading in this language:

Speaking

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

Understanding spoken language

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

Reading

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

6. Language E:

This is my _____________ (First, second, third etc.) language. All questions below refer to your knowledge of language E.

(1) Age when you...

Began acquiring this language: ___________

Became fluent in this language: ___________

Began reading in this language: ___________

Became fluent reading in this language: ________

(2) Please circle your level of proficiency in speaking, understanding, and reading in this language:

Speaking

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

Understanding spoken language

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

Reading

0	1	2	3	4	5	6	7	8	9	10
None	Very Low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very Good	Excellent	Perfect

7. Please list what percentage of the time you are *currently* and *on average* exposed to each language. (Your percentages should add up to 100%):

List language here:					
List percentage here					

Appendix E: Modified Version of the Remote Associates Test.

Remote Associates Test

Example:

Break / Bean / Cake	***Answer: Coffee***

1. Piece/mind/dating
2. Hound/pressure/shot
3. Rocking/wheel/high
4. Flower/friend/scout
5. Health/taker/less
6. Cover/arm/wear
7. Food/forward/break
8. Cottage/swiss/cake
9. Night/wrist/stop
10. Control/place/rate
11. River/note/account
12. Cross/rain/tie
13. Home/sea/bed
14. Dew/comb/bee
15. Fish/mine/rush
16. Political/surprise/line
17. Print/berry/bird
18. Wise/work/tower
19. Fur/rack/tail
20. Force/line/mail
21. Man/glue/star
22. Safety/cushion/point
23. Worm/shelf/end
24. Opera/hand/dish
25. Cream/skate/water
26. Pea/shell/chest
27. Aid/rubber/wagon
28. Cracker/fly/fighter
29. Cane/daddy/plum
30. Dream/break/light

Appendix F: Informed Consent Form

THE SCHOOL OF HUMAN AND COMMUNITY DEVELOPMENT
(SHCD)

Informed Consent Form

I confirm that I am an adult above the age of 65 who is capable of independent living. I have read and understand the information provided in the information sheet in relation to the research entitled: *Modelling the Theoretical Relationship between Creativity, Fluid Intelligence, Executive Control and the Multilingual Experience in the Elderly.* I have adequately been informed about the research procedures, what participation entails and have been given sufficient time to consider whether or not to participant in this study. I also understand that:

- My participation is completely voluntary.
- I may withdraw from the research at any time with no negative consequences for me
- My results and identity will be kept anonymous and the information will be kept in apassword secure file in a password secure computer and the protocols of the tests will be kept in a locked cabinet, both only accessible to the researchers and the supervisors.
- My participation will be treated with confidentiality
- I have been offered R150.00 to cover any travel or refreshment expenses.
- No risks are associated with participation
- I have been given a number for free counselling services if I experience any distress that may be elicited by this study
- I have received the contact details of the researcher Miss Stephanie Alcock and her supervisor Professor Kate Cockcroft and co-supervisor Mrs Aline Ferreira-Correia.

Declaration by Participant
I hereby consent to take part in this study

Participant's name:

Signature: Date:

Declaration by Researcher
I confirm that I have explained the research to the participant and have answered any questions about it.

Researcher's name:

Signature: Date:

Appendix G: Information Sheet

THE SCHOOL OF HUMAN AND COMMUNITY DEVELOPMENT
(SHCD)

Information Sheet

Good day. My name is Stephanie Alcock and I am currently a PhD student in Psychology within the School of Human and Community Development, at the University of the Witwatersrand. I have contacted you because you are an individual above the age of 65 who is capable of independent living. I would therefore like to invite you to take part in this study.

Title of Study: Modelling the Theoretical Relationships between Creativity, Fluid Intelligence, Executive Control, and the Multilingual Experience in the Elderly.

Purpose of the Study: This study aims to develop an integrated theoretical model of creativity. By focusing on an elderly sample, I wish to assess the effects of age on the cognitive functions underlying creativity and how particular activities, such as the multilingual experience, potentially influences creative thinking.

What Participation Entails: You will be required to complete a consent form, a demographic questionnaire and several cognitive tests, which involves answering questions, creative thinking tasks and problem solving. Any personal details provided in these documents and any data collected will remain confidential as they will only be available to the researchers and their supervisors. It will take approximately 60-90 minutes to complete all the tests, including a 10 to 15 minute break halfway.

Risks and Benefits of the Study: Please be aware that if you participate you will be offered R150.00 to cover any travel or refreshment expenses. I would like to stress that you are not obliged to participate in this study and may withdraw from it at any point without a given reason. You have the option to not answer any particular question and there will be no negative consequences if you should do so. Please note that if you are not invited to proceed with your participation it is because you do not meet the study's demographic and screening criteria, which is in no way diagnostic but rather a consequence of the sample design. All data collected and information of those who have been excluded or withdraw voluntarily will in default be disregarded and destroyed.

Participation is not anticipated to have risks in any manner. However, you may feel distressed or frustrated when taking the cognitive tests as they involve time constraints and may be perceived as difficult. Should you feel distressed because of this study, you may receive free counselling by contacting the South African Depression and Anxiety Group: 011 262 6396 or Mrs Aline Ferreira-Correia: 011 717 4527, who is a registered clinical psychologist with the Health Professions Council of South Africa (HPCSA).

Research Outcomes: The results from this study will be used to compile a research report, which will be available and accessible in the library of the University of the Witwatersrand and the world-wide web. Should you be interested in obtaining these results, you are more than welcome to contact me. It is anticipated for these results to be ready in December 2020.

Concerns and Enquiries: Should you have any concerns, complaints, enquiries or require further information about this study please do not hesitate to contact me or either of my supervisors by using the contact details provided below.

Researcher	Supervisor	Co-supervisor
Stephanie Alcock	Kate Cockcroft	Aline Ferreira-Correia
Phone Number: 076 975 8467	Phone Number: (011) 717 4511	Phone Number: (011) 717 4527
Email: 716976@students.wits.ac.za	Email: Kate.Cockcroft@wits.ac.za	Email: Aline.FerreiraCorreia@wits.ac.za.

Appendix H: Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research & Post Graduate Affairs)

TO: Mlles S Alcock and AF Correia
School of Human and Community Development
Department of Psychology
University

E-mail: 716976@students.wits.ac.za

CC: Supervisor: Professor K Cockcroft <Kate.Cockcroft@wits.ac.za>
and <HREC-Medical.ResearchOffice@wits.ac.za>

FROM: Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 03/10/2018

REF: *R14/49*

PROTOCOL NO: **M180726** *(This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study)*

PROJECT TITLE: *Modelling the theoretical relationship between creativity, fluid intelligence, executive control and the multilingual experience in the elderly*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to the Government funding of the University.

MSWorks2000/Iain0007/Clearscan.wps

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Mlles S Alcock and AF Correia

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M180726

NAME: Mlles S Alcock and AF Correia
(Principal Investigator)

DEPARTMENT: School of Human and Community Development
Department of Psychology
University

PROJECT TITLE: Modelling the theoretical relationship between creativity, fluid intelligence, executive control and the multilingual experience in the elderly

DATE CONSIDERED: 27/07/2018

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Professor K Cockcroft

APPROVED BY: CB Penny
Dr CB Penny, Chairperson, HREC (Medical)

DATE OF APPROVAL: 03/10/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on 3rd floor, Phillip V Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date of the meeting when the study was initially reviewed. In this case, the study was initially reviewed in **July** and will therefore reports and re-certification will be due early in the month of **July** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Stephanie Alcock
Principal Investigator Signature

05/10/2018.
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES