The eleven-year-old subjects

The responses from the eleven-year-old subjects in this study represented some measure of extreme between relying on the immediately perceptually obvious at one end of the spectrum to those who explored an increasing number of possibilities for sorting the blocks at the other. The subjects' approaches ranged from what seemed to be the only "physiognomic" response (see Hanfmann & Kasanin, 1942, pp. 23-25) in the study (S1109M); through to unstable chains and chain-like reasoning (S1104F), to several examples of diffuse and inconsistent approaches (S1102F and S1103F); to concrete (and pseudoconceptual to varying degrees) but more consistent approaches by five subjects (S1106M, S1110M, S1101F, S1105F, and S1107M); to a highly elaborate and sophisticated response from one subject (S1108M) who entertained a good number of possibilities for sorting the blocks before arriving at the combination of height and size. Three subjects sorted the blocks by height or size almost from the beginning (S1106M, S1110M and S1105F), where, for example, S1106M sorted the blocks because they *looked* the same (and not because he *thought* there was something about them that embodied a principle) and S1105F took a great deal of convincing that there were in fact only two differences in the height of the blocks (and not four, which was her first insistence) before she noticed that size combined with height was the solution to sorting the blocks.

Four of the male subjects (excluding S1109M) were confident and sure of themselves in approaching their sessions, whereas three female subjects were more timid or hesitant and one was very reserved. Nine of the ten subjects selected shape as their first attack on sorting the blocks: in this respect Hanfmann and Kasanin note that the initial selection of shape "seems to predominate on the intermediate level" (1942, p. 39). This group's selection of shape as their first move was the highest in comparison with the other five groups in this cross-sectional study.

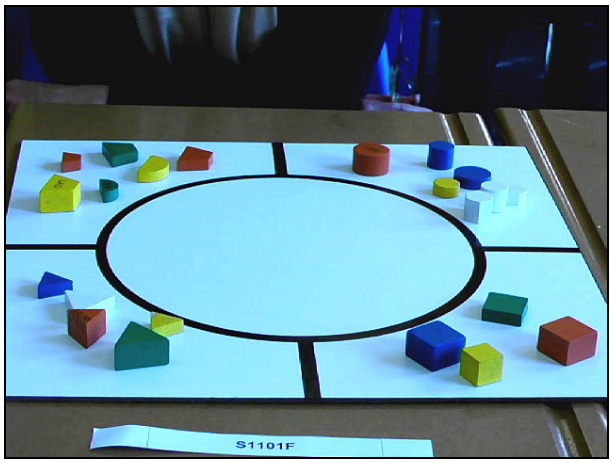
Whereas only one of the eight-year-old subjects (S809M) mentioned the number of sides of the blocks, four of the eleven-year-old subjects (S1102F, S1103F, S1108M and S1110M) mentioned or used the number of sides of the blocks as a possibility for sorting them. Further, five subjects (S1101F, S1102F, S1104F, S1107M and S1108M) advanced the notion of a number of elements in combination as possible solutions to sorting the blocks.

Once again, I will present a selection of the findings of the eleven-year-old subjects in detail, and in less depth for the remainder of the group.

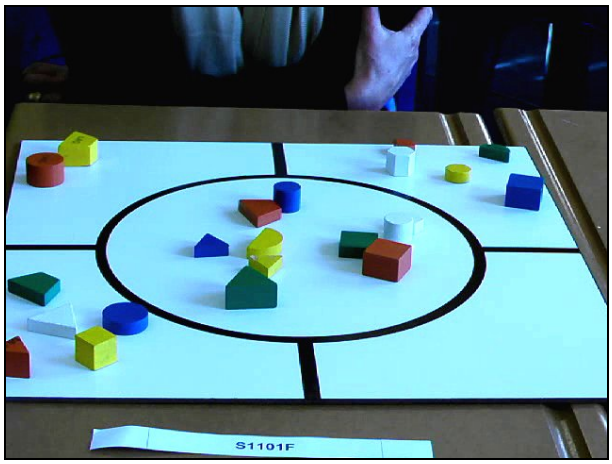
Examples of Phase Two, Stage Five – the Pseudoconcept – and concrete and factual connections, but more consistently so – emergence of potential concepts

Two eleven-year-old subjects provided evidence of a more consistent approach to sorting the blocks: these approaches still contained pseudoconceptual logic to some degree, but the emergence of potential concepts, and the ability to focus on these, seemed to lead to increasingly logical ways of sorting the blocks.

The subject S1101F started by creating four groups based on shape. She remembered that four groups were needed and removed the trapezoids which she had placed with the squares, resulting in the groupings below.



The groups were all triangles, all squares, "all round and the circles", and the top left-hand group was described as "all the ones that have been cut" (quite an elegant solution, and certainly one that I hadn't thought of). The subject turned over the *lag* trapezoid and read its name, and then the *cev* semi-circle and said "Oh! A *cev*! So it's not the same one". She left it there and turned the orange *lag* circle over "*Lag*!" she said, "but why these two? [the yellow and orange *lag* blocks]". I assured her that this would be something she would discover for herself in the process of playing the game. I suggested we put the two *lag* blocks together, and asked if we could move the *cev* semi-circle to the middle of the board for now. It appeared that she did not pay any attention to this *cev* block at the time because she was very eager to continue turning over the blocks and she needed to be restrained and reassured about getting things right or wrong. With prompting, she said that she was unable to find another way to sort the blocks, and when asked what the discovery of the *cev* semi-circle had done to her idea of the cut-off group, she then said it meant "That there is no cut-off group". We agreed to move the cut-off blocks into the middle of the board and after about a minute she said "Maybe it's like one of each colour". She started to sort the blocks in this way, saying the names of the colours as she sorted the blocks in the first group.



This photograph was taken eight minutes into the session. The subject S1101F had started off by suggesting that one of each colour per group (starting at top right) was a possibility, but then, interestingly, when it came to the second group (*mur* at bottom left) she said "Triangle, square, one cut-off one, and a circle". These moves demonstrated quite clearly the fluidity and instability of her approach where colour was given less prominence after only one group had been grouped in this way, and she had created a delightful chain in the *mur* group – shape to same height to similar shape

to flat as per the trapezoid. She repeated this with the *lag* group, but then began to swap quite a few blocks to fit with her emerging approach of one of each colour but particularly one of each shape per group. In starting the fourth group, she noticed that there were not enough colours to go around, and instead of stopping to count the colours and the shapes, she continued with much re-arranging and increasingly random moving of the blocks to get them to fit her idea of one shape per group.

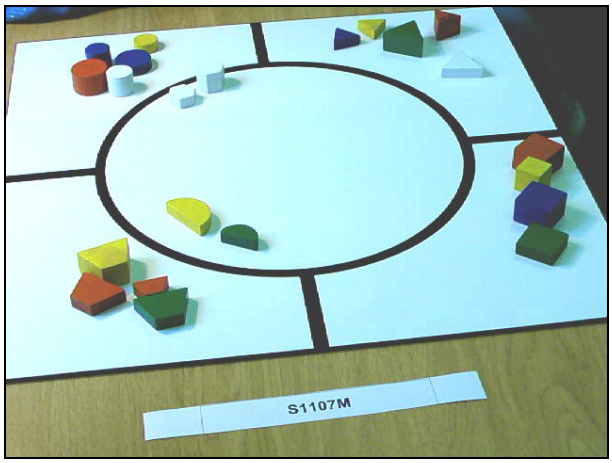
Then this subject (S1101F) noted that there were (only) two semi-circles (something that she had not perhaps been quite conscious of before when she included them in the cut-off group), but this observation did not influence her insistence that there had to be a way to find one shape per group. Her ignoring this fact (as well as her earlier disregard about the *cev* semi-circle's effect on her cut-off idea until prompted), led me to see quite clearly that her approach was in fact pseudoconceptual: although her approach seemed to be one of systematic intent, its pseudoconceptual and concrete and factual connections were evident in this matter of the number of semi-circles, a tiny detail that could easily be overlooked by any researcher. As Vygotsky notes "To find a borderline separating pseudoconcept from real concept is not easy…" (1986, p. 121).

This subject's increasingly random and unstable swapping and moving the blocks led her to focus now on colour and now on shape. The blocks which had at first been placed with a fair amount of systematic intent gave way completely, to the extent where neither of us would have been able to remember what had been where. After four minutes of swapping and rearranging, I offered to give her a clue, and introduced a *bik* exemplar – the green square. At this, she said "Oh! I think I know!", and then once again revealed the concrete and factual nature of her thinking by measuring the height of the *bik* and *cev* exemplars. She exclaimed "Ag-a-no!" and did the same to the *mur* and *lag* exemplars, saying "I thought it was the sizes" (meaning the heights). She measured them several times more, and when I asked what she meant, she repeated "the sizes" while touching the *bik* block. She then exclaimed – "Oh, that could work!". "Show me," I said.

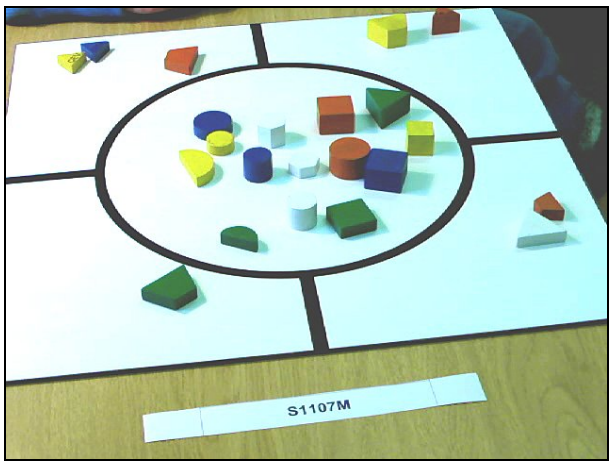
She then went about sorting the blocks according to size and height, measuring some of them against each other as she proceeded, and with increasing confidence until she had finished. She described the blocks accordingly, using big and tall, and big and thin, and so on. However, this subject (S1101F) was unable, even with substantial prompting, to transfer the words and the characteristics to the glasses and the candles (she scored 2 for each, which could have been lucky guesses as she was unable to remember the combinations and neither was she able to put these together consistently with the words *cev*, *bik*, *mur*, and *lag*): as Vygotsky points out:

> The greatest difficulty of all is the application of a concept, finally grasped and formulated on the abstract level, to new concrete situations that must be viewed in these abstract terms – a kind of transfer usually mastered only toward the end of the adolescent period. (1986, p. 142)

The next subject in this group, S1107M, was the only one of the eleven-year-olds to be mindful of the implications of his moves in terms of the totality of the blocks. He started by forming four groups based on shape, and hesitated before assigning the two semi-circles to the trapezoid group and the two hexagons to the group of circles: "It's confusing… It just is. Because you don't know how it could be… about colour or shape…". He further noted (of his four 'problem children') that "We've got different random shapes [pointing to the semi-circles and trapezoids] and…" so too with the hexagons.



In this photograph, taken four minutes into the session, the subject (S1107M) had agreed that we could place the four 'problem children' back into the middle of the board. When asked what six shapes would do to his idea of shape, he said "It messes it up!". His next idea was that it could be colours, but this approach was abandoned because there were too many (five): "It also messes it up!". In response to my suggestion that it had to be something else if not colour and shape, he quirkily suggested "The names on the bottom?". His next idea was height, but this was quickly eliminated because there were only two. My clue of a *cev* triangle did not help to begin with, until he said "Oh I get it!" and placed a triangle in each corner. When asked how he would continue with this approach, he said it couldn't work because there was one triangle too many.



Ten minutes into the session, the subject S1107M was trying to find a solution. In a discussion before this photograph was taken, he had considered including the *cev* trapezoid with the two *cev* triangles, but abandoned this idea of size because the trapezoid had its top cut off. This factual and concrete observation led him to consider that it would not be logical to include this block with the other two, because although the size was the same, the fact that it was an incomplete shape had greater influence for this subject. I suggested that perhaps the cut-off top was not necessarily a problem, and encouraged him to count how many trapezoids there were. He noted that there were four, and instead of putting the *cev* trapezoid back with the *cev* triangles, he placed it with the *bik* triangle instead. He gave no reason for this move, or for why he had placed two trapezoids of the same size and height into different groups, but then he did note that this idea probably couldn't work because the assignment of any of the shapes to any of the corners could be entirely random. His focus was still very much on shape at this stage of the session, even though he had earlier abandoned

the idea of shape which was his first 'hypothesis'.

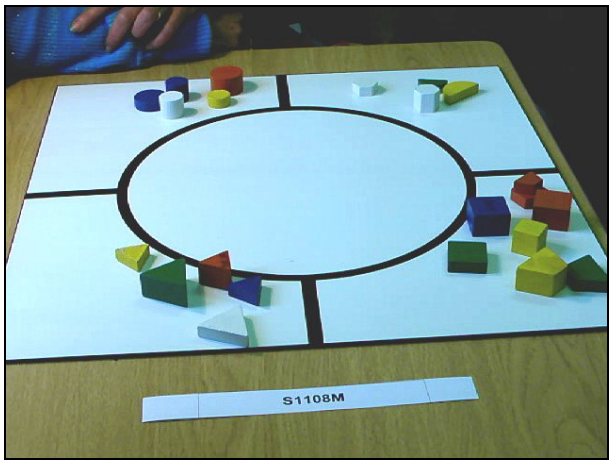
Further on into his session, this subject's (S1107M) description for his groups was "This group is all this size. That group is that size." and so on. When prompted to tell me more specifically what he meant by "that size", he repeated his explanation which included "the same height and the same size" for each of the four groups. He had not, at this stage, formulated (in words) the double dichotomy of smaller in height and bigger in circumference.

However, after resorting the blocks successfully, he was able to describe the blocks as being of the same height and size, and added additional information (number of shapes or colours) that was superfluous to the principle of the double dichotomy. This subject, although he sorted the groups in terms of height and size, did not say (as the adults and adolescents did in this study) "Oh! I see! It's the combination of height and size". This critical insight forms part of Hanfmann and Kasanin's scoring method in terms of formulating the principle of the double dichotomy, as opposed to relying on the perceptually obvious without the accompanying insight. However, this subject (S1107M) approached the blocks with more logic and a greater appreciation for the totality than did his peer ((S1110M) but not described in detail in this section).

An example of Phase Two, Stage Four – the Diffuse complex – and Stage Five – the Pseudoconcept: an elaborate diffuse complex

The highest scoring of the eleven-year-old subjects was the only one to formulate the principle of the double dichotomy. He explored many elaborate and sophisticated reasons for grouping the blocks (14 modified approaches) before arriving at the simplicity of the double dichotomy. This subject, S1108M, was highly articulate and his well-developed use of language could have been taken as an indication of mature, logical, abstract thinking. However, regardless of the elaborateness of the approaches suggested by this subject, two main elements emerged, which I took to be indicative of diffuse thinking in complexes and pseudoconceptual disregard for consistency of principles to be applied across the four groups (as discussed in more detail below).

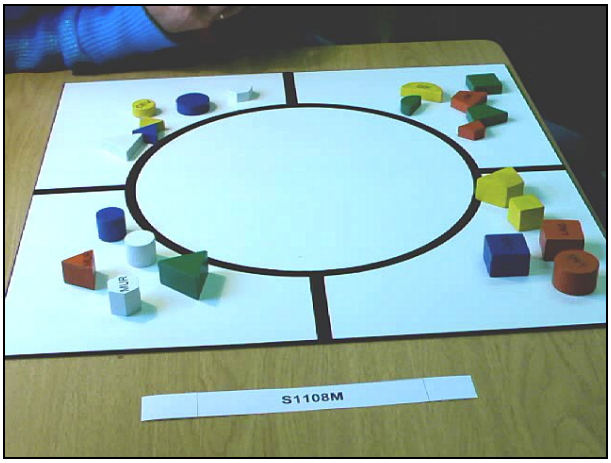
This subject (S1108M) quickly abandoned the shape approach because the semi-circles were not circles, squares, triangles "or rhombuses". Colour was also tried on for size and abandoned.



By seven minutes into the session, the subject (S1108M) advanced this solution as a possible one where the bottom right-hand group had six sides; the triangles had five; the circles had three; and the group at top right was not working because the number of sides did not work out. However, the subject was prepared to leave this group there for now. After some discussion, where he was

thinking things out aloud to himself, I allowed him to turn over another block. Although he had not made any move to remove the blocks placed according to the number-of-sides hypothesis, he agreed that "it didn't make sense [the newly turned *lag* block]" and "it's probably not working… neither would colour… or angles…".

At my suggestion that we return the blocks to the middle of the board, and try again, the subject noticed "an interesting pattern" in the numbers of shapes of some of the blocks, and the numbers of colours of some of the others. I asked how complex that type of solution would be, and he answered "Extremely". From this point on, because this subject (S1108M) advanced a number of combinations and permutations in trying to arrive at the solution, the turned over blocks seemed to (tantalizingly) support one hypothesis or another.



This photograph was taken about 14 minutes into the session and it could be interpreted that the subject (S1108M) had begun to get an idea of height and size. However, his descriptions for the groups belied this interpretation and was indicative of a regression to a more diffuse mode of thinking, compared with the elaborateness of the subject's earlier and more logical approaches. The *bik* group (top right) was described as "This is just smalls and six [sides for] two of them and six and four sides and the semi because the rhombus just looks like them". The *cev* group (top left) was described as "Just the rest of them"; the *lag* group as "Large and six sided"; and the *mur* group (bottom left) as "Large, and two triangles and then this [hexagon] is kind of like this [the white circle]". Further, the *lag* group (bottom right) contained a circle which he quirkily explained as "Because it says '*lag*' on top of it". Whilst it could be argued that Hanfmann and Kasanin's observation regarding some subjects who start with a more logical approach can descend to a less logical one as the session continues (because it is so easy to be overwhelmed by the possible combinations of colour, size, shape, and height), I believed this applied only in part to this subject. It seemed clearer to me that the sophistication of his suggestions and ideas was not uniformly applied across the four groups, and this matter was a clearer indication of a pseudoconceptual disregard for the totality, as well as the unclearly formed ideas which he seemed to be trying on for size. For example, the *mur* group was analysed a minute or two later as "having only minor differences… related to colour… whereas here [*bik*], the differences are more pronounced". Although this was an accurate observation of his groupings, it did not question the validity of the underlying principles as not being logical or consistently applied.

As the session continued, this subject (S1108M) would ask for a block to be turned over, for example, to see "in which areas *bik* is differentiated" or he explained that the *bik* group was

"rhombuses and semi-circles", and that there could be some kind of relationship between the small cylinders as possible *mur* candidates (where the link between the triangle, the hexagons and the circles could be as yet some undiscovered link). When he did discover the solution he exclaimed that "It was an extremely good game… because it tackles you. I'm supposed to be very good at this kind of thing but this one totally got me." He then explained how other games based on guessing subsequent patterns in terms of colour and a number of other factors "which work on the basis of the process of elimination" had influenced his engagement with the blocks. This subject (S1108M) also admitted that it (Vygotsky's Blocks) "was supposed to be such a big thing, so it must be extremely hard so you look for all the hard things you could think of".

This subject's response to the blocks was indicative to me of being at the crossroads between the use of elaborate possible connections in which attempts were made to follow a trend of thought along abstract lines and the pseudoconceptual application of these as revealed by their inconsistent application as guiding principles. There was also evidence in his responses of the use of abstraction in potential concepts: as mentioned in the theoretical framework, potential concepts are involved in the abstraction processes in complexive thinking; however, the abstracted characteristics can be unstable and have no privileged or hierarchical positions. As Vygotsky (1986) notes, in a potential concept proper, once a trait is abstracted, it is seldom

> lost again among the other traits. The concrete totality of traits has been destroyed through its abstraction, and the possibility of unifying the traits on a different basis opens up. Only the mastery of abstraction, combined with advanced complex thinking, enables the children to progress to the formation of genuine concepts (p. 139).

Hanfmann and Kasanin's (1942) adapted framework as an analysis of how subjects perform during the method of double stimulation in concept formation

The clearest indication of an appreciation for how the blocks are to be sorted into their groups is provided for in Hanfmann and Kasanin's (1942) scoring of the 'totality'. In this respect, seven of the eleven-year-olds in this study did not take the totality into consideration, and this response in turn affected their reactions to inconsistencies and contradictions (they were either unconcerned about these, or simply moved the offending block elsewhere, as ineffective as such moves were). Only one subject (S1107M) indicated that the totality was affected by possible solutions ("It messes it up!"), and two subjects (S1101F and S1108M) took some measure of the implication of their moves in relation to the totality, but inconsistently so.

The table below presents the results of the eleven-year-old subjects in this study. In the table, only one subject (S1109M) scored 1 in each of the four columns for the category interpretation of the task (because of his inconsistent and apparently physiognomic descriptions), and one subject (S1104F) in the four columns of finding and mastering the solution, as hers was a more mechanical process with little insight. Of these columns and categories, the highest average for the group was in the resorting exercise (repetition), and even though three subjects (S1101F, S1103F and S1105F) elected not to resort, it was my opinion that their approaches to finding and mastering the solution would have enabled them to do so. Further, in terms of the first three columns of finding and mastering the solution, four subjects (S1102F, S1103F, S1106M and S1110M) scored 2 because their approaches indicated that they were being perceptually guided (as opposed to conceptually) in this category.

Subject's code	**Interpretation of the task (1-3) per column**				**Levels of perfor-mance**	**Finding and mastering the solution (1-3) per column**				**Total score=36**
N=10	Principle	Names	Sample	Totality	Includes early approaches scored from -1 to -3	Solution	Formulation	Dichotomy	Repetition	
S1101F	2	2	2	2	8	2	2	2	3*	**25***
S1102F	2	2	2	1	7	2	2	2	3	**23**
S1103F	2	2	2	1	7	2	2	2	3*	**23***
S1104F	2	2	2	1	6	1	1	1	1	**17**
S1105F	3	2	2	1	8	2	2	2	3*	**25***
S1106M	2	2	2	1	5	2	2	2	3	**21**
S1107M	2	2	3	3	8	2	2	2	3	**27**
S1108M	3	3	3	2	9	2	2	3	3	**30**
S1109M	1	1	1	1	4	1	1	2	3	**15**
S1110M	3	2	2	1	5	2	2	2	3	**22**
Averages	***2.2***	***2.0***	***2.1***	***1.4***	***6.7***	***1.8***	***1.8***	***2.0***	***2.8***	***22.8***
Total scores	**22**	**20**	**21**	**14**	**67**	**18**	**18**	**20**	**28**	**228**
Maximum possible	*30*	*30*	*30*	*30*	*120*	*30*	*30*	*30*	*30*	*360*

Table 9: Adapted (Hanfmann & Kasanin, 1942) Scoring for Eleven-year-old Subjects

**=Repetition/resorting did not take place*

In the category of levels of performance, one subject (S1109M) scored 4, and this scoring was done in terms of Hanfmann and Kasanin's (1942) "Physiognomic groupings", as Vygotsky does not write about this type of performance (and which I interpreted as being quite different to that of his writings on subjective relationships in syncretic images). For example, this subject (S1109M) had noted different heights of two of his groups, and, more tellingly, that there was no other block identical to the green *lag* triangle, observations which, I believe, would have been beyond the ability of the subject fully in a syncretic mode.

Two subjects (S1106M and S1110M) scored 5 in the category of levels of performance as they noticed either height or size fairly early on during their sessions. Only one subject (S1108M) described the principle of the double dichotomy and was also the highest scoring in the category of levels of performance because of his sophisticated diffuse complexes in attempting to solve the problem of the blocks. The subject S1104F scored 6 in this category due to her chains and chain-like reasoning across the four groups. Two subjects' (S1102F and S1103F) scores of 7 in the category of levels of performance were reflective of their unstable diffuse complexes, and three subjects scored 8 (S1101F, S1105F and S1107M), where the first two displayed pseudoconceptual reactions to inconsistencies in their groupings, and where the third, although more consistently logical in his approach, paid more attention to the totality than did these other two subjects. Although the maximum possible score for the group in the first and third sections of the scoring was just over two thirds of the maximum possible score (161 out of a possible 240, or 67.08%), the middle section, levels of performance, was the most revealing of the range of these subjects' modes of functioning (with an average of 6.7 of a maximum possible 12, or 55.83%). The range of total score per subject

was between 15 and 30 and this group's average score was 22.8 of a maximum possible of 36 (63.33%).

The table below presents the responses from these eleven-year-old subjects for the transference exercise.

Four subjects (S1101F, S1103F, S1104F, and S1105F) transferred to the glasses and the candles by remembering the positions of the blocks on the board; five subjects (S1102F, S1106M, S1108M, S1109M and S1110M) remembered the traits of the groups of blocks; and S1107M relied on both the board and the traits in this transference exercise.

Subject's code	**Transfer scoring**			**Totals for transfer=16**
N=10	Common=8	Glasses=4	Candles=4	
S1101F	8	2	2	**12**
S1102F	2	4	4	**10**
S1103F	8	0	3	**11**
S1104F	8	3	4	**15**
S1105F	6	2	4	**12**
S1106M	5	1	1	**7**
S1107M	8	2	1	**11**
S1108M	8	2	2	**12**
S1109M	3	0	4	**7**
S1110M	7	2	2	**11**
Averages	***6.3***	***1.8***	***2.7***	***10.8***
Total scores	**63**	**18**	**27**	**108**
Maximum possible	*80*	*40*	*40*	***160***

Table 10: Transfer Scoring (Towsey, 2006) for Eleven-year-old Subjects

It is interesting to note that three eight-year-old subjects scored 4 in the transfer to both the glasses and the candles, whereas of these eleven-year-old subjects, only one (S1102F) was able to do so. It was entirely possible that the eight-year-olds were able to do so because, as a group, they were more concrete and factual in their modes of thinking, whereas with this group of eleven-year-old subjects, although their modes of thinking were still in the realm of the concrete and factual, six of them were moving into diffuse and pseudoconceptual modes where more possibilities could be entertained and opened up. Because of this 'middle ground', so to speak, the increase in possibilities could conceivably have removed their focus from the immediately perceptually obvious, resulting in them battling to return to the concrete and the particular. What is also interesting to note was that while two eleven-year-old subjects (S1102F and S1104F) scored 4 and 3 respectively with the glasses, five of the eleven-year-olds (S1102F, S1103F, S1104F, S1105F and (surprisingly) S1109M) scored 4, 3, 4, 4, and 4 in the transfer to the candles. While this increase could have been as a result of a consolidation, fully half of them (S1101F, S1103F, S1104F, S1107M and S1108M) were able to describe what the groups of blocks had in common (scores of 8), and a further two of them (S1110M and S1105F) scored 7 and 6 respectively in this category. (None of the eight-year-old subjects scored a full 8 in this category.)

Whilst there does seem to be some link between the highest scoring subjects in the Hanfmann and Kasanin scoring above and the ability of four of the eleven-year-old subjects to describe what the

groups of blocks had in common (S1108M, S1107M, S1101F and S1103F), the reverse seemed to be the case in only one subject (S1109M) who scored 3 in his description of what the groups of blocks had in common. As a group, the eleven-year-old subjects scored above two thirds in the average score (6.3) out of a maximum possible 8 (or 78.75%) in describing what the groups of blocks had in common. Whereas their average score for transfer to the glasses was below half (at 1.8 out of 4), their transference to the candles was 2.7 out of 4 (although this score could possibly have been affected by the surprising score by the subject S1109M).

The table below presents the supplementary scoring for the eleven-year-old subjects.

Subject's code	**Total score for all blocks (NX5+NX3 in 1st column) and No. of blocks turned 2nd + 3rd**			**Supplementary scoring**			**Total score (between 1 and 165)**
N=10	Total score for all blocks	No. incorrectly turned	No. correctly turned	Minutes	Incorrectly	Correctly	
S1101F	71	4	17	13	20	51	**84***
S1102F	105	21	0	40	105	0	**145**
S1103F	105	21	0	19	105	0	**124***
S1104F	105	21	0	58	105	0	**163**
S1105F	73	5	16	14	25	48	**87***
S1106M	67	2	19	9	10	57	**76**
S1107M	73	5	16	17	25	48	**90**
S1108M	93	15	6	40	75	18	**133**
S1109M	105	21	0	50	105	0	**155**
S1110M	69	3	18	14	15	54	**83**
Averages	***86.6***	***11.8***	***9.2***	***27.4***	***59.0***	***27.6***	***114.0***
Total scores	**866**	**118**	**92**	**274**	**590**	**276**	**1140**
Maximum possible		*210*	*210*	*600*	*1050*	*630*	

Table 11: Supplementary Scoring (Hanfmann & Kasanin, 1937/42) for Eleven-year-old Subjects

**=Repetition/resorting did not take place*

In the table above, all of the scoring times were taken after the subjects' attempts to resort the blocks or at the time for the three subjects who declined this attempt. While four of these eleven-year-old subjects turned 21 blocks during their sessions, two of these had responded to the problem of the blocks with diffuse complexes (S1103F and S1102F) and one (S1104F) with chains and chain-like reasoning across the four groups. The two subjects (S1110M and S1106M), who both noticed either height or size fairly early on into their sessions, required 3 and 2 incorrectly turned blocks before needing to turn the other blocks to confirm their approaches. In the case of the higher scoring subjects in the Hanfmann and Kasanin scoring above, three subjects (S1107M, S1105F and S1101F) required 5, 5, and 4 blocks to be turned over before turning the rest to confirm their approaches. The subject S1108M, who entertained the largest number of possible solutions, required 15 blocks to be

turned in the course of his coming to solve the problem of the blocks.

What is of interest in this group's turning of the blocks was that the averages of 11.8 and 9.2 of incorrectly and correctly (or confirmatory) blocks were nearly mid-way of the total possible of 21.

The total supplementary score for the eleven-year-old subjects in this study ranged between 76 and 163, and of some interest is that the two lowest scoring subjects in the Hanfmann and Kasanin scoring above were also the two lowest scoring in the supplementary score (S1104F and S1109M who scored 163 and 155 respectively). However, this apparent trend was not clear or supported by the scores of the other eight participants in this age group: the supplementary scoring is affected by the variation in time taken as well as the number of turned blocks (emphasising Hanfmann and Kasanin's assertion that the qualitative discussion is necessary as an indication of how the subjects performed during their sessions).

The shortest period of time for this age group's engagement with the blocks was 9 minutes and the greatest was 58 minutes, with an average of 27.4 minutes of a possible maximum of 60 minutes.

The fifteen-year-old subjects

Most of these subjects asked questions about the nature of the research, such as what it intended to achieve, what it was looking for – and whether I would be able to discern personality types or intelligence in any way through the subjects' engagement with the blocks. After their sessions, many of them expressed appreciation about the simplicity of the solution and yet the 'brilliance' of the blocks in that no one block is identical to another, given the number of possible permutations. Three of them admitted that because the problem-solving activity was in the realm of psychology they were under the impression that the solution had to be more difficult than the simplicity of the double dichotomy. Nine of the ten subjects specifically stated that they had thoroughly enjoyed participating in the research exercise. They also indicated that the way in which the procedure is constructed, where each participant is given the opportunity to build their own understanding of the solution in their own way, was an extremely good method of learning something new: they said that had they been told upfront what the solution was, it was possible that their understanding of it would have been more superficial and not as long lasting ("From now on, I'll definitely be asking for a *lag* glass of water after a long hot day!")

Four of the fifteen-year-old subjects in this study approached the problem of the blocks with the implications for the totality evident in each of their moves: in other words, if an idea or approach would affect the stability of the totality negatively, it was abandoned. This approach by S1504F, S1505F, S1507M and S1510M was indicative of the hypothesis-testing approach in which the subjects tried out moves physically and then abandoned the ones which yielded inconsistent groups, or they examined the blocks in the middle of the board either analytically or mathematically. Four subjects (S1501F, S1506M, S1508M and S1509M) were prepared to allow for exceptions as part of their approach to the blocks, although they noted that the exceptions did exist. Two subjects (S1503F and S1502F) did not appear to regard the totality of the set of blocks in their approaches: however, with the first subject, there appeared to be a misunderstanding in her interpretation of the task and the resorting exercise (then again, she say did beforehand that she had tried to conduct Internet research on the blocks beforehand, and would probably have experienced the same difficulties that I did).

It would seem also that, with an emerging ability to rely on the conceptual as opposed to the purely perceptual, more possibilities were opened up. This observation might sound like stating the

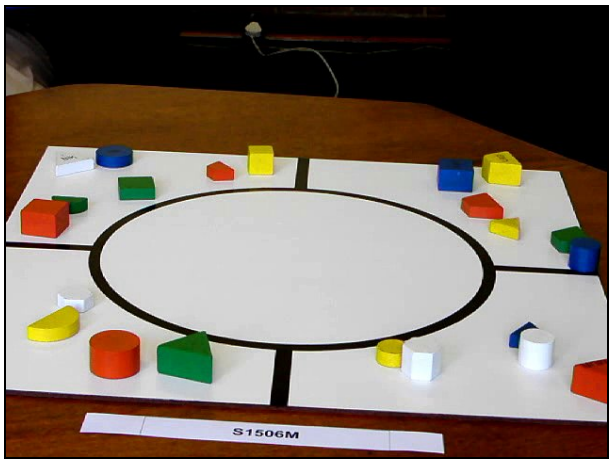
obvious; however, in relation to the blocks, it seemed that the older the subject, the more possibilities for solutions opened up and could be entertained. This ability to consider or bear in mind more possibilities could actually in some respects interfere with solving the problem of the blocks because subjects looked for more elaborate reasons. Some of the ideas advanced by these subjects were so challenging to me as a researcher – discussions such as the difference between size and volume of the blocks, or attempting to mirror patterns of blocks across the four quadrants, or creating sub-groups according to height and size within each group – that it was in some cases very difficult for me to choose a block as a clue that would be most helpful to these subjects.

However, for example, for two subjects (S1502F and S1503F), these reasons included cutting the squares, trapezoids, or circles in half, that would make it possible to put them in groups with their complete or incomplete counterparts. When I advanced the observation that, strictly speaking, such a splitting in half of squares would result in isosceles rather than equilateral triangles, the subjects suggested putting the hexagons with the trapezoids instead, as this splitting would result in groups of trapezoids and hexagons. However, even if their focus shifted away from the 'half theory' debate to some extent, subsequent moves and returns to the 'half theory' provided further indications of the pseudoconceptual attempts they had been using to solve the problem of the blocks.

One subject started her opening move by considering colour (S1501F); six subjects commenced theirs on the basis of shape (S1502F, S1503F, S1504F, S1506M, S1507M and S1509M); one subject considered elevation (S1508M); one subject considered volume from analysing the blocks in the middle of the board (S1510M); and one subject analysed the blocks in the middle of the board, eliminating possibilities before committing herself to the combination of height and size (S1505F).

An example of the emergence of the potential concept 'proper' in combination with sophisticated reasons

The subject S1506M started with shape, after asking questions about colours, shapes or in what way the blocks could be sorted. His solution to the problem of the semi-circles and hexagons was to assign them to the group with the circles. He said he wasn't sure if this grouping was right, and elected to choose clues for himself: two *lag* blocks. In response to prompting, he said that the *lag* square did change his approach somewhat. He moved the blocks around for a while and said he was trying to work out what the connection was between the *lag* trapezoid and the *lag* square. He tried out representative allocation of shape per group, and, inconsistent as it was, stated that he was comfortable with this approach.



Fourteen minutes into his session, the subject S1506M came up with this attempt to create

pairs of blocks in each group which would mirror across the four groups. The trapezoid/square pair (top right) of *lag* exemplars was mirrored within the *lag* group (the green *bik* square at the edge of the board and the orange *bik* trapezoid further in), as well as across in the *bik* group (top middle). The triangle/circle pair from the *bik* exemplars was mirrored at bottom left and bottom right in the *mur* group, as well as in the yellow *cev* triangle and the blue *mur* circle back in the *lag* group (not close together). The two white hexagons were paired with circular shapes of the same colour (bottom left and right), and then the system broke down because the pair of the orange *lag* square and green *cev* semi-circle (top left) had no mirrored pair anywhere else on the board. The subject was also left with the unaccounted-for green *lag* square (also top left). Whilst there were obvious inconsistencies with the last three blocks in this particular solution, it was a sophisticated attempt to deal with the possible permutations of shape.

After several more clues, the subject (S1506M) asked if it would be possible to have ten blocks in two groups and just one in each of the others (an indication that he had counted them), and he asked this question after he had started to make groupings that seemed to be a similar attempt to the solution above, but based this time on colour. A few seconds after this, at 18 minutes into the session, an accidentally turned *cev* triangle made the subject change his mind "Quite a bit". How? "I'll show you", he said.

And he did. With seven blocks turned (ones which he selected, and which were not helpful clues from me), he sorted the groups correctly. Although this subject described his groupings on "height" and did not mention "size" initially, it was obvious that he meant height and size. This was confirmed when I asked him to tell me more about "height" ("a smaller version of these blocks"). He elected not to resort the blocks, was able to identify two of the glasses, and all four of the candles.

This subject (S1506M) provided for me a clear example of the potential concept 'proper' in operation (Vygotsky, 1986, p. 139):

> In potential concepts proper, a trait once abstracted is not easily lost again among the other traits. The concrete totality of traits has been destroyed through its abstraction, and the possibility of unifying the traits on a different basis opens up.

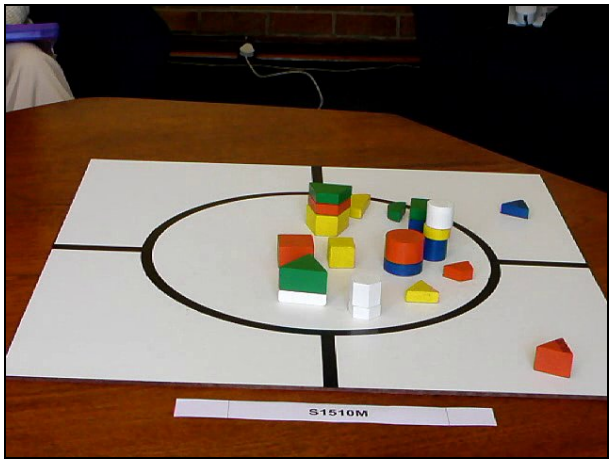
Two examples of analysis of the blocks – mathematical and methodical

The subject S1510M's opening comments were that the possibilities were shape or colour, or perhaps even height. He also made the point that he would start by selecting blocks as possible *mur* candidates before extrapolating his ideas to the other three groups. I encouraged him to test out his hypotheses in the middle of the board if he wished before committing himself, which he proceeded to do. He then noted that there were two different heights which would not yield the four groups required. He also eliminated colour as a possibility. "Different heights, different sizes, different…." he mused, "I haven't a clue!".

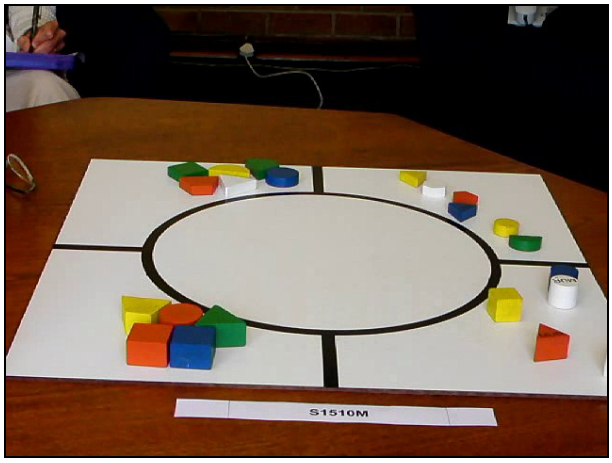
He then selected a *bik* circle and placed it next to the *mur* block, saying "I think it has something to do with volume". I had to say to him in response to this hypothesis of volume that the blocks were not mouldable so it was not possible for me to prove or disprove his hypothesis, but I had to agree that it was possible. Without having any ability to confirm or disconfirm his hypothesis of volume, I asked if he could perhaps find another block on the board that did not have to be remoulded or destroyed in the process of establishing similar volume.

The subject S1510M then stacked the blocks according to diameter and concluded that the

blocks he had stacked in this way were similar in outside area (diameter) but not in volume, as depicted in the photograph below.



After this photograph was taken, nine minutes into S1510M's session, much discussion ensued about volume, and in many respects I felt I was out of my depth (by my own admission, I am mathematically illiterate).



After 15 minutes into the session, the subject (S1510M) said that these blocks had been sorted according to size and not volume, and were his "think-tank" for "hypothetical" candidates (two blocks had been accidentally turned over in the process of our discussion, and the *mur* hexagon was off-screen at right). His discussion about the differences in volume between the *cev* circle and semi-circle seemed to indicate to me that the differences he had noted with this group were, in volume terms, too great to allow them to be grouped together. (Quite apart from the theoretical possibility that two stacked *cev* triangles would be similar in volume to one *mur* triangle, but that this approach would not result in four groups.) This meant he that had switched his principle to one of size (as depicted above).

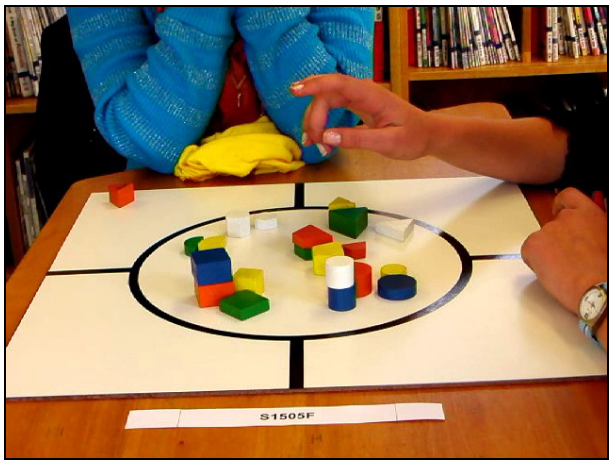
When it was suggested to this subject (S1510M) that he knew now what the principle of the double dichotomy involved, we could leave out the resorting exercise and move on to the next part. He said that although he knew what the principle was, he'd like to try again, and this time "Look for something else [another possible solution]". He covered his eyes while I mixed up the blocks and, after some attempts not to group them in the way which he knew was the solution, he was not able to come up with an alternative way of sorting the blocks (Phew!).

This subject then identified the glasses "*cethikmurlag*" so quickly that it was impossible for me or

my research assistant to note whether he had named them correctly or not. When I asked this subject (S1510M) to repeat this again slowly, it was evident that in his hastiness, he had actually mixed up "cet" with *bik* and I corrected him. However, in the transference to the candles, which he did more slowly, he did identify all four candles (less hastily) and more accurately.

The next subject to analyse the blocks in the middle of the board was the subject S1505F. She said after a very short time that she'd been looking at the blocks to find out how many heights there were, and then had counted how many shapes there were, including the basic regular and irregular ones. She'd also counted the triangles "because *mur* is a triangle". This subject also asked if there were "necessarily an equal number" of blocks in certain of the groups to establish whether she could be assisted by this when creating four groups.

This subject's next observation was the number of sides of the blocks, but this yielded "Too many groups, so I'll have to change it". She thought about possibilities for a while before stacking the blocks as depicted below.



In this photograph, taken nearly nine minutes into the session, the subject (S1505F) had noted that in stacking them the way she had, it yielded different sizes – small, medium, and large. However, what she had been looking for, though, was a pattern of two stacked blocks of the same diameter, coupled with two which were not. She said that this pattern worked for the squares and the trapezoids, but not with the circles, the triangles or the irregular shapes.

After some discussion about why these approaches didn't work (inconsistent and too many or too few blocks), she said that it was quite hard because it was "…just so open… there's so many possibilities that it's just so hard to find one that will work. There are just, like, endless options".

At just over 13 minutes, with three triangular clues that I had offered her, she solved the problem of the blocks, giving an explanation for her grouping in terms of the double dichotomy. The explanation she provided was logically deducted rather than entirely perceptually gained because she grouped the blocks before placing them with the exemplars – this came after her explanation. (Her solving the problem with the number of exemplars provided was remarkable, because some subjects in this study, when confronted by these four exemplars, did not manage to get beyond the obvious exception of the last remaining triangle – the second *cev*.)

Hanfmann and Kasanin's (1942) adapted framework as an analysis of how subjects perform during the method of double stimulation in concept formation

The individual responses from each of the fifteen-year-old subjects in this study I found to be charming as well as insightful in terms the theoretical aspects of Vygotsky's and Hanfmann and Kasanin's writings. The discussion below attempts to give a brief description of the reactions of the fifteen-year-old subjects in this study in these respects.

