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AN ANALYSIS OF A TRANSLATION OF A SCIENTIFIC TEXT ACCORDING TO JULIANE HOUSE'S MODEL OF TRANSLATION ASSESSMENT

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A Translation Project Submitted to the Faculty of Arts, University of the Witwatersrand, Johannesburg in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Translation

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TO MY FAMILY

WITH LOVE

ABSTRACT

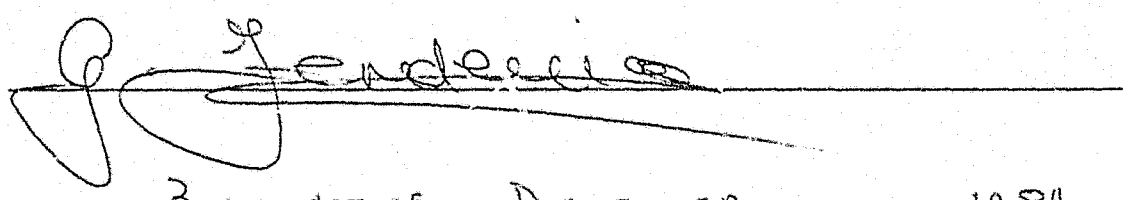
This translation project attempts to examine the applicability of Juliane House's theory for translation evaluation on a scientific text. To this end, an article on cellular biology taken from a scientific journal (Naturwissenschaften, Vol. 62, pp. 331-340) was translated by the author, and problems of a terminological and syntactic nature were examined. Although terminological and syntactic peculiarities seem to be related, a lot of emphasis was placed on the latter in an attempt to show that style does in fact play a role in the translation of scientific and technical texts. For the sake of clarity, the annotations to the translation were divided into two broad categories: annotations of a stylistic nature and annotations of a terminological nature. Furthermore, the annotations dealing with stylistic and syntactic peculiarities were divided into four subsections: additions, repetitions, syntactic changes and use of the impersonal.

In conclusion, it should be borne in mind that this translation project does not attempt to give a detailed analysis of Juliane House's theory for translation evaluation as the theory was used as a tool with which the translator may be made aware of certain problem areas (such as the determination of a text's 'area

of operation' and the description of the salient features to be found in a scientific or technical text).

DECLARATION

I declare that this research report is my own, unaided work. The report is submitted for the degree of Master of Arts (Translation), University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.



3RD day of DECEMBER, 1984

"The common assumption that scientific and technical writing is concerned only with facts ... is misplaced"

(Juliane House, 1977 p. 186)

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P R E F A C E

This translation project attempts to examine the applicability of Juliane House's translation evaluation theory to a scientific text. To this end, the author decided that the best criterion to use would be to apply this theory to a text which was translated by the author himself and the main aim of this translation project is to show, amongst other things, that style does play an important role in the translation of scientific and technical texts. Although a wide range of literature maintains that stylistic considerations are generally of a secondary importance in the translation of scientific texts, the author believes that style should play a fundamental role as it often defines to what extent the message is to be understood by the recipient. For example, Finch believes that "it is pedantic to suggest that a technical translation should possess literary elegancy" (C.A. Finch 1969). The author believes that comments like these should be re-examined in the light of Juliane House's theory for translation evaluation.

Throughout this translation project, it should be assumed that any problems involving a basic understanding of the source text (from a linguistic point of view) as well as any terminological problems were dealt with by the author by either seeking expert advice or consulting the relevant literature (mostly specialised text books and scientific dictionaries - refer to the

Bibliography.) Nevertheless, when problems of this kind were encountered, the author gave a detailed explanation of how he went about solving that specific problem in the footnotes to the translation. These footnotes have been numbered sequentially and as they exceed one hundred, the author deemed it fit to divide them into various headings and only discuss ten for each category in order to draw some general conclusions.

The source text was taken from a specialised biological publication written in German (Naturwissenschaften) which discusses issues relating to the biological and physical sciences. The text is entitled 'Struktur und Funktion des Endoplasmatischen Retikulums' and provides a detailed description of the functions of the endoplasmic reticulum (an organelle in the cell made of a system of folded membranes which plays an important role in the synthesis of excretory products) and some related structures (for example, microsomes). Although this article is highly specialised and very theoretical, it also describes a number of experiments carried out by the authors and the related findings and conclusions. Therefore, the function of the article exceeds the purely theoretical aspect usually ascribed to most scientific texts, as it also puts forward a number of more practical considerations.

Finally, due to the highly specialised nature of the source text, a number of scientific dictionaries and specialised textbooks and publications were used by the author (refer to the Bibliography). It was felt that in order to achieve a 'faithful' translation of the source text, a number of such extralinguistic sources had to be used so that the translator could gain insight into the subject matter.

INTRODUCTION

A wide range of literature has been written on the subject of scientific and technical translations, yet it seems that only a few authors, such as Juliane House for example, would accept the preface that style plays an important role in the translation of such texts. As is the case with any other genre of writing (the most obvious being literature), scientific texts cover a wide spectrum which ranges from childrens' primers of basic scientific principles to extremely advanced and specialised reports geared for the university professor or researcher. It would therefore, now be logical to accept that not all scientific and technical texts fall under the same category and that their style varies according to the information they contain and the person for which they were originally intended. Isadore Pinchuck provides a categorisation of scientific and technical texts which seem to be appropriate for the scope of this translation project. According to him, there are three broad categories according to which such texts may be classified:

1. Texts dealing with pure science

   These texts only provide theoretical scientific information and do not deal with any practical considerations or applications. The language used in these texts is usually very specific (mainly terminology) and the author will always presume that the recipient has a level of education which

is above average. From the translating point of view, the difficulties encountered in these texts are usually of a terminological nature and it will often be necessary that the translator acquaint himself with the subject matter before attempting a translation.

2. Texts dealing with applied scientific research

In this case, a problem is usually described by the authors, and scientific research is often undertaken with the aim of providing a practical solution. The language used in these texts is also very specialised and will require a good understanding of the subject matter from the translator. From the translator's point of view, these texts are usually slightly easier to translate as involved terminology will only be used in so far as it provides a basic outline of the problem under discussion.

3. Technological texts

These texts have wide practical applications in the field of marketing, industry and medicine. The register employed in texts of this kind is lower than that used in the previous two categories as they are clearly geared to a different audience. Due to their strong practical orientation, mechanics and technicians will be more likely to read these

texts than, say, academic professors or researchers. Furthermore, where the previous category of texts would mainly include textbooks and scientific publications, this last category would include maintenance and instruction manuals. Therefore, the language used in this last category is of a 'workshop' nature, which clearly differs from the 'purely scientific' language used in the other categories. The terminology used in these texts does not usually pose a problem for the translator although ideally the translator should know about the kind of equipment described in the article as this would make any possible translations of, say, instructions for use, much easier to translate.

The text analysed in this translation project falls into the second category as it seems to combine theoretical issues with empirical considerations. Although a number of experiments undertaken by the authors are described, the language is strictly scientific and there are no signs of 'familiarity' between the author and the reader. Moreover, the text also describes, at length, the structure and function of the endoplasmic reticulum and therefore contains a lot of information which is purely of a theoretical nature. In the light of this, the author felt that both stylistic and terminological considerations had to be considered if an ade-

quate translation was to be achieved. However, the author discovered that pure problems of terminology were not very difficult to solve and that stylistic considerations were much more important in the translation of the text. This may be due to the fact that problems of a terminological nature are very easy to detect, as there is no doubt that any conscientious translator will acquaint himself with the subject matter discussed in the text before attempting a translation. Furthermore, there are usually a number of good technical and scientific dictionaries (see Bibliography) which the translator has at his disposal, particularly in the language combination German-English. It should however, be borne in mind that such semantic considerations should not be underplayed as the informative function of a scientific text is probably still one of its most important characteristics. However, stylistic notions are often overlooked and this often makes the text difficult to read and understand. The degree of comprehensiveness of any scientific text is usually low if the reader has no knowledge of the subject matter, and unless a 'good and flowing' style is used, the translated text will become even more difficult to understand. It is difficult to define what is meant by style let alone 'good style', but for the purposes of this translation project, the definition provided by Abrams should be taken into consideration: "style is the manner of linguistic expression

in prose or verse - it is how a speaker or writer says whatever he says. The characteristic style of a work or a writer may be analysed in terms of its diction, or characteristic choice of word; its sentence structure and syntax; the density and types of its figurative language; the patterns of its rhythm and of its component sounds; and its theoretical aims and devices." (M.H. Abrams 1957)

As far as scientific and technical translations are concerned, the following points should be borne in mind:

1. The translation should read clearly and the unnecessary use of high register words should be avoided at all costs.

2. The arguments in the translation should follow a logical order. This may often require the translator to use his discretion as it may often be necessary to change the sentence structure (the most typical examples include sentence splitting and sentence joining), however, as will be seen in the section on Annotations, whole sentences were sometimes changed in order to convey a clearer meaning.

3. Particular attention should be paid to the semantic range used in the source text. Whenever possible, the same register should be used and it is therefore important for the translator to know for what type of audience the text is geared (i.e. manual, research report, etc.).

Although these points may seem obvious, it often happens that a scientific or technical text does not follow these simple rules simply because the author considers them unimportant. One of the aims of this translation project is to show that unless a good style is used in the translation, the meaning will become very difficult to grasp, even in the case of somebody who has sufficient knowledge in the field of biology.

The author feels that Juliane House's theory for translation evaluation is particularly well suited to highlight these problem areas and to provide the translator with a means through which he may become aware of these shortcomings.

In conclusion, problems encountered during the process of translating were divided into two broad categories for the sake of clarity - stylistic and terminological

(including lexical and semantic). Problems of a purely syntactic nature have not been analysed in depth as they were considered beyond the scope of this translation project. However, where the different grammatical constructions of English and German did influence the style and the understanding of the text, then a few comments will be spent on them.

S O U R C E T E X T

STRUKTUR AND FUNKTION DES ENDOPLASMATISCHEN RETIKULUMS

Endoplasmatisches Retikulum und Mikrosomen

Im elektronenoptischen Bild(1) einer Leberzelle, aber auch von anderen Parenchymzellen sieht man Doppel-membranen, die die Zelle von der Kernmembran bis zur Plasmamembran durchziehen(2). Sie(3) grenzen ein 'Lumen' vom cytoplasmatischen Raum ab. Dieses Membransystem ist in der Nähe des Kernes(4) dicht mit Ribosomen besetzt (rauhes endoplasmatisches Retikulum(5) oder auch Ergastoplasma). Nach der Peripherie zu sind die Membranen frei von Ribosomen (glattes endoplasmatisches Retikulum)(6). Ein dreidimensionales Modell, das nach den elektronenoptischen Befunden entworfen wurde, lässt erkennen, dass dieses System aus verzweigten und vernetzten Schläuchen besteht, die die ganze Zelle durchziehen.

Schon(7) 1938 hat Claude beschrieben(8) dass er nach Homogenisieren von Zellen und anschliessender Differentialzentrifugation(9) eine unbekannte Zellfraktion isolieren konnte, die er wegen der Kleinheit der darin vorkommenden Partikeln 'Mikrosomen' nannte. Durch die Untersuchungen(10) von Palade und Siekevitz wurde 1956 klar, dass diese Mikrosomenfraktion aus dem endoplasmatischen Retikulum stammt. Das Retikulum wird beim Homogenisieren der Zellen zerstört(11). Es bilden sich kleine, elektronenmikroskopisch nachweisbare Bläs-

chen(12), die durch Zentrifugieren isoliert werden können. Diese Bläschen sind die Mikrosomen. Es handelt sich also um Kunstprodukte(13).Die Grösse der Mikrosomen ist abhängig von den Präparationsbedingungen. Unter den üblichen Bedingungen erhält man Teilchen mit einem mittleren Durchmesser von 200nm (Original-Mikrosomen)(14). Die Mikrosomen sind biochemisch(15) das Aquivalent für das endoplasmatische Retikulum, und alle Untersuchungen über Struktur und Funktion des endoplasmatischen Retikulums wurden an solchen Mikrosomen durchgeführt.

Bevor auf die chemischen und enzymologischen Untersuchungen der Mikrosomenfraktion eingegagen wird, sei noch darauf hingewiesen, dass das endoplasmatische Retikulum wie alle Zellorganellen einem ständigen Auf-und-Abbau(16) unterliegt. Der 'turn over', d.h. die Halbwertszeit des Retikulums, ist relativ kurz. Für verschiedene Enzyme, die im Retikulum vorkommen, ist sie verschieden. Sie kann zwischen 22Std und 110Std(17) schwanken. Das Retikulum wird, so vermuteten schon Palade und Siekevitz, ständig in den zellkernnahen Abschnitten, die die Ribosomen enthalten, neu synthetisiert(18). Es wächst gewissermassen vom Zellinnern nach der Zellperipherie(19) zu ständig neu(20). Wahrscheinlich ist der Golgi-Apparat ein Derivat des endoplasmatischen Retikulums. Der Golgi-Apparat selbst schleust sein eigenes Membransystem und die darin enthaltenen Sub-

stanzen durch Sekretion (eine umgekehrte Pinocytose(21) (Exocytose)) aus der Zelle aus. Das Membransystem des Golgi-Apparates wird dabei vermutlich zum Membransystem der Plasmazelle umgewandelt. Die Geschwindigkeit, mit der das endoplasmatische Retikulum auf- und abgebaut wird, ist variable. Sie kann z.B. durch Pharmaka beeinflusst werden. Wie Conney und Remmer zeigen konnten, wird die Biosynthese des endoplasmatischen Retikulums und einiger dort lokalisierter Enzyme durch Barbiturate, aber auch durch viele andere Pharmaka beschleunigt. Man sieht nach Barbituratgaben in der Leber der behandelten Tiere ein viel dichteres Retikulum; vor allem die peripher gelegenen Teile, also die ribosomenfreien glatten Membranen, sind vermehrt.

Chemische Zusammensetzung der Mikrosomenfraktion(22)

Die 'chemische' Zusammensetzung der Mikrosomenfraktion bietet nicht viele Anhaltspunkte, die Rückschlüsse auf ihre Funktion erlauben(23). Die Mikrosomen enthalten Lipide, Proteine und Nucleinsäuren. Die Nucleinsäuren kommen im wesentlichen, wenn auch nicht ausschliesslich, in den begleitenden Ribosomen vor. Diese gehören nicht eigentlich zur Struktur der Mikrosomen(24). An den Ribosomen, die etwa 10-15nm Durchmesser haben, findet die Proteinbiosynthese der Zelle statt(25). Diese Vorgänge sind weitgehend aufgeklärt, sie betreffen aber ein anderes Gebiet der Biochemie, das hier aus-

gespart werden soll. 80-85% der Gesamtlipide(26) sind Phosphatide, ca. 10% Cholesterin, ca. 5% Triacylglycerine und etwa 1% Cholesterinester und freie Fettsäuren. Die Phospholipoide bestehen aus Phosphatidylcholin (≈55%), Phosphatidyläthanolamin (≈22%), Phosphatidylinositol (≈9%) und Phosphatidylserin (≈7%). Ferner sind Sphingomyelin (5%) sowie Lysophosphatide und Phosphatidsäuren (≈2%) gefunden worden. Die an dem Aufbau der Phospholipoide beteiligten Fettsäuren sind: Palmitinsäure (16:0), Palmitoleinsäure (16:1), Stearinsäure (18:0), Oleinsäure (18:1), Linolsäure (18:2), Arachidonsäure (20:4) und Dokasahexaensäure (22:6). Ähnliche Zusammensetzungen haben alle bisher untersuchten Membranen(27). Die in den Mikrosomen vorkommenden Proteine sind z.T. in der Membran fest verankert, z.T. nur lose an die Membran adsorbiert. Zu den Letzteren gehören die exkretorischen Proteine im(28) Lumen des endoplasmatischen Retikulums. Die in der Membranstruktur fest verankerten Proteine sind für die Funktion der Mikrosomen des endoplasmatischen Retikulums von besonderer Bedeutung(29).

Enzyme der Mikrosomen

Im Jahre 1962 hatten wir zum ersten Mal einen Überblick mit etwa 300 Literaturstellen über die Funktion der Mikrosomen gegeben. In der beigefügten Tabelle waren etwa 35 verschiedene Enzymaktivatäten aufgeführt(30).

Heute(31) ist die Literatur über die Enzyme der Mikrosomen mindestens hundertmal umfangreicher(32). Etwa 50 verschiedene Enzymaktivatäten sind bekannt. Die wichtigsten durch Enzyme katalysierten biochemischen Leistungen sind in Tabelle 1 aufgeführt(33). In der erwähnten Zusammenfassung wurden schon die wesentlichen Funktionen der Mikrosomen dargestellt. Die heutigen Kenntnisse sind zwar viel detaillierter, aber nicht prinzipiell anders geworden(34). Über die wichtigen Funktionen des endoplasmatischen Retikulums, wie die mischfunktionelle Oxygenierung, die Fettsäuredesaturierung, den Steroidstoffwechsel, den Elektronentransport usw., findet man in der Literatur gute Darstellungen (35).

Topologie mikrosomaler Enzyme im endoplasmatischen Retikulum

Wenn man sich das elektronenoptische Bild des endoplasmatischen Retikulums vor Augen führt, so ergibt sich die Frage, ob die enzymatische Ausstattung des Membransystems in den kernnahen rauhen und den kernfernen glatten Abschnitten verschieden ist(36). Wenn das Membransystem in der ganzen Zelle gleichmässig aufgebaut wäre, müsste man Mikrosomen erhalten, die im Mittel gleichartig zusammengesetzt sind und deshalb nicht in Fraktionen mit verschiedener enzymatischer Ausstattung getrennt werden können(37). Enthält aber das Membransystem kernnah und kernfern verschiedene Enzyme,

wie gelegentlich behauptet worden ist, so müsste man auch Mikrosomen verschiedener enzymatischer Aktivität gewinnen können. Über die 'Heterogenität' oder 'Homogenität' ist viel Widersprüchliches in der Literatur publiziert worden(38). Einige Forscher nehmen an, dass die 'rauhen' Mikrosomen sich enzymatisch von den 'glatten' Mikrosomen unterscheiden lassen(39). Andere finden, dass die beiden Mikrosomenfraktionen enzymologisch identisch sind. Wieder andere fanden, dass sowohl die Fraktionen der rauhen als auch die der glatten Mikrosomen in Unterfraktionen getrennt werden können. Da die Frage von theoretischer Bedeutung für die Beurteilung der Funktion des endoplasmatischen Retikulums in der Zelle ist, haben wir sie seit einigen Jahren mit verschiedenen Methoden untersucht(40).

Um die theoretische und experimentelle Grundlage unserer Untersuchungen zu erläutern, sei zunächst auf Tabelle 2 hingewiesen(41). Dort ist angegeben, wie aus der Grösse der Mikrosomen und aus der morphometrisch bestimmten(42) Gesamtoberfläche des endoplasmatischen Retikulums errechnet werden kann, wieviel einzelne Mikrosomen pro mg Protein der Mikrosomenfraktion vorkommen (etwa 5×10^2 Mikrosomen pro mg Protein). In der Tabelle sind fünf gut untersuchte, zum teil gereinigte Enzyme aufgeführt, aus deren Umsatzzahl und spezifischer Aktivität in den Mikrosomen ihre Konzentration in dem Mikrosomen-

protein bestimmt werden kann(43). (Bei den Cytochromen kann die molare Extinktion zur Grundlage dieser Berechnung gewählt werden.) Aus dieser Rechnung ergibt sich die molekulare Konzentration der Enzyme pro mg Mikrosomenprotein. Da die Zahl der Mikrosomen pro mg Protein bekannt ist, kann man errechnen, dass jedes Original-Mikrosom mindestens 5, im allgemeinen mehr Moleküle eines Enzymproteins enthält(44). Dieser Befund ist als Voraussetzung für die weiteren Überlegungen(45) wichtig. Wenn nämlich weniger als durchschnittlich ein Proteinmolekül eines bestimmten Enzyms pro Einzelmikrosom gefunden worden wäre, so müsste man mit dem Vorkommen von Mikrosomen mit verschiedener enzymatischer Ausstattung rechnen(46). Da aber jeweils mehrere Moleküle einer Enzymspezies pro Mikrosom vorkommen, kann man bei der Annahme einer gleichmässigen Verteilung auf dem endoplasmatischen Retikulum erwarten, dass alle Mikrosomen im Durchschnitt die gleiche Enzymausstattung haben.

Einheitlichkeit der Mikrosomenfraktion

Zwei extreme Annahmen sind möglich:

1. Alle Enzyme sind gleichmässig über das gesamte Retikulum verteilt.

2. Das endoplasmatische Retikulum enthält grössere Abschnitte (z.B. glattes und rauhes Retikulum), in denen bestimmte Enzyme vorwiegend oder ausschliesslich vorkommen.

Mikrosomen, die aus dem endoplasmatischen Retikulum hergestellt worden müssten im ersten Fall die gleiche Zussammensetzung haben, d.h. alle vorkommenden Enzyme müssten sich mehr oder minder gleichmässig auf allen Mikrosomen wiederfinden. In zweiten Fall müsste man Mikrosomenfraktionen mit verschiedener enzymatischer Zussammensetzung isolieren können(47).

Diese theoretische Voraussage haben wir experimentell geprüft(48). Wenn die Mikrosomen verschiedene Enzyme tragen, müssten sie sich durch physikalische Mittel trennen lassen. Eine geeignete Methode zur Trennung sehr kleiner Partikel verschiedener Zusammensetzung ist die Zonenzentrifugation. Wir konnten mit der Zonenzentrifugation Zellpartikel verschiedener enzymatischer Zussammensetzung trennen. Die obere Hälfte von Fig. 3 zeigt die Trennung einer durch Differentialzentrifugation bei 100 000g gewonnenen Fraktion eines Leberzellhomogenats in Plasmamenbranen, Mikrosomen und 'Mitochondnentrümmer'. Die Zuordnung der Fraktionen zu bestimmten Zellorganellen ist mit Leitenzymen möglich. (Plas-

mamembranen wurden durch die 5'- Nucleotidase, Mikrosomen durch die Glucose-6-phosphatase, Mitochondrientrümmer durch die Succinatdehydrogenase charakterisiert.)(49)

Wird nun die Mikrosomenfraktion eines Leberzellhomogenates der Zonenzentrifugation unterworfen und werden verschiedene typische mikrosomale Enzyme in den anfallenden Fraktionen untersucht, so findet man die in der unteren Hälfte von Fig. 3 wiedergegebenen Kurven(50). Sie zeigen alle etwa den gleichen Verlauf(51). Das Maximum aller untersuchten Enzymaktivitäten findet sich in der gleichen Fraktion (mit Ausnahme eines offensichtlich 'nicht mikrosomalen' Enzyms). Die Verteilung der untersuchten Enzymaktivitäten über die verschiedenen Fraktionen, die bei der Zonenzentrifugation anfallen, ist also gleich. Das heisst aber dass die Mikrosomen, die sich in den verschiedenen Fraktionen nach ihrer Grösse und nach ihrem spezifischen Gewicht ordnen, etwa gleiche enzymatische Zusammensetzung haben. Die Enzyme verteilen sich also gleichmässig über das gesamte endoplasmatische Retikulum.

Subfraktionierung sehr kleiner Mikrosomen

Man könnte nun einwenden, dass die Zonenzentrifugation nicht die richtige Methode zur Trennung der Mikrosomenunterfraktionen ist. Um diesem Einwand zu begegnen,

haben wir weitere Versuche gemacht(52). Wir hatten(53) wie erwähnt, berechnet, dass pro Original-Mikrosom mindestens 5 Moleküle eines Enzyms vorkommen. Bei weiterer Zerkleinerung müssen die Mikrosomen einmal so klein werden, dass ihre Zahl gröser als die Zahl der Moleküle einer Enzymspezies wird. Nicht jedes Enzym kann also wie zuvor im Mittel in allen Mikrosomen gefunden werden(54). Sehr kleine Mikrosomen sollten danach verschiedene enzymatische Zusammensetzung haben. Das Experiment bestätigt die Richtigkeit dieser Annahme. Fig. 5 zeigt das Verhalten von durch Ultraschall(55) zerkleinerten Mikrosomen bei der Zonenzentrifugation. Maximale Aktivitäten der verschiedenen mikrosomalen Enzyme finden sich nicht mehr wie in Fig. 3 in einer Fraktion vereinigt, sondern sie dissoziieren auf verschiedene Zonen. Mikrosomen mit verschiedener enzymatischer Ausstattung lassen sich also durch Zonenzentrifugation trennen. Auch die Voraussage, die sich aus den Rechnunngen ergeben hat, ist experimentell verifiziert worden. Sehr kleine Mikrosomen lassen sich in Populationen mit verschiedenen Enzymen trennen, da die Anzahl der insgesamt vorhandenen Enzymmoleküle nich ausreicht, um sich gleichmässig auf alle Mikrosomen zu verteilen.

Behandelt man die Mikrosomen kürzere Zeit als bei dem eben beschriebenen Experiment mit Ultraschall(56), so

entstehen weniger zerkleinerte Teilchen. Man findet dann noch einige Enzymaktivitäten in einer Population vereinigt, während andere schon getrennt sind(57). Bemerkenswert ist, dass Enzyme, die eine gemeinsame Funktion haben, z.B. NADH : Ferricytochrom-b_5-Oxidoreduktase und Cytochrom b_5 oder NADPH : Ferricytochrom-P-450-Oxidoreduktase und Cytochrom P-450, in Versuchen mit nur geringfügig zerkleinerten Mikrosomen noch in einer Fraktion gefunden werden, während andere Enzyme, z.B. Glucose-6-phosphatase, bereits in einer anderen Fraktion gefunden werden. Erst nach der intensiven Ultraschallbehandlung gelingt es, auch die funktionell zusammengehörenden Enzyme voneinander zu trennen; sie liegen also auch in der Membran nahe zusammen. Man kann so eine Vorstellung über die räumliche Anordnung der Enzyme zueinander gewinnen, eine Art 'Enzymkarte' der Mikrosomen entwerfen.

Die durch Zonenzentrifugation gewonnenen Befunde, dass die Original-Mikrosomen mit einem Durchmesser von etwa 200nm alle Enzyme in gleicher Weise enthalten, kleine Mikrosomen sich aber in Populationen mit unterschiedlichen Enzymaktivitäten(58) trennen lassen, wurden noch mit anderen Methoden, z.B. immunologisch, bestätigt.

Molekulare Architektur der endoplasmatischen Membranen

Es gibt verschiedene Vorstellungen, wie die Ultrastruktur einer solchen Membran, die aus Lipiden und Proteinen aufgebaut ist, aussieht. Ein Modell wurde schon 1935 von Danielli und Davson vorgeschlagen. Es wurde später von Robertson modifiziert(59). Danach(60) bestehen biologische Membranen aus einer bimolekularen Lipidschicht, die beiderseits mit Proteinen besetzt ist. Die hydrophoben Teile beider Lipidlamellen sind in der Doppelschicht einander zugekehrt, die hydrophilen Teile, die Phosphatgruppen und die Basen zeigen nach aussen. An diese sind in einer weiteren Schicht die Proteine durch salzartige Bindungen angelagert. In einem anderen Modell wird keine durchgehende Lipiddoppelschicht angenommen. Proteine und Lipide bilden gemeinsam die Membran, die Lipidmizellen liegen inselartig zwischen den Proteinen. Für beide Modelle finden sich bei natürlichen Membranen Beispiele. Wir haben uns gefragt(61) welches Modell für die Mikrosomen zutreffend ist. Zur Beantwortung(62) haben wir den Flächenbedarf der in den Mikrosomen vorkommenden Phospatide und Proteine aufgrund des bekannten Flächenbedarfs der einzelnen Molekül-Reste berechnet und auf jeweils 1mg Mikrosomenprotein bezogen. Diese Berechnungen ergeben, dass die gesamten Lipide des endoplasmatischen Retikulums als Doppellamelle eine Fläche von ungefähr $0,2m^2$ einnehmen würden. Die gesamten Proteine nehmen im endo-

plasmatischen Retikulum eine Gesamtfläche von 0,3m² ein. Die Gesamtoberfläche des endoplasmatischen Retikulums beträgt aber 0,63m². Es kann also keine homogene Schicht von Lipiden und Proteinen vorliegen, sondern Proteininseln und Lipidinseln müssen gemeinsam die mikrosomale Membran bilden(63).

Membrangebundene Enzyme

Membrangebundene Enzyme können nicht als aktive reine Proteine isoliert werden. Sie benötigen, um enzymatisch aktiv zu sein, die Gegenwart von Lipiden(64). Die Lipidabhängigkeit ist für mehrere in Membranen vorkommende Enzyme genauer untersucht worden. Nach (.,) sind nicht alle Enzymproteine in die Membran. eingebaut. Sie liegen z.T. mehr auf der Oberfläche auf(65). Diese Enzyme lassen sich leicht solubilisieren und als reine Proteine gewinnen (z.B. Carboxylesterase). Die Enzymproteine jedoch, die für den Aufbau der Membran selbst konstitutiv sind, sind sehr schwer zu solubilisieren. Man kann sie nur als grössere Lipidkomplexe, die noch immer mizellaren Charakter(66) haben, gewinnen. Werden diese Proteinlipidkomplexe weiter gereinigt, indem das Lipid vom Protein abgetrennt wird, so werden diese Enzyme inaktiv. Das(67) wurde an der Glucose-6-phosphatase, aber auch an anderen Enzymen genauer untersucht. Bei einer enzymatischen Hydrolyse der Phospholipoide inaktivieren Glucose-6-phosphatase oder NADH : Semide-

hydroascorbat-Oxidoreduktase mit der gleichen Kinetik(68) mit der die Phospholipoide gespalten werden. Man kann die Lipide auch mit organischen Lösungsmitteln extrahieren. Lipidgehalt und Aktivität sind eng korreliert.

Die inaktivierten lipidfreien Mikrosomen können durch Zugabe von Lipiden reaktiviert werden. In Fig. 6 ist dargestellt, dass die durch Extraktion der Lipide inaktivierte NADH : Semidehydroascorbat-Oxidoreduktase durch Zugabe von Asolectin, einem Gemisch von Phospholipiden aus Sojabohnen, reaktiviert wurde. Werden statt des Lipidgemisches sehr reine isolierte Phospholipoide, z.B. Phosphatidylcholin (Lecithin), zu den extrahierten Mikrosomen gegeben, so lässt sich die enzymatische Aktivität nicht wieder herstellen. Fügt man hingegen ausserdem wenig Lysolecithin zu, so können die extrahierten Mikrosomen vollständig reaktiviert werden. Lysolecithin ist ein Detergens(69). Die Reaktivierung von extrahierten Mikrosomen gelingt auch mit einigen synthetischen Detergentien (Tritonreihe).

Fügt man den nicht extrahierten Original-Mikrosomen Spuren von Detergens zu, so wird deren enzymatische Aktivität noch gesteigert. Wird die Konzentration an Detergens allerdings erhöht, so sinkt die Aktivität der membrangebundenen Enzyme sehr schnell bis auf nahezu

Null ab. Man kann auch optisch verfolgen(70), wie in Gegenwart der höheren, bereits hemmenden Mengen von Detergens sich die Membranen auflösen. Die ursprünglich trübe Mikrosomensuspension klärt sich mit der gleichen Abhängigkeit von der Detergenskonzentration wie die Enzyme inaktiviert werden(71). Es ist schwierig, das verwendete hochmolekulare neutrale Detergens wieder aus den Versuchsansätzen zu entfernen. Wir haben versucht, die durch Detergentien inaktivierten Mikrosomensuspensionen zu reaktivieren, indem wir andere, enzymatisch inaktive, Membranstrukturen zu setzten(72). Dadurch wird das Verhältnis Lipoprotein: Detergens zugunsten des Lipoproteins verschoben, die freie Detergenskonzentration nimmt ab. Zur Vergegenwärtigung dieser Versuche müssen in Fig. 7 die Kurven 2 und 3 von rechts nach links gelesen werden. Entweder binden die inaktiven Membranstrukturen das Detergens oder sie stellen eine mizellare Matrix für gelöste Enzymproteine dar. Die enzymatische Aktivität steigt steil an, sogar über die Werte der Original-Mikrosomen(73). Zugabe von Rinderserumalbumin (RSA) oder β-Globulin führt nicht zu einer Reaktivierung. Es müssen 'Membranen' zugefügt werden(74). Um die Deutung dieser schwierigen Experimente anschaulich zu machen, sei auf Fig. 8 verwiesen(75). Die Enzyme, die in einer geordneten mizellaren Membranstruktur vorliegen, verklumpen nach Entfernen der Phospholipide zu unstrukturierten Knäueln, weil ihre hydrophoben Reste mitein-

ander in Wechselwirkung treten(76). Das kann man an einer zunehmenden Trübung erkennen. Die aktiven Seiten der Enzyme ragen möglicherweise nicht mehr nach aussen. Sie sind inaktiv. Durch Ultraschall kann ein solches Knäuel von Proteinmolikülen zerkleinert werden.Wenn(77) die Proteine eine unveränderte Konformation behalten haben, müssen sie ihre Aktivität wiedergewinnen, nachdem sie aus dem Knäuel freigelegt worden sind. Das trifft zu für die Enzyme, die äusserlich an der Membran hängen(78), z.B. NADH : Ferricytochrom-b_5 -Oxidoreduktase. Dieses Enzym ist inaktiv nach der Extraktion der Lipide aus den Mikrosomen, durch Ultraschall alleine, ohne Zusatz von Phospholipiden, wird es wieder aktiv(79). Anders(80) bei den membrangebundenen Enzymen, z.B. der NADH : Semidehydroascorbat-Oxidoreduktase. Durch Ultraschallbehandlung alleine kann dieses Enzym, nachdem es durch Extraktion der Lipide aus den Mikrosomen inaktiviert wurde, nicht reaktiviert werden(81). Es wird erst wieder aktiv, wenn die verklumpten Enzymknäuel mit Ultraschall in Gegenwart von Phosphatiden oder geringen Mengen von anderen oberflächenaktiven Substanzen behandelt werden.

Alle Ergebnisse lassen sich zu folgender Hypothese zusammenfassen: Enzyme, die in einer Membranstruktur integral gebunden sind, sind nur dann aktiv, wenn im Verbund einer mizellaren Lipidproteinstruktur die kataly-

tisch wirksame Konformation erhalten bleibt.

Solche von der Mizellarstruktur der Membran abhängigen Enzyme gibt es auch in Mitochondrien und Plasmamembranen. Sie haben etwas mit gerichteten Stoffwechselprozessen(82) zu tun. Es handelt sich um 'vektorielle' Enzyme. Sie haben die Aufgabe, Ionen oder ungeladerne Moleküle in einer Richtung durch die Membran zu translokieren. Da biologische Membranen Diffusionsbarrieren sind, werden als Folge dieser vektoriellen Katalysen Konzentrationsgradienten zwischen den beiden von der Membran getrennten Kompartimenten aufgebaut(83).

Das lamelläre und tabuläre Membransystem des endoplasmatischen Retikulums trennt ebenfalls verschiedene Kompartimente voneinander(84). Es ist daher naheliegend anzunehmen, dass die von einer Membranstruktur abhängigen nur als Proteinlipidkomplexe isolierbaren Enzyme des endoplasmatischen Retikulums vektorielle Enzyme sind(85). Diese Annahme ist hypotetisch. Sie bedarf noch der experimentellen Bestätigung(86). Bevor aber auf die Bedeutung von vektoriellen Enzymen für das Verständnis der Funktion des endoplasmatischen Retikulums eingegangen wird, sollen noch einige andere allgemeine Hinweise auf die Enzymaktivitäten der Mikrosomen gegeben werden(87).

Funktion des endoplasmatischen Retikulums

Bisher sind aus dem endoplasmatischen Retikulum vier Enzyme rein dargestellt worden, so dass man ihr Molekulargewicht messen kann. Für ein fünftes Enzym, Cytochrom P-450, kann das Molekulargewicht aus Vergleich mit einem bakteriellen Enzym abgeschätzt werden. Die Konzentration dieser fünf Enzyme in Mikrosomen kann somit errechnet werden(88). Sie beträgt etwa 8-10% des gesamten Enzymproteins in Mikrosomen. Insgesamt wurden etwa 50 verschiedene Enzymaktivitäten in Mikrosomen gefunden. Sollte ihre molekulare Konzentration in den Mikrosomen etwa gleich der der fünf bekannten sein, müssten sie das gesamte mikrosomale Protein ausmachen(89). Wenn diese Rechnung auch noch sehr grob ist, kann man doch daraus folgern, dass die bekannten und beschriebenen Enzymaktivitäten vermutlich auch die 'gesamte mikrosomale Funktion' darstellen.

Hier kann nicht auf die Bedeutung aller 50 Enzymaktivitäten der Mikrosomen eingegangen werden(90). Man kann sich aber fragen, wie sie in eine gesamte Zellfunktion einzuordnen sind(91). Macht man sich klar, dass das endoplasmatische Retikulum ein Schlauchsystem ist, das die ganze Zelle durchzieht, so ergibt sich die mögliche Antwort(92). Schläuche und Schlauchsysteme dienen dem Stofftransport. Also dient wohl auch das endoplasmatische Retikulum dem intrazellulären Stoff-

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transport(93). Ein Hinweis für eine solche Funktion des endoplasmatischen Retikulums ergibt sich aus der Abhängigkeit der Enzymaktivitäten von einer Membranstruktur(94). Daraus wurde geschlossen, dass die in der Membran lokalisierten Enzyme vektorielle Enzyme sein konnten und die Substrate aus dem cytoplasmatischen Raum aufnehmen, die Reaktionsprodukte aber ins Lumen der Schläuche abgeben. Von dort werden sie nach aussen in den extrazellulären Raum transportiert.

Dies wurde schon für einige hochmolekulare Exkretionsprodukte der Zelle bewiesen. In den an den Mikrosomen haftenden Ribosomen werden Proteine synthetisiert. Sie sind für jedes Organ spezifisch(95). Zum Beispiel entstehen die Verdauungsenzyme im Pankreas, die Globuline und die Albumine des Blutserums ins der Leber. Es konnte nun gezeigt werden, dass die durch die Ribosomen an der cytoplasmatischen Seite der Membran synthetisierten Proteine im Inneren des Lumens wandern, zum Golgi-Apparat transportiert und von dort durch 'Exocytose' nach aussen in das Blut abgegeben werden. Diese Art des Transportes konnte besonders gut für die Glykoproteine nachgewiesen werden. Das Proteinskelett selbst, das an den Ribosomen im rauhen Teil des endoplasmatischen Retikulums entsteht, wandert als 'nacktes' Protein im Inneren des endoplasmatischen Retikulums. Dabei werden nacheinander die verschiedenen Zuckerreste an

das Protein gehängt. Die Reihenfolge, mit der die Zuckerreste auf das Glykoprotein durch spezifische Transferasen im endoplasmatischen Retikulum übertragen werden, konnte festgestellt werden(96). Zuletzt wird auf das wandernde Glykoprotein der Sialinsäurerest übertragen, und zwar ganz in der Peripherie des Retikulums, schon im Golgi-Aparat.

Im Gegensatz zu den gut belegten Anschauungen über den Transport makromolekularer Stoffe im endoplasmatischen Retikulum ist über den Mechanismus der Exkretion von niedermolekularen Stoffen noch wenig bekannt. Es konnte bisher nicht bewiesen werden, dass kleine Moleküle ebenso wie Makromoleküle im endoplasmatischen Retikulum transportiert werden. Dennoch spricht viel dafür, dass z.B. auch die Glucose-6-phosphatase ein vektorielles Enzym ist und dass das endoplasmatische Retikulum zum Transport der durch die Spaltung von Glucose-6-phosphat freigesetzten Glucose dient(97).

Die Glucose-6-phosphatase der Leber und der Niere hat die Funktion, den Organismus mit freier Glucose zu versorgen. Sie(98) kan induziert werden, z.B. ist sie bei diabetischen Stoffwechsellagen oder im Hunger vermehrt. Die Glucose-6-phosphatase gehört aber auch zu den Enzymen, die nur im Verbund mit einer Membran-

struktur aktiv sind. Das spricht dafür, dass sie auch ein vektorielles Enzym ist(99). Die Annahme ist somit naheliegend, dass die Glucose, die aus dem Glucose-6-phosphat des Cytoplasmas durch die Wirkung der Glucose-6-phosphatase in der Membran entsteht, im Lumen des endoplasmatischen Retikulums nach aussen(100) befördert wird. Würde nämlich die Glucose-6-phosphatase die freigesetzte Glucose nich in das Lumen, sondern zurück in das Cytoplasma abgeben, so würde die freie Glucose dort von der Hexokinase und dem ATP rephosphoryliert(101). Die freie Glucose kann also nur über das endoplasmatische Retikulum ins Blut abgegeben werden. Ergänzend wäre anzumerken, dass zwar Transportmechanismen bekannt sind, die freie Glucose aus dem extrazellulären Raum in das Cytoplasma transportieren, dass aber der umgekehrte Transport durch die Plasmamembran von innen nach aussen bisher nicht beobachtet wurde(102). Somit ist die Annahme, dass das endoplasmatische Retikulum dem Glucosetransport vom Zellinnern nach dem Zelläussern dient, nich unbegründet.

Ahnliche Annahmen können für den Transport der Stoffwechselprodukte von Fremdstoffen gemacht werden. Pharmaka, die als lipidlösliche Substanzen durch die Zellmembran aufgenommen werden, werden im endoplasmatischen Retikulum durch das Cytochrom P-450 hydroxyliert und dann durch die Uridyltransferasen mit Glucuronsäure(103)

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glykosidiert. (Auch die Veresterung mit Schwefelsäure ist bekannt.) Diese wasserlöslichen Glucuronide der hydroxylierten Fremdstoffe (z.B. Arzneimittel) werden dann entweder ins Blut oder in die Galle abgegeben. Auch hier ist es sinnvoll anzunehmen, dass dieser Transport der Stoffwechselprodukte von Pharmaka und Fremdstoffen im Lumen des endoplasmatischen Retikulums erfolgt, ähnlich wie der Transport der Stoffwechselprodukte von Steroidhormonen, die auch durch Enzyme des endoplasmatischen Retikulums inaktiviert werden. Es muss aber betont werden, dass Beweise für solche an sich plausiblen Annahmen noch ausstehen.

TARGET TEXT

STRUCTURE AND FUNCTION OF THE ENDOPLASMIC RETICULUM

The Endoplasmic Reticulum and the Microsomes

In examining electronmicrographs(1) of liver cells and other parenchymal cells, double membranes, which run through the cell, from the cell membrane to the plasma membrane, may be seen(2). These membranes(3) surround a 'lumen' in the cytoplasmic region. In the nuclear area(4), the membrane system is thickly scattered with ribosomes (rough endoplasmic reticulum(5) or ergastoplasm). Towards the periphery of the cell, these membranes do not have any ribosomes (smooth endoplasmic reticulum) and(6) a three-dimensional model based on electronmicrographs seems to suggest that this system is composed of ramifying, net-like tubules which run through the whole cell.

As early as 1938,(7) Claude showed(8) that he could isolate an unknown cell fraction by homogenising cells and thereafter subjecting them to a process of differential centrifugation(9). He called this fragment 'microsome', due to the small size of the particles it contained. Owing to the experiments(10) carried out by Palade and Siekevits, it became clear in 1956, that this microsomal fraction originated from the endoplasmic reticulum. In these experiments the reticulum was destroyed by homogenising the cells(11).

Small vescicles which could only be seen under an electron microscope were formed(12), and these were later isolated by centrifugation. These vescicles were called microsomes. They are clearly synthetic products(13) and their size is dependent upon experimental variables. Under normal conditions, particles with an average diameter of 200nm (original microsomes) were obtained(14). From a biochemical point of view(15), these microsomes are equal to the endoplasmic reticulum and all experiments dealing with the structure and function of the endoplasmic reticulum were carried out on these microsomes.

Before ading to a chemical and enzymological examinati microsomal fractions, it should be pointed o at, like all other cell organelles, the endoplasmic reticulum undergoes a constant process of ageing and regeneration(16). The turn-over, i.e. the half-life of the reticulum, is relatively short. This differs in the various enzymes which are found in the reticulum and may vary from 22 to 110 hours(17) Already Palade and Siekevits assumed that the reticulum is resynthesized(18) in the nuclear area containing ribosomes. In other words, the growth process of th reticulum is constant and occurs from the inside to the outside of the cell(19), and(20) it is possible that the golgi apparatus originates from the reticulum.

The golgi apparatus secretes its own membrane system and the substances contained in it by a process of secretion (exocytosis, a reverse process of pynocytosis(21)). Consequently, the membrane system of the golgi apparatus is converted into the membrane system of the plasma cell. The time taken by the endoplasmic reticulum for its process of ageing and regeneration, varies. This may, for example, be influenced by drugs. As Conney and Remmer have shown, the biosynthesis of the endoplasmic reticulum and of some of the enzymes which are found in it, may be accelerated by using barbiturates as well as a number of other drugs. Following injections of barbiturates, the livers of treated animals showed a much thicker reticulum. This was particularly the case in the peripheral areas i.e. the smooth, ribosome-free areas, which experienced a marked growth.

Chemical composition of microsomal fractions(22)

The chemical composition of microsomal fractions does not provide ample grounds which would allow satisfactory conclusions regarding their function to be drawn(23). Microsomes contain lipids, proteins and nucleic acids. The neighbouring ribosomes constitute one of the major sites where nucleic acids are found, yet they are not part of the microsomal structure(24). Protein synthesis in the cell takes place in these ribosomes

which have a diameter of approximately 10-15nm(25). These processes have been discussed in detail. However, they are part of a separate section of biochemistry and are as such beyond the scope of this paper. 80-85% of the overall lipid contents(26) is composed of phosphatides, approximately 10% cholesterol, approximately 5% tryacylglycerine, and approximately 1% cholesterol ester and free fatty acids. Phospholipids are made up of phosphatidylcholine (≈ 55%), phosphatidylathonolamine (≈ 22%), phosphatidylinosite (≈ 9%), and phosphatidylserine (≈ 7%). Sphingomyeline (5%), lysophosphatide and phosphatic acids are also found. The fatty acids which are associated with the formation of phospholipids are: palmitic acid (16:0), palmitic-oleic acid (16:1), stearic acid (18:1), oleic acid (18:1), linoleic acid (18:2), arachic acid (20:4), and dokasahexic acid (22:6). All the membranes analysed so far, have a similar composition(27). The proteins found in the microsomes are in part firmly anchored to the membrane and in part loosely adsorbed to the membrane. To the latter class, belong those excretory proteins which are found(28) in the lumen of the endoplasmic reticulum. Those proteins which are firmly anchored to the membrane structure play an important role(29) in the functioning of the microsomes in the endoplasmic reticulum.

Microsomal Enzymes

In 1962, an overview of microsomal functions with approximately 300 references appeared for the first time and tables included in this survey listed approximately thirty-five different enzymal activities(30). Since then(31), literature on the subject has increased a hundredfold and(32) at least fifty different enzymal activities are known today. Table one lists the most important biochemical processes which are a result of enzyme catalysis(33). The abovementioned survey listed the essential functions of microsomes, and although current knowledge is more profound, it has not undergone fundamental changes(34).A number of books discussing the most important functions of the endoplasmic reticulum, which include oxidation, desaturation of fatty acids, metabolism of steroids and electron transport, are available(35).

Typology of microsomal enzymes found in the endoplasmic reticulum

When one examines an electronmicrograph of the endoplasmic reticulum, the question arises as to whether the production of enzymes in the membrane system of the nuclear area differs from the production of enzymes in the smooth areas remote from the nucleus(36). If the membrane system were equally distributed over the whole cell, then microsomes which are fundamentally

alike and which could therefore not be split into fractions each having different enzymes(37), should be found. However, if the membrane system contains different enzymes which are located both distant from and proximally to the nucleus as has occasionally been observed, then microsomes performing different functions should be found. Literature published on 'heterogeneity' and 'homogeneity' often provides contrasting views on the subject(38). Some researchers assume that 'rough' microsomes differ from 'smooth' microsomes in their enzymes(39), whereas others believe that both microsomal fractions are enzymatically alike. Others still, have found that the fractions of both rough and smooth microsomes can be further divided into subfractions.

As this point is of theoretical importance as far as the function of the endoplasmic reticulum in the cell is concerned, different methods have been used in related experiments over the years(40).

In order to explain the theoretical and experimental criteria employed in the experiments carried out by the authors(41), Table Two should be examined. This table explains how to calculate the number of single microsomes which may be found for every milligram

of protein in the microsomal fraction (approximately 5×10^2 microsomes per mg of protein), by taking the size of the microsomes and the total surface area of the endoplasmic reticulum (morphometrically determined(42)) into account. The table lists five partly refined enzymes which have been examined in depth and whose concentration in the microsomal protein may be determined by taking their decomposition rates and specific activity into account(43). (In the case of cytochromes, molar extinction may be taken into consideration when performing this calculation.) This calculation gives the molecular concentration of enzymes per mg of microsomal protein. As the number of microsomes per mg of protein is known, it follows that every original microsome must contain at least five more molecules than an enzymal protein(44). This result forms an important basis for later observations(45), namely, that if less than a protein molecule were, on the average, to be found for every single microsome, then the possible occurrence of microsomes with different enzymal composition would have to be considered(46). However, as there are always more molecules of any specific enzyme for each microsome, and assuming that there is an equal distribution in the endoplasmic reticulum, then one may expect that on the average all microsomes have the same enzymal composition.

Uniformity of microsomal fractions

Two extreme assumptions are possible:

1. All enzymes are equally distributed over the whole reticulum.

2. There are large areas (e.g. smooth and rough reticulum) in the endoplasmic reticulum, in which specific enzymes are found either predominantly or exclusively.

Microsomes produced by the endoplasmic reticulum should firstly all have the same composition. In other words, all the enzymes should generally be found in all the microsomes. Secondly, it should be possible to isolate microsomal fractions with a different enzymal composition(47).

This theoretical hypothesis was tested experimentally (48). If all the microsomes carried different enzymes, it should then be possible to separate them under experimental conditions. A method suited to the separation of very small particles with different compositions, is the method of zonal centrifugation. The authors succeeded in separating cellular particles with dif-

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ferent enzymal compositions by means of zonal centrifugation. The top half of Fig. three shows the separation of a fragment of a homogeneous liver cell derivate, plasmamembranes, microsomes and mitochondrial residues, following differential centrifugation at 100.000g. The assignment of the fractions to specific cell organelles was made possible by using controlling enzymes (plasmamembranes are characterised by the 5'- Nucleotidase enzyme, microsomes by the Glucose-6-phosphatase enzyme, and mitochondrial residues by the succinate-hydrogenase enzyme(49)).

The microsomal fraction of a homogeneous liver cell derivate which has been subjected to zonal centrifugation and the various typical microsomal enzymes found in these fractions were examined. The results are shown graphically in the bottom half of Fig. Three(50). All the enzymes seem to show the same tendency(51). The maximum level of activity, from all the enzymal activities examined, can be found within the same fraction (with the exception of a clearly non-microsomal enzyme). The distribution of the examined enzymal activities over the various fractions which have been obtained by zonal centrifugation, is therefore equal. However, this means that the microsomes which arrange themselves in the various fractions according to their size and their specific

weight, have an almost similar composition. The enzymes are therefore distributed evenly over the whole surface of the endoplasmic reticulum.

Subfractioning of very small microsomes

It may now be debated whether zonal centrifugation is in fact the right method for the separation of microsomal subfractions. To prove that it is(52), further research was undertaken. As expected, it was calculated(53) that at least five enzymal molecules would be found for every original microsome. As the microsomes were subjected to further subfractioning, these eventually became so small that their number exceeded that of the molecules found in an enzyme species. Consequently, not every enzyme could be found in all the microsomes as had been the case previously(54), and it therefore follows that very small microsomes must have a different enzymal composition. The correctness of this hypothesis is backed by experimental evidence. Fig. five shows the behaviour of pulverised microsomes (by means of ultrasound(55)) under zonal centrifugation. Maximum activity levels of the various microsomal enzymes are no longer concentrated in one fraction as had been the case in Fig. three, but they are now spread over different areas. Therefore, microsomes having a different enzymal composition may be separated by zonal centrifugation.

The assumption resulting from the calculations was also verified experimentally. As the overall number of enzymal molecules is not sufficient for them to be spread equally throughout all the microsomes, very small microsomes may be divided into different groups having different enzymes. If the microsomes are exposed to ultrasound for a period of time which is shorter than that prescribed(56) in the experiment, then fewer pulverised small parts will occur. Moreover, it will be found that a few enzymal activities are concentrated in specific areas, while others will be spread over different areas(57). It is worth noting that in experiments dealing with the fractioning of microsomes, enzymes with a common function such as NADH: Ferricytochrome-b_5-oxidoreductase and Cytochrome b_5, or NAPDH: Ferricytochrome-P-450-oxidoreductase and Cytochrome P-450, were still found in the same fraction. On the other hand, other enzymes such as Glucose-6-phosphatase, were found in another fraction. Only after intensive ultrasound treatment was it possible to separate those enzymes which had the same function; it may therefore be said that these enzymes are also located in the vicinity of the membrane. It is in this way possible to imagine the spatial arrangement of enzymes and to design a kind of 'enzymal chart'. The hypothesis resulting from the application of zonal centrifugation which proposes that original microsomes having a circumference of approximately 200nm contain

all enzymes to the same degree and that small microsomes may nevertheless be subdivided into groups according to their enzymal functions(58), is still being confirmed by employing other methods, for example, immunology.

The molecular architecture of the endoplasmic membrane

There are a number of ideas concerning the ultrastructure of this membrane which is composed of lipids and proteins. A model was already proposed in 1935 by Danielli and Davson and was later modified by Robertson(59). According to this model(60), biological membranes are composed of a bio-molecular lipid layer which is covered on both sides with proteins. The hydrophobic sections of the double layer face each other while the hydrophylic sections, the phosphate groups and the bases, face the outside. To these, proteins are attached in a wide layer, by means of saline bonds. Another model does not make any mention of a continuous double lipid layer. According to this model, proteins and lipids form the membrane and there are lipid micelles scattered between the proteins. There are examples for both models in natural membranes. It was asked what model may be applied to microsomes(61), and with this in mind(62), the surface requirements of microsomes in phosphatides and proteins were calculated. This was done by taking the known surface requirements of single molecular

remnants into account, and each time, 1mg of microsomal proteins was used. These calculations showed that the overall amount of lipids in the form of a double lamella found in the endoplasmic reticulum occupy a surface area of approximately $0,2m^2$. However, the total surface area of the endoplasmic reticulum is $0,63m^2$. It therefore follows that there can be no homogeneous layer of lipids and proteins, and that these only occur in the form of 'islands' thus forming the microsomal membrane(63).

Membrane-bound enzymes

Membrane-bound enzymes may not be isolated as active, pure proteins as they require the presence of lipids in order to be active(64). The dependence of enzymes on lipids has been more closely examined for a number of enzymes found in the membranes. According to (...), not all enzymal proteins may be found in the membrane, as they mostly lie on the surface(65). These enzymes may be dissolved easily and converted into pure proteins (e.g. Carboxylesterase). However, enzymal proteins which play a role in the construction of the membrane are very difficult to dissolve and may only be isolated as rather large lipid compounds which will still retain their micellar nature(66). If these lipoproteid complexes are purified even further, to the extent that the lipids are separated from the proteins, then these

enzymes will become inactive. This phenomenon(67) is being examined for Glucose-6-phosphatase as well as for other enzymes. Glucose-6-phospatase or NADH: Semidehydroascorbate-oxydoreductase which has the same kinetics(68) as those chemicals used to separate phosphilipids, will become inactive under enzymal hydrolysis of phospholipids. Lipid contents and its related activity are closely related. The inactive lipid-free microsomes may be reactivated by adding lipids. Fig. six shows how NADH: Semidehydroascorbate-oxidoreductase, made inactive by extracting lipids, may be reactivated again by adding asolectin - a compound of phospholipids derived from soyabeans. If instead of lipid compounds, very pure phospholipids which have been isolated, are added e.g. phosphatidylcholine (Lecithin) to the microsomes, then the enzymal activity will no longer be re-established. If, on the other hand, a small amount of lysolecithin is also added, then the isolated microsomes will be reactivated fully. Lysolecithin is a detergent(69), and the reactivation of isolated microsomes may only be achieved by using synthetic detergents (Triton range).

If traces of detergent are added to the original microsomes which have not been isolated, then their enzymal activity will increase even further. If the detergent

concentration is increased, then the activity of the membrane-bound enzymes will decrease very rapidly until it nearly reaches zero. The way in which the membranes dissolve in the presence of higher amounts of detergent which also possess an inhibitive quality, may also be observed visually(70). The originally cloudy microsomal suspension will clear up if the same concentration of detergent required to inactivate the enzyme is used(71). It is difficult to isolate the neutral detergent having a high molecular value under experimental conditions. Microsomal suspensions which had been previously deactivated by using detergents were tentatively reactivated by adding other membrane structures which are enzymatically inactive(72). In doing this, the ratio Lipoproteid:Detergent shifted in favour of the lipoproteids and the free detergent concentration decreased. For a visual idea of the experiment, curves two and three of Figure seven must be read from right to left. The inactive membrane structures either bind the detergent or provide a micellar matrix for the dissolved enzymal proteins. Enzymal activity rises sharply and even exceeds the enzymal activity found in the original microsomes(73). Furthermore, addition of cattle serum albumin (CSA) or β-Globulin does not cause reactivation, and 'membranes' will have to be added(74). In order to shed some light on the significance of these involved experiments, reference should be made to Fig. eight(75).

The enzymes which are found in an ordered micellar membrane structure, will turn into lumpy, unstructured bundles once the phospholipids are removed. On the other hand, their hydrophobic remains will join with each other during a process of interaction(76). This phenomenon may be recognised by a growing cloudiness. It is probable that the active sides of the enzymes now no longer face the outside - they are inactive. By using ultrasound, such bundles of protein molecules may be pulverised. If during this process(77), the proteins keep their unaltered conformation, then it follows that they can only regain their activity once they have been isolated from the bundle. This applies to enzymes which are located(78) outside the membrane, e.g. NADH:Ferricytochrome-b_5-oxidoreductase. This enzyme becomes inactive once lipids are extracted from the microsomes. By using ultrasound but without adding any phospholipids, this enzyme will become active once more(79). This, however, does not apply (80) to membrane-bound enzymes such as NADH:Semidehydro-ascorbate-oxidoreductase. Once this enzyme has been made inactive by extracting lipids from the microsomes, it can no longer be reactivated by subjecting it to ultrasound treatment(81). This enzyme will only regain its activity if the lumpy enzyme bundles are subjected to ultrasound in the presence of phosphatides or small quantities of other surface-active substances.

All the results seem to point to the following hypothesis: enzymes which are integrally bound to a membrane structure are only active when their catalyst-effective conformation and their micellar lipoproteid structure are kept intact.