The range of actions and types of performances from these fifteen-year-old subjects varied from the subjects (S1502F, S1503F, S1508M and S1509M) who displayed elaborate but pseudoconceptual approaches to the blocks to begin with, to those (S1501F and S1506M) who entertained sophisticated possibilities during their engagement with the blocks but more consistently so, to those (S1504F and S1507M) who tried hypothesis testing through physically moving the blocks around, to those (S1505F and S1510M) who analysed the blocks in the middle of the board before coming up with possible solutions. These responses were all highly personalised ones, in addition to providing excellent examples of the observations which Vygotsky wrote about over 70 years ago in relation to the intellectual challenges and responses which face adolescents (worth citing here, I believe, in full (1986, p. 108)):

> Unlike the development of instincts, thinking and behavior of adolescents are prompted not from within but from without, by the social milieu. The tasks with which society confronts an adolescent as he enters the cultural, professional, and civic world of adults undoubtedly becomes an important factor in the emergence of conceptual thinking. If the milieu presents no such tasks to the adolescent, makes no new demands on him, and does not stimulate his intellect by providing a sequence of new goals, his thinking fails to reach the highest stages, or reaches them with great delay.
>
> The cultural task per se, however, does not explain the developmental mechanism itself that results in concept formation. The investigator must aim to understand the intrinsic bonds between the external tasks and the developmental dynamics, and view concept formation as a function of the adolescent's total social and cultural growth, which affects not only the content but also the method of his thinking. The new significant use of the word, its use *as a means of concept formation*, is the immediate psychological cause of the radical change in the intellectual process that occurs on the threshold of adolescence.

The table below presents the results of the fifteen-year-old subjects in this study.

Subject's code	**Interpretation of the task (1-3) per column**				**Levels of perfor-mance**	**Finding and mastering the solution (1-3) per column**				**Total score=36**
N=10	Principle	Names	Sample	Totality	Includes early approaches scored from -1 to -3	Solution	Formulation	Dichotomy	Repetition	
S1501F	3	3	3	2	10	3	3	2	3	**32**
S1502F	3	2	2	1	9	2	3	2	3	**27**
S1503F	3	2	1	1	9	2	2	2	2	**24**
S1504F	3	3	3	3	11	3	3	3	3	**35**
S1505F	3	3	3	3	12	3	3	3	3*	**36***
S1506M	3	3	3	2	10	3	3	2	3*	**32***
S1507M	3	3	3	3	11	3	3	3	3	**35**
S1508M	3	2	3	2	9	3	3	3	3*	**31***
S1509M	3	3	3	2	9	3	3	2	3	**31**
S1510M	3	3	3	3	12	3	3	3	3	**36**
Averages	***3.0***	***2.7***	***2.7***	***2.2***	***10.2***	***2.8***	***2.9***	***2.5***	***2.9***	***31.9***
Total scores	**30**	**27**	**27**	**22**	**102**	**28**	**29**	**25**	**29**	**319**
Maximum possible	*30*	*30*	*30*	*30*	*120*	*30*	*30*	*30*	*30*	*360*

Table 12: Adapted (Hanfmann & Kasanin, 1942) Scoring for Fifteen-year-old Subjects

**=Repetition/resorting did not take place*

In the table above, only one subject (S1503F) scored 1 in both of the last two columns for the category interpretation of the task (because of her unclear understanding of what the task involved and her disregard for the totality), and one subject (S1502F) scored 1 in the last column in this category in relation to understanding the implication of her moves in terms of the totality. The four highest scoring subjects in the middle section (levels of performance) also scored a total of 3 in each of the four columns relating to interpretation of the task (S1504F, S1505F, S1507M and S1510M). Four subjects (S1501F, S1506M, S1508M and S1509M) allowed for inconsistencies in their solutions in this first category, noting that they were aware of the inconsistencies. All ten subjects understood the need to look for some quality in the blocks (the principle) in order to arrive at the solution (the first column).

In the category of finding and mastering the solution, the only subject to score 2 in each of these four was the subject S1503F because of how she went about approaching the blocks and also because of her apparent misunderstanding of what was required in the subsequent resorting of the blocks. The three subjects who elected not to resort the blocks (S1505F, S1506M and S1508M) could easily have done so, because of their scores of the preceding columns. Five of these fifteen-year-old subjects did not verbally formulate the principle of the double dichotomy (S1501F, S1502F, S1503F, S1506M, and S1509M), although, in discussion with them afterwards, when this was pointed out to them, they expressed amazed appreciation for the simplicity of the solution.

The maximum possible score for this age group in the first and third sections of the scoring was just over ninety per cent of the maximum possible score (217 out of a possible 240, or 90.41%), and, once again, the middle section, levels of performance, was the most revealing of these subjects'

modes of functioning (with an average of 10.2 of a maximum possible 12, or 85%). The range of total score per subject was between 24 and 36 and this group's average score was 31.9 of a maximum possible of 36 (88.61%).

The table below presents the responses from these fifteen-year-old subjects for the transference exercise.

Subject's code	**Transfer scoring**			**Totals for transfer=16**
N=10	Common=8	Glasses=4	Candles=4	
S1501F	8	4	4	**16**
S1502F	4	2	4	**10**
S1503F	6	3	3	**12**
S1504F	8	4	4	**16**
S1505F	8	4	4	**16**
S1506M	8	2	4	**14**
S1507M	8	2	4	**14**
S1508M	8	4	4	**16**
S1509M	8	4	4	**16**
S1510M	8	2	4	**14**
Averages	***7.4***	***3.1***	***3.9***	***14.4***
Total scores	**74**	**31**	**39**	**144**
Maximum possible	*80*	*40*	*40*	***160***

Table 13: Transfer Scoring (Towsey, 2006) for Fifteen-year-old Subjects

It is interesting to note that of the five fifteen-year-old subjects who scored a total of 16 in the transference exercise, three were female (S1501F, S1504F and S1505F) and two were male (S1508M and S1509M), although, to be fair, if S1510M had not been so hasty with the glasses, I am sure he would have correctly identified these. Another very interesting observation is that eight of the ten fifteen-year-old subjects were able to describe the groups of blocks in terms of both characteristics.

The only link between the Hanfmann and Kasanin scoring above and the ability of these subjects to describe the blocks in terms of both characteristics was apparent for S1503F and S1502F, the two lowest scoring subjects in both. As a group, the fifteen-year-old subjects scored above 90 per cent in the average score (7.4) out of a maximum possible 8 (or 92.5%) for the description of what the blocks have in common. Whereas their average score for transfer to the glasses was above two thirds (at 3.1 out of 4, or 77.5%), their transference to the candles was much closer to the full score of 4 (3.9 or 97.5%). The total transference score for the group was 14.4 of a total possible 16 (90%).

These fifteen-year-old subjects used a variety of mnemonics in the transference exercise: S1501F and S1504F used both the traits and the positions of the blocks on the board; S1503F, S1505F and S1506M remembered the traits of the groups of blocks; S1502F, S1507M and S1509M relied on a combination of the board, the traits, and mnemonics (such as "jet-*lag*", and "large" for *lag*); S1508M described the characteristics or traits, applied the names *cev*, *bik*, *mur* and *lag*, and *then* placed the glasses and candles in relation to where the blocks had been on the board; and S1510M's response was very, very quick(!).

In the table below, all of the scoring times were taken after the subjects' attempts to resort the blocks or at the time for the three subjects who declined this attempt.

Subject's code	**Total score for all blocks (NX5+NX3 in 1st column) and No. of blocks turned 2nd + 3rd**			**Supplementary scoring**			**Total score (between 1 and 165)**
N=10	Total score for all blocks	No. incorrectly turned	No. correctly turned	Minutes	Incorrectly	Correctly	
S1501F	77	7	14	33	35	42	**110**
S1502F	71	4	17	34	20	51	**105**
S1503F	71	4	17	26	20	51	**97**
S1504F	77	7	14	35	35	42	**112**
S1505F	15	3	0	16	15	0	**31***
S1506M	35	7	0	18	35	0	**53***
S1507M	73	5	16	20	25	48	**93**
S1508M	15	3	0	26	15	0	**41***
S1509M	69	3	18	36	15	54	**105**
S1510M	6	0	2	16	0	6	**22**
Averages	***50.9***	***4.3***	***9.8***	***26.0***	***21.5***	***29.4***	***76.9***
Total scores	**509**	**43**	**98**	**260**	**215**	**294**	**769**
Maximum possible		*210*	*210*	*600*	*1050*	*630*	

Table 14: Supplementary Scoring (Hanfmann & Kasanin, 1937/42) for Fifteen-year-old Subjects

**=Repetition/resorting did not take place*

The first immediately apparent observation about the total scores in the table above is the range from 22 all the way to 112. The explanation for this wide range had less to do with the amount of time taken to solve the problem of the blocks, and more to do with the number of turned blocks: in the cases where the subjects were absolutely certain of the correctness of their hypothesis of height and size, the final turning over of the blocks served merely to confirm this. (Hanfmann and Kasanin note in their 1937 paper that the range in scoring is "between 1 (one minute, no corrections) and 165, the lower score standing for the better performance and vice versa" (1937, p. 534). I therefore took this note to be an indication that if subjects had demonstrably solved the problem of the blocks, turning over the remaining blocks, as confirmation of the solution, was confirmatory and thus not scored.) In this respect, then, as with the adult subjects in the next section, I did not count these confirmatory blocks as 'correctly' placed blocks, because the subjects had demonstrably solved the problem of the blocks. In two cases (S1505F and S1510M) these subjects had described the blocks in terms of the double dichotomy (and were also the highest scoring of the subjects in the Hanfmann and Kasanin scoring above). Further, in the case of the subject S1510M, both of the blocks turned over during his session were accidental, and so I have scored these as 'correctly' placed blocks.

The two exceptions to the link between the scoring of Hanfmann and Kasanin above were the subjects S1506M and S1508M: in the case of the first (S1506M), when he noticed the combination of height and size, he had said to me "I'll show you" and because of this certainty, turned the remaining

blocks simply to confirm his obvious demonstration that he had solved the problem of the blocks. In the case of the subject S1508M, he also really only needed to turn the blocks over to confirm his approach because he has said that was "logical to combine size with elevation".

What was of great interest to me in this group's turning of the blocks was that the averages of 4.3 and 9.8 of incorrectly and correctly (or confirmatory) blocks out of a possible 21 indicated to me that these subjects as a group were perhaps relying more on the function of 'the word' in terms of their use of language (everyday and mathematical) to structure their thinking processes, and less on the role of 'the word' in terms of the words *cev*, *bik*, *mur* and *lag*, which served to confirm their approaches. In other words, most of these fifteen-year-old subjects were using language to structure their thinking processes in solving the problem of the blocks, as they relied on between 0 and a maximum of 7 incorrectly turned blocks or clues to help them to arrive at the correct solution, and between 0 and 17 to confirm their solutions.

The shortest period of time for this age group's engagement with the blocks was 16 minutes and the greatest was 36 minutes, with an average of 26.0 minutes of a possible maximum of 60 minutes.

The adult subjects

One of the most obvious differences between the adults in this study and the other groups is that all of the adults conducted their moves in solving the problem of the blocks with the implications of these moves in relation to the totality. Even those who explored the possibilities of representative allocation of shape or colour or some other combination would be halted by this awareness ("Oh, I can't do that because it won't work for four groups in the same way"). Further, while some of the adults in this study might have in some cases 'lumped' the 'leftovers' into one of the groups (eg, those who sorted by shape), the difference between this type of grouping and that of the preconceptual and pseudoconceptual subjects was that the adults were 'bothered' or uncomfortable with this because it implied inconsistent groupings.

Even so, there was a range of levels of performance within this group of adults, from what became an apparently more random approach to the blocks (this subject admitted afterwards that he "had a problem with names" (more below)) to one of mathematical and statistical analysis of the blocks, which, when extrapolated out to the other groups of shapes, resulted in a logically deduced solution.

When it came to describing what the blocks had in common, although all ten adults scored a full 8 in this category, four subjects (SX03F, SX04F, S808M and SX09M) did so without any hesitation at all; four subjects (SX01F, SX02F, SX05F and SX06M) took a while before they came up with both characteristics; and two subjects (SX07M and SX10M) took a while longer to do so. Some subjects also described the blocks in hierarchical terms (eg, SX01F and SX05F) both before and after describing both characteristics.

Another interesting observation about the adult subjects in this study is that while half of them scored a full 16 in the transference exercise, five of the adolescents managed to do so. Whereas the adolescent group with a score of 16 comprised three female and two male subjects, with the adults, all five female subjects scored a full 16, and none of the male adults did(!).

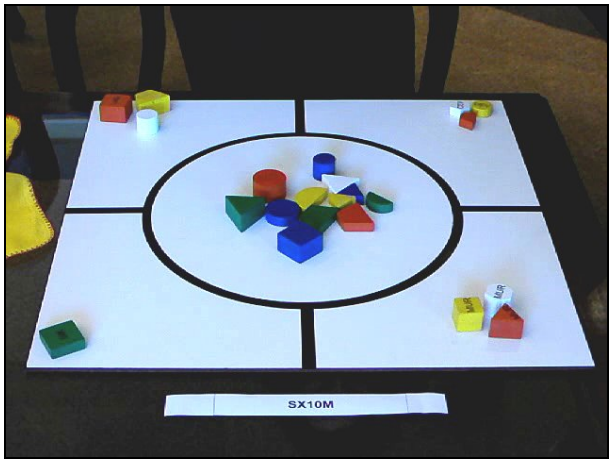
Two adult subjects (SX08M and SX10M) selected colour as their first consideration; three subjects (SX02F, SX04F and SX06M) selected shape; one subject (SX07M) looked for a pattern in

the *mur* group; one subject (SX05F) considered shape and number of edges; and three subjects (SX01F, SX03F and SX09M) analysed the blocks in the middle of the board.

Of the type of grouping referred to by Hanfmann and Kasanin (1942) as the "collection", not one of the adults in this study grouped the blocks in this way. Please note that range in scoring of this group was very close: in the presentation below, a selection of subjects' responses will be presented in depth and others in less detail.

Starting with the subject (SX10M), he only admitted after his session that he had a problem with names: "If what was written under the blocks was numbers and not names, I wouldn't have had a problem. When I saw the first name, I thought to myself straight away "Oh dear! This is never going to work!"". However, he persevered, but because I was unaware of his problem before the session, I was surprised at his reaction during it. (If I had known about this problem beforehand, I could possibly have delayed his session and written numbers and taped them to blocks (as Semeonoff and Laird (1952) had done in their use of the method of double stimulation).)

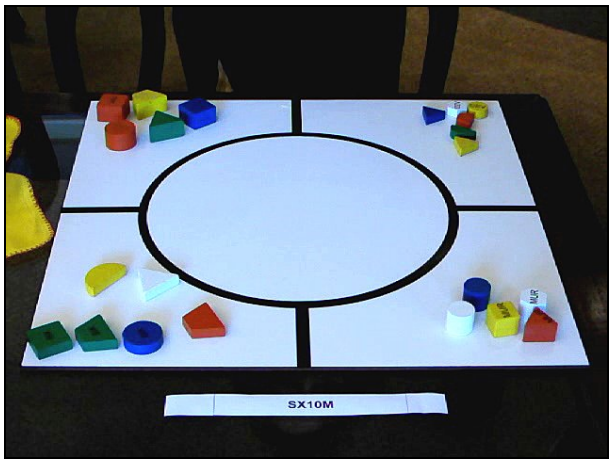
After trying colour, then shape, then height, and going back to a variation of colour, this subject (SX10M) resorted to trial and error, before trying representative allocation on the basis of shape, and then suggesting the possibility of colour combined with height and size. At about 16 minutes into the session, the subject had been attempting to create representative allocation on the basis of colour, height and size. Instead of thinking things through, or counting the number of shapes and colours and remembering that he had noted these before (he appeared to be highly frustrated), he was now working on three possibilities at once.



As Hanfmann and Kasanin note of frustration, as in the case of this subject (SX10M):

> Of extreme interest are the cases that take a different course [to the ones who collect their thoughts and approach the blocks more logically]. Instead of formulating and testing hypotheses, he may now persist in applying the same principle over and over again, in spite of all proofs he has had of its falsity; he may make inconsistent groupings, form collections, or even primitive complexes, and altogether lose sight of the requirement of the task for a consistent system. (1942, p. 45).

However, when the green *bik* square was offered as a further clue (as depicted above), this subject (SX10M) said straight away that "the green one throws this completely". The subject had also been reluctant to physically engage with the blocks by moving them around spontaneously possibly because, from the outset, the name of the *mur* exemplar signalled to him that he'd have a problem with names. At 23 minutes into the session, the subject (SX10M) came up with this solution:



he said that this combination of height and size was the only one he hadn't tried before, as he had tried various other approaches and they hadn't worked. Despite there being only eight blocks with their names revealed, he conjectured that this would be the only logical solution he'd advanced so far. When asked if he could think of any other way for the blocks to be sorted, he replied "This is the only one I've come up with that logically groups the blocks into four corners". Further, although this subject was able to describe the blocks in terms of both characteristics per group, he was only able to identify one of the glasses ("flick of the *bic*", in reference to a South African advertisement for cigarette lighters), but none of the candles.

The second subject to experience frustration during his engagement with the blocks was SX06M. It was possible that because this subject had at one stage been a teacher, he seemed to be second-guessing what would be a "game" more suitable to children than to adults (I was unaware that he'd had some involvement with education before his session). He started by noting that there were more than four different shapes and colours, and noted that there was a variety of these in height and size. Having eliminated colour and shape, he advanced the possibility of creating patterns of shapes with the blocks in each of the four corners. He contemplated this arrangement for a while, and then opted to create four groups of regular (circle, square, triangle) and irregular shapes (trapezoids, semi-circles and hexagons). When the *lag* triangle was turned over, his frustration level began to rise, because he said it was "all a bit confusing" that there would be four names all meaning different yet the same things.

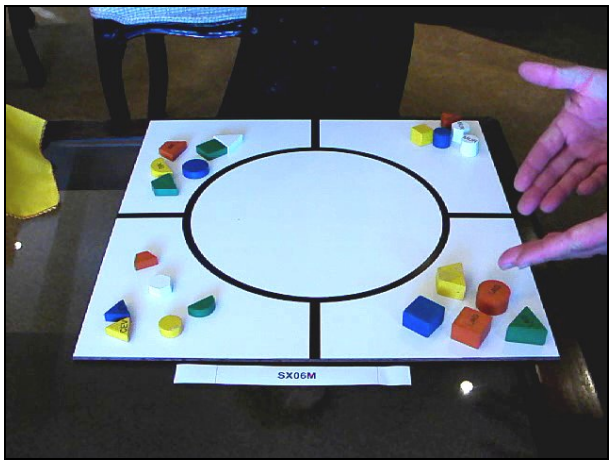
After the orange *bik* trapezoid and the white *mur* hexagon had been turned over, the subject said he had been trying to work out the relationship between exemplars and that it "wasn't making sense". He was reluctant to engage physically with the blocks by moving them around or putting them into the middle while he was working out the possible relationships.

When the *cev* triangle was turned over, the subject (SX06M) noted of the exemplars that there were different heights and sizes – and different names. The subject then suggested that if we were to present this game to children who'd had a few years of schooling it was probable that they'd be able to come up with the solution very quickly. When I assured him that this was not the case, his level of frustration began to rise noticeably.

Hanfmann and Kasanin (1942, p. 44) describe a type of reaction that depicted the subject SX06M almost to the letter: "The intensity of emotion and the speed at which it grows with repeated frustration seems to be greatest in persons who, from the outset, displayed an ambitious attitude towards the task and expected to find a solution very quickly". They also note (p. 44) that while

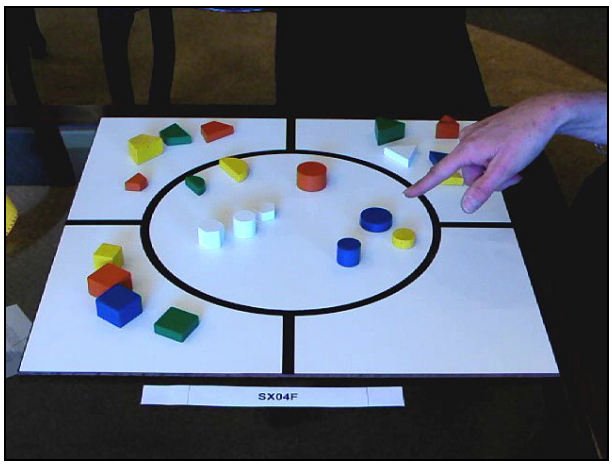
"Some subjects get over the shock of finding themselves in a blind alley" and collect their thoughts, others, as in the case of this subject (SX06M), do not: "I don't know why I am putting this one here – this is not a category" (Hanfmann & Kasanin, 1942, pp. 44-45). (This last statement of Hanfmann and Kasanin's example was made by this subject, practically word for word.)

After 25 minutes, the subject (SX06M) advanced this as a possible solution (below), after he had become increasingly frustrated with each new turning of a block (there were nine turned over, excluding the exemplar). The subject came up with this solution of height and size, but also mentioned the different types of blocks in several groups (possibly being dismissive of such an easy solution and in defence of his frustration from earlier attempts).



However, the combination of height and size was offered by this subject as the only logical solution to four groups. He resorted the blocks successfully, described them in terms of the double dichotomy, and was able to transfer to two of the glasses and four of the candles, by which stage he had regained his composure and was far more relaxed.

The subject who frequently went back to trying various combinations of shape and colour to form patterns was SX04F. This nearly 60-year-old subject started by saying "Logic to me means that all the triangles would go together", but, after she'd created groups of trapezoids ("Those funny looking shapes… what-a-zoids?") and squares, said "…which doesn't make sense because there are too many shapes" (as depicted below).

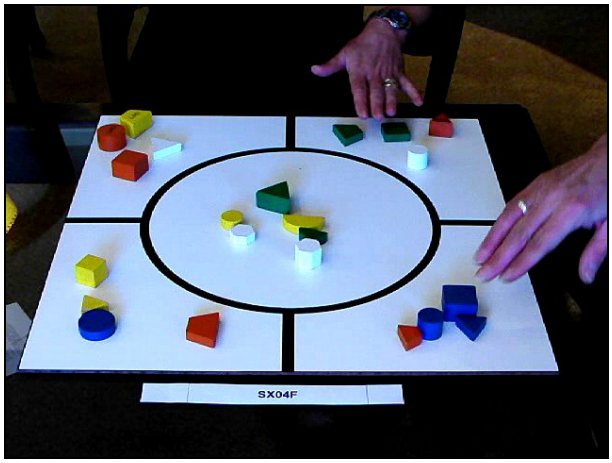


At this point (nearly two minutes into her session) this subject (SX04F) said that there were also too many colours for four groups ("It makes life a lot more difficult, doesn't it?").