These enzymes which depend on the micellar structure of the membrane may also be found in mitochondria and plasmamembranes and are found to play a role in normal metabolic processes(82). They are 'vectorial' enzymes and have the function of translocating ions or unloaded molecules through the membrane in one direction. As biological membranes act as diffusion barriers, concentration gradients between both compartments (divided by the membrane) are formed(83) as a result of this vectorial catalysis.

The lamellar and tubular membrane system of the endoplasmic reticulum also forms a number of separate compartments(84). It is therefore logical to assume that the enzymes of the endoplasmic reticulum which may only be isolated as lipoproteid complexes and which are membrane bound, are vectorial enzymes(85). However, this is still a hypothetical speculation and still requires experimental backing(86). Before the importance of vectorial enzymes with reference

to the functions of the endoplasmic reticulum are examined, a few more general comments should be made concerning the enzymal activity of microsomes(87).

Functions of the Endoplasmic Reticulum

Until now, four enzymes have been isolated from the endoplasmic reticulum in order to establish their molecular weight. As far as the fifth enzyme, cytochrome-P-450, is concerned, its molecular weight may be determined by comparing it to a bacterial enzyme. In this way, the concentration of this fifth enzyme can now be calculated(88). The concentration of cytochrome-P-450 contains between 8-10% of the overall amount of enzymal proteins found in the microsomes. There are about fifty different enzymal activities located in microsomes. Supposing that their molecular concentration within the microsomes is the same as the concentration of the five known enzymes, it must then follow that these enzymes must account for the total amount of microsomal proteins(89). Even if this is a very rough calculation, it can still be deduced that the known enzymal activities probably account for the 'total microsomal function'.

It is beyond the scope of this paper to delve into the mechanism of all fifty enzymal activities of micro-

somes(90). Nevertheless, how these activities integrate in the overall cell functions should be investigated(91). If one accepts that the endoplasmic reticulum is a tubular system which runs through the whole cell, this should then provide a suitable solution(92). Both tubules and tubular systems play a role in the transportation of metabolites(93). Consequently, the endoplasmic reticulum is also active in the transportation of intracellular metabolites and it has been due to the dependence of enzymal activities on a membrane structure that this transport function of the endoplasmic reticulum has been identified(94). Consequently, while the enzymes located in the membrane could well be vectorial enzymes and receive substrates from the cytoplasmic area, they also release the reaction products into the lumen of the tubules. From the lumen, these products are then transported outside to the extracellular region. This phenomenon has already been proved for some excretory products with a high molecular content. Proteins are synthesized in ribosomes which cling to the microsomes. These proteins are specific for every organ(95), for example, digestive enzymes are found in the pancreas, while globulins and albumins are found in the blood serum of the liver. It follows from this that those proteins which are synthesized by ribosomes in the cytoplasmic region wander towards the inside of the lumen and are then transported to the golgi apparatus. From there

these proteins are secreted into the blood by a process of exocytosis. Glycolic proteins, in particular, clearly manifested this phenomenon. The 'skeleton' of the protein which originates in the ribosomes of the rough endoplasmic reticulum wanders as a 'naked' protein towards the interior of the endoplasmic reticulum. Following this, the various sugar residues cling to the protein in sequence. The sequence in which these sugar residues are transcribed to glycolic proteins through transferase was established in the course of this experiment(96). Finally, salicylic acid residues are transported to the wandering glycolic proteins, and more specifically to the periphery of the reticulum and eventually reach the golgi apparatus. In contrast to the well-researched information available on the transportation of macromolecular metabolites, little is known on the mechanism of excretion of metabolites with a low molecular content. Until now, it could not be proved whether small molecules and macromolecules are transported into the endoplasmic reticulum. Nevertheless, there is substantial evidence which suggests that, for example, Glucose-6-phosphatase is also a vectorial enzyme and that the endoplasmic reticulum also plays a role in the transportation of glucose, released by the cleavage of Glucose-6-phosphatase(97).

Glucose-6-phosphatase in the liver and the kidneys supplies the organism with free glucose. This enzyme(98) may be induced; for example, its amounts increase; in the metabolic sites of diabetics or whenever a person feels hungry. Glucose-6-phosphatase, however, belongs to that class of enzymes which are only active in the presence of a membrane structure and this shows that Glucose-6-phosphatase is a vectorial enzyme(99). It follows from this that the glucose which develops in the Glucose-6-phosphate of the cytoplasm by the interaction of Glucose-6-phosphatase in the membrane is transported to the lumen of the endoplasmic reticulum towards the exterior(100). If the Glucose-6-phosphatase were to release the glucose back in the cytoplasm and not in the lumen, then the free glucose in the cytoplasm assisted by hexokinase and ATP would once again absorb phosphate(101). Therefore, free glucose may only be released in the blood by the endoplasmic reticulum. It should also be remembered that although the transport of free glucose from the extracellular space to the cytoplasm has been observed, the same may not be said for the reverse process, viz. from the interior to the exterior through the plasmamembrane (102). Therefore, the supposition that the endoplasmic reticulum plays a role in the transportation of glucose from the inside to the outside of the cell is not unfounded.

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Similar suppositions may be made regarding the transport of metabolic products by foreign substances. Certain drugs pass through the cell membrane in the form of lipid-soluble substances. Cytochrome P450 causes these drugs to absorb hydroxyl in the endoplasmic reticulum, while glycolic acid(103) causes them to absorb glucose through uridic acid transferase. (Esterification by means of sulphuric acid is another possible method.) These water soluble glycolics of foreign substances which have absorbed hydroxyl (e.g. drugs) are then either released in the blood or in the bile. It is also reasonable to assume in this case that the transport of metabolites of drugs and foreign substances in the lumen of the endoplasmic reticulum is similar to the transport of metabolites of steroid hormones which are also inactivated by enzymes found in the endoplasmic reticulum. It must be stressed, however, that these assumptions have not yet been verified.

IMPLEMENTATION OF JULIANE

HOUSE'S THEORY AND

GENERAL COMMENTS

At this point, the main difficulties facing the translator of a scientific text should begin to emerge. During the process of translating, he will have to consider what kind of style will be most suited to that specific text. In order to achieve this, the translator should take into consideration two very important concepts: informativeness and intelligibility, and the extent to which they play a role in the general understanding of the text. It would seem logical to assume that in the case of a scientific text, the concept of informativeness will play a more important role as the main function of such texts is to inform. However, the author strongly feels that in order to achieve an 'adequate' translation, the concept of intelligibility is just as important, as a badly written text (from the stylistic point of view) will not succeed in clearly conveying the meaning. However, before examining the validity of Juliane House's theory to the scope of this translation project in more depth, one should perhaps attempt a definition of the concept of 'adequacy of a translation' which has perhaps been used rather loosely so far. Although a number of theorists have attempted to define exactly what constitutes an 'adequate' or an 'acceptable' translation, it is the author's opinion that few have succeeded. For example, Savoury believes that "the most satisfying translations are made by those whose personalities are in tune with those of the writers and also those of the readers"

(House, J.: A Model for Translation Quality Assessment, p. 6). At first glance, this may seem a very logical statement but it is clear that it does not take a number of practical considerations into account as such an 'idyllic' state of affairs would necessitate that the translator be familiar with the personality of the author. Not only is this often impossible but it would also clearly limit the author to only translating those texts which are written by a specific author and it is needless to say what consequences this would entail.

Elsen believes that "Une traduction .. de qualité est une traduction dont la forme fait oublier au lecteur qu'il s'agit précisement d'une traduction" - "A good translation ... is one which makes the reader forget that he is in fact reading a translation" (Juliane House p. 6). There is no doubt that such a translation could be considered more than 'adequate' however, this statement may be debatable from a literary critic point of view who more often than not will adamantly state that a translation must not attempt to take the place of the original and that in a case such as this, the dividing line between translating and plagiarising may become very thin. In the case of a scientific translation such as the one examined in this translation project, such a definition becomes vague as it does not seem to offer any real practical hints vis á vis

the concepts of informativeness, intelligibility and different types of scientific texts.

However, it may be said with certainty that any written text conveys some kind of meaning and that consequently, the process of translation will involve the conveying of meaning from the source text to the target text. Although such a statement may seem superficial, it forms the foundations for the process of translation as it holds true for any kind of text. It should be borne in mind that in order to arrive at a definition of the concept of 'an adequate translation', it is necessary to examine its components, and meaning is perhaps one of the most important features.

In her theory, Juliane House provides a clear definition of meaning and according to her any text may have three different kinds of meaning:

1. Semantic aspect of meaning: In the literal sense of the word, semantics entails the meaning of a particular word and the relationship of the linguistic units of the text to their referents. As semantics embraces the concept of denotative meaning, problems in this sphere would include basic problems of terminology (refer to Annotations).

In the case of a scientific