After thinking about possibilities for a while, she reluctantly added the semi-circles to the circles

to create a group, and then, "If logic dictates the number of sides, then these [the two hexagons] go together, and these [the squares] go with those [the trapezoids]". She then elected to turn the yellow *lag* trapezoid, and stated that her hypothesis "remained intact". Another clue was needed. When I turned over the *lag* circle she said "That threw that out the window, didn't it?".

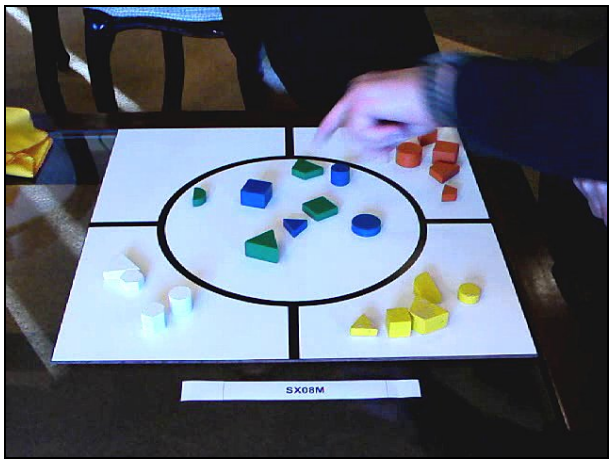
She then repeated that it was not colour, shape, or number of sides, and suggested the possibility of the blocks forming a shape or a pattern. (I did say it was an avenue she could explore, and when asked if I was sure about this, I pleaded the 5th Amendment.) The subject (SX04F) then tried height, but dismissed it as yielding only two groups. She also considered representative allocation on the basis of shape, but dismissed this because of the hexagons and semi-circles. When I prompted her about this idea she said she'd considered the possibility of groups with one shape per corner and possibly addressing the inconsistencies once these were placed. She demonstrated what she meant, as depicted in the photograph below:



"You see, we have a problem", she said. This was at nearly 11 minutes into her session.

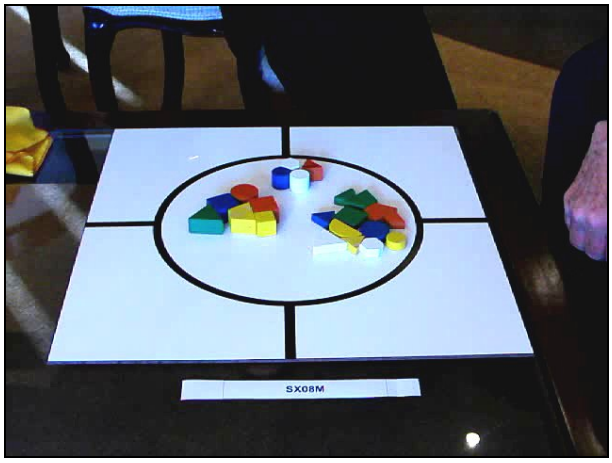
This subject (SX04F) then went down the (dangerous) route of exploring pairs of blocks in representative allocation of combinations of colour and shape, to account for the 'problems' noted above. As she did this, she kept arranging the blocks into patterns or lines of shapes leading out from the exemplar blocks diagonally into the middle of the board. At about 38 minutes into her session, the subject said "There seems to be a pattern emerging here, but I don't know what it is… I still think it has something to do with height… although there're going to be odd ones [the semi-circles and hexagons] it just seems logical that it would go according to height". She then sorted the blocks according to height and described the characteristics in terms of "big and tall, small and short" and so on. "Okay", she said, "logic". She also transferred correctly to all four glasses and candles.

The oldest adult subject to participate in this study was intrigued that this procedure had been used by Semeonoff and Laird for special services selection in the United Kingdom (he was nine years old when the Second World War began and was living in England at the time.) This subject, SX08M, started by saying that "You want me to put them into four categories", and then noted that there were different colours, shapes, and heights: "They're the variables".



He said that the easiest would be to go by colour, and although that would probably not be it, he would try this to eliminate this hypothesis first. At this stage, the subject (SX08M) said "Well as hypothesis testing, this is not a good approach. I should have counted the number of colours first and didn't. Mmm".

The subject's next approach was height.



As depicted in this photograph, taken a minute after the one above, this subject (SX08M) eliminated height as a possibility, because it only yielded three categories for him, and not the required four. Interestingly, he only had one *mur* block with the *lag* blocks, and had not at this stage noted size. He toyed with the idea of shape, and considered the possibility of eliminating all the obvious shapes and would then deal with the exceptions (the hexagons and semi-circles) after that. However, before he had made more than two groups on obvious shape, he decided that volume might be a possibility. He sorted the blocks according to volume, and then described the principle of sorting the blocks according to the double dichotomy of height and volume: "Oh, I see, it is a simple solution… Variations of height and volume. Very interesting".

Although this subject (SX08M) discovered the principle of the double dichotomy relatively quickly (in 14 minutes, including the resorting), he experienced some difficulty in transferring the names *cev*, *bik*, *mur*, and *lag* to the glasses and the candles in terms of height but not the same volume. As my research assistant recorded in her notes: "While he is able to sort the glasses and recall characteristics with relative ease, he is having some difficulty putting names to all candles. Can't seem to recall associations for each one: ie, tall/big; tall/small."

The next subject, SX07M, laughed a great deal throughout his session, even when he was

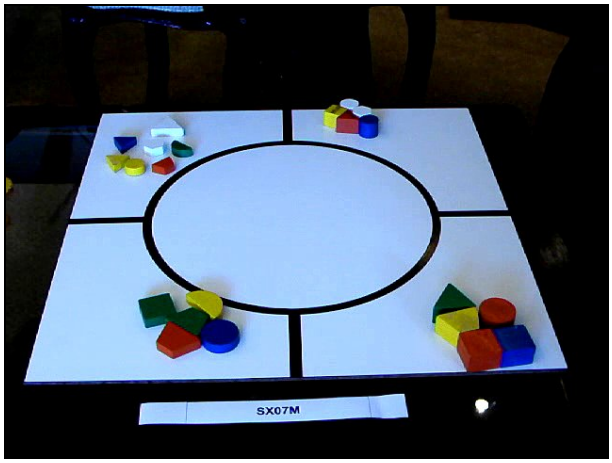
battling to describe the glasses and the candles with the new words (he only managed with one glass and with two candles). He started out by confirming his understanding of the instructions "So, Paula, we are saying that all the blocks actually belonging to *mur* … they're not exactly identical, in shape that is… Or is it a question of me finding out exactly which ones belong to *mur*… Oh, yes. It is."

The subject (SX07M) said that the first thing that came to mind was that it would not be colour. He then said he believed that these blocks, when put together, would form some kind of shape in each quadrant, and rubbing his hands together, commenced by selecting trapezoids, where the two flat ones were placed together and the *cev* trapezoid was joined to the *mur* triangle, even though they were of different heights. He was not entirely comfortable with this height difference, but in terms of his opening hypothesis, it could either be blocks placed together to form a shape, or blocks sorted according to shape and height. In this way, he came up with five groups "…which is surprising, because there are supposed to be four. This means that my approach was not quite correct".

In thinking about this further, the subject (SX07M) noted the problem and number of the two semi-circles: he hypothesised that if they were joined together, they could be in the round or circular group, so his principle was changed to one of shape, similar shape and different heights in each group.

When the first block to confirm or disconfirm his hypothesis was the *mur* square, his reaction was "Oi! Oi-yoi-yoi yoi yoi!". He asked for permission to return the blocks to the middle, said shape was definitely "not the solution here", and that he would then be looking for something else "that would be identical" to the two *mur* exemplars.

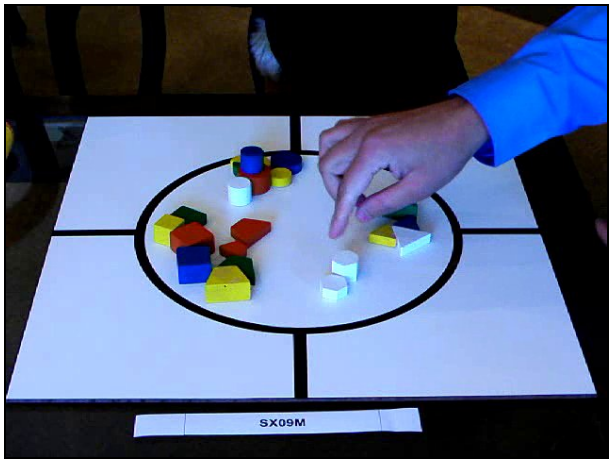
"Maybe that's the size", he said, rubbing his hands together, and continuing to explain to me: "Now, if we actually look at these ones [the two *mur* exemplars], they are the same size and the ones that match them in size will be this one [*mur* hexagon], this one [*mur* circle], and this one [the last *mur* circle]". Then, moving on to the *lag* blocks, he said we do the same thing. He repeated this with the *bik* and *cev* blocks, and explained that his hypothesis was one of size and height, because shape and colour were not the solution.



At nine minutes into his session, the subject (SX07M) had hypothesised that size and height combined was the solution to the blocks because he had eliminated colour and shape. He had managed to come up with this solution with only one block other than the *mur* exemplar turned up, and despite the misplaced *bik* triangle in the *cev* corner ("Oh [expletive]! This one was supposed to go here [with the *bik* blocks]!"), was convinced that this was the only logical solution to the problem of

the blocks. As he turned over the blocks, he said "Ha!" and chuckled a great deal to himself, and laughed out aloud when the last block was turned over.

The last adult subject in this study to be discussed is SX09M. Although quite hesitant verbally and rather reserved, these characteristics belied the razor-sharp mind of this subject. His opening comments were "Just looking at it, I would probably work it on shapes as opposed to colour, as there seems to be five colours". This subject (SX09M) started to calculate the number of shapes in the middle of the board, and then came up with his opening suggestion as depicted below.

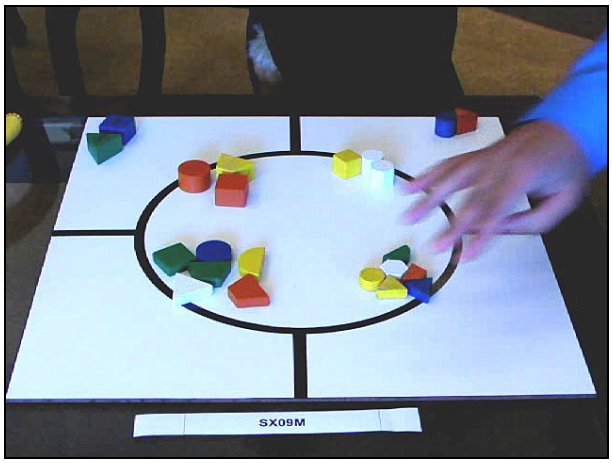


Nearly four minutes into this session, the subject (SX09M) said that he would categorise the blocks according to the number of sides – two, five, six, and eight. He chuckled when the first block to be turned over was a *mur* circle: "Okay," he said, "I'm going to resort these blocks on the basis of the size of these blocks. This is because this [the *mur* triangle] is a smaller version of this triangular [*lag*] block [and the same with the *bik* circle]".

The subject (SX09M) moved the blocks around briefly and then said "There is a problem here, because there are definitely not four sizes". He went on to say that he was looking at height as well, "…but that doesn't come into play. It's possible that there are four groups categorised on variation of colours and size… the number of permutations that you can get from these blocks is quite a lot – enormous. So I think I would need another clue". He also added that it was possible to have categories based on colour, shape, height, and size, and when I turned over the blue *lag* square, he said that this "threw the colour and other permutations out of the equation completely. However, it is still possible that the four quadrants are differentiated on the basis of…", and he went back to moving the blocks around in the middle of the board.

The subject also noted that he was "toying with the idea of weight" but that this was quite difficult to tell definitively. He then said he was thinking of another possibility to see if he was on the right track, and but asked if it was possible to have another clue (the *lag* triangle).

At 13 minutes into the session, this subject (SX09M) said "I've got an idea. The common thing between these shapes is that the triangles come in four different sizes" (this despite there being five triangles).



This subject, SX09M, said that "How I deduced this categorisation is that the common thing in the triangles is that they are the ones which seem to differentiate on the height and the size. And so there's this in the circular ones as well – they also have that characteristic." He had then extrapolated this principle to the other blocks and solved the problem – statistically and mathematically – by analysing the characteristics of groups of blocks to establish where the areas of commonality lay, which would form the basis for sorting the blocks.

Hanfmann and Kasanin's (1942) adapted framework as an analysis of how subjects perform during the method of double stimulation in concept formation

The table below presents the results of the adult subjects in this study.

Subject's code	**Interpretation of the task (1-3) per column**				**Levels of perfor-mance**	**Finding and mastering the solution (1-3) per column**				**Total score=36**
N=10	Principle	Names	Sample	Totality	Includes early approaches scored from -1 to -3	Solution	Formulation	Dichotomy	Repetition	
SX01F	3	3	3	3	12	3	3	3	3	**36**
SX02F	3	3	3	3	10	3	3	3	3	**34**
SX03F	3	3	3	3	12	3	3	3	3	**36**
SX04F	3	3	3	3	10	3	3	2	3	**33**
SX05F	3	3	3	3	12	3	3	3	3	**36**
SX06M	3	3	3	3	10	2	2	2	3	**31**
SX07M	3	3	3	3	12	3	3	3	3	**36**
SX08M	3	3	3	3	12	3	3	3	3	**36**
SX09M	3	3	3	3	12	3	3	3	3	**36**
SX10M	3	2	2	3	10	2	2	3	3	**30**
Averages	***3.0***	***2.9***	***2.9***	***3.0***	***11.2***	***2.8***	***2.8***	***2.8***	***3.0***	***34.4***
Total scores	**30**	**29**	**29**	**30**	**112**	**28**	**28**	**28**	**30**	**344**
Maximum possible	*30*	*30*	*30*	*30*	*120*	*30*	*30*	*30*	*30*	*360*

Table 15: Adapted (Hanfmann & Kasanin, 1942) Scoring for Adult Subjects

In the table above, only one subject (SX10M) scored 2 in the two middle columns for the category interpretation of the task (because of his "problem with names") and he also scored 2 in the first two columns of finding and mastering the solution, possibly for the same reason. The subject SX06M scored 2 in the first three columns of finding and mastering the solution, perhaps because of his attempts to second-guess the activity as a game for children, which could have led to his increased levels of frustration. I also scored him at 2 in the column for formulation of the solution in terms of the double dichotomy, because at the time he advanced his "logical" solution of height and size, he also mentioned the shapes of the blocks in some of the groups (possibly, as mentioned, in defence of his earlier frustrated attempts to solve the problem of the blocks). The only other subject to score 2 in the column of formulation of the double dichotomy was the subject SX04F, because she sorted the blocks according to what she said was "height", which seemed to mean height and size, but which became much more obvious when she was describing what the groups had in common.

All ten adult subjects in this study scored 3 in the columns of looking for the principle for sorting the blocks (first column), in terms of their moves in relation to the totality (fourth column), and in the resorting exercise (second-last column, before the totals).

In the category of levels of performance, four adult subjects scored 10 each, for the following reasons: SX02F because her approach involved combinations of various permutations, and attempting mirrored pairs of blocks across the four groups in representative allocation of a number of combined possibilities; SX04F because her approach was looking for patterns and representative allocation of a number of combinations, including mirrored pairs; SX06M because his levels of frustration interfered with the more logical approach he had adopted at the outset; and SX10M because of his problem with names and his attempts at combinations of representative allocation. The remaining six adult subjects scored 12 because their approaches had been hypotheses testing by analysing the characteristics of the blocks and eliminating those possibilities immediately which would have resulted in anything but four groups. (If it were possible to score any of the subjects in this cross-sectional study as above 12 in this category, I believe it would have to be the subject SX09M because of his statistical and mathematical analysis of the triangles, which he then also found with the circles, and then extrapolated these relationships to the remaining blocks to arrive at the correct solution.)

The maximum possible score for the adult subjects in this study in the first and third sections of the scoring was just over ninety-five per cent (232 out of a possible 240, or 96.66%). In the middle section, levels of performance, these subject's modes of functioning had an average of 11.2 of a maximum possible 12 (93.33%). The range of total score per subject was between 31 and 36 and this group's average score was 34.4 of a maximum possible of 36 (95.56%).

The table below presents the transference exercise findings of the adult subjects.

All of the female subjects scored a full 16 in the transference exercise, and the male subjects all scored a full 8 in describing what the groups of blocks had in common in terms of both characteristics.

There did not appear to be any discernable link between the Hanfmann and Kasanin scoring above and the ability of these subjects to describe the blocks in terms of both characteristics and it would not be relevant to point to the obvious case of SX10M. However, the highest scoring of the male subjects in this study was SX09M, who scored 36 in the Hanfmann and Kasanin scoring above, and 15, the highest of the male subjects, in the transference exercise.

Subject's code	**Transfer scoring**			**Totals for transfer=16**
N=10	Common=8	Glasses=4	Candles=4	
SX01F	8	4	4	**16**
SX02F	8	4	4	**16**
SX03F	8	4	4	**16**
SX04F	8	4	4	**16**
SX05F	8	4	4	**16**
SX06M	8	2	4	**14**
SX07M	8	1	2	**11**
SX08M	8	2	1	**11**
SX09M	8	3	4	**15**
SX10M	8	1	0	**9**
Averages	***8.0***	***2.9***	***3.1***	***14.0***
Total scores	**80**	**29**	**31**	**140**
Maximum possible	*80*	*40*	*40*	***160***

Table 16: Transfer Scoring (Towsey, 2006) for Adult Subjects

As a group, the adults subjects scored a full 8 out of a maximum possible 8 (100%) for the description of what the blocks have in common. Whereas their average score for transfer to the glasses was above two thirds (at 2.9 out of 4, or 72.5%), their transference to the candles was slightly above this (3.1 out of 4, or 77.5%). The total transference score for the group was 14.0 of a total possible 16 (87.5%).

In the transference exercise, six adult subjects (SX05F, SX06M, SX07M, SX08M, SX09M and SX10M) relied on remembering the positions of the groups of blocks on the board; SX01F and SX02F remembered the traits of the groups of blocks; and SX03F and SX04F used both the traits and the positions on the board. Further, SX10M used a mnemonic ("flick of the bic") to remember the *bik* glass, and was unable to transfer to the others or to any of the candles.

In the table below, all of the scoring times were taken after the subjects' attempts to resort the blocks. The time in minutes reflected here also did not include the time for transference, as the method of scoring for timing of Hanfmann and Kasanin (1937/42) was used consistently throughout the study.

The first immediately apparent observation about the total scores in the table below is the closer range in total score from 14 to 89. This closeness in range had more to do with the number of turned blocks, and not so much the time taken, because the subjects had demonstrably solved the problem of the blocks and didn't really need to turn them to confirm that their hypothesis was correct.

There did appear to be a trend between the Hanfmann and Kasanin scoring above and the supplementary scoring, where generally the rankings in both were fairly similar, and differed only in movement by one ranking up or one ranking down. For example, in the two cases of SX04F and SX06M, where these subjects had scored 2 in the category of formulation of the double dichotomy in the Hanfmann and Kasanin scoring above (and were also ranked 9th and 8th overall in that scoring), their scores in this supplementary scoring ranked them 10th and 9th overall: the clearest link here was also because they relied on the greatest number of blocks (9 and 1, and 9 and 2) of the group before

arriving at the correct solution. Further, in the cases of SX09M and SX07M, both were ranked highly in the Hanfmann and Kasanin scoring above (1st and 2nd), and in the supplementary scoring as 2nd and 1st: these subjects relied on the fewest number of blocks to be turned (3 and 1 respectively) and the time taken was also very short (13 and nine minutes). The subject SX03F was ranked 6th in both sets of scorings. The next three subjects (SX01F, SX02F and SX08M) ranked 4th, 7th and 3rd in the scoring above, and 5th, 8th and 4th in the supplementary scoring. The exception to this trend was the subject SX10M who was ranked 10th in the scoring above, and 7th in the supplementary scoring.

Subject's code	**Total score for all blocks (NX5+NX3 in 1st column) and No. of blocks turned 2nd + 3rd**			**Supplementary scoring**			**Total score (between 1 and 165)**
N=10	Total score for all blocks	No. incorrectly turned	No. correctly turned	Minutes	Incorrectly	Correctly	
SX01F	35	7	0	10	35	0	**45**
SX02F	38	7	1	43	35	3	**81**
SX03F	41	4	7	22	20	21	**63**
SX04F	48	9	1	41	45	3	**89**
SX05F	15	3	0	15	15	0	**30**
SX06M	51	9	2	31	45	6	**82**
SX07M	5	1	0	9	5	0	**14**
SX08M	28	5	1	14	25	3	**42**
SX09M	15	3	0	13	15	0	**28**
SX10M	40	8	0	26	40	0	**66**
Averages	***31.6***	***5.6***	***1.2***	***22.4***	***28.0***	***3.6***	***54.0***
Total scores	**316**	**56**	**12**	**224**	**280**	**36**	**540**
Maximum possible		*210*	*210*	*600*	*1050*	*630*	

Table 17: Supplementary Scoring (Hanfmann & Kasanin, 1937/42) for Adult Subjects

What is of great interest to me in this group's turning of the blocks was the averages of 5.6 and 1.2 of incorrectly and correctly placed blocks compared with that of the adolescent subjects (4.3 and 9.8 of incorrectly and correctly (or confirmatory) blocks) out of a possible 21. Although the adolescents, on average, relied on fewer incorrectly placed blocks or clues than did the adults, the adults relied on far fewer correctly placed blocks than did the adolescents. This difference in the case of correctly or confirmatory blocks between the adult and adolescent subjects was that the adults, without exception, had all demonstrably solved the problem of the blocks as the 'logical' solution and did not need to turn the blocks to confirm the correctness of their approach, whereas with the adolescent subjects, six of them did need to do so.

The shortest period of time for the adult subjects' engagement with the blocks was nine minutes and the greatest was 43 minutes, with an average of 22.4 minutes of a possible maximum of 60 minutes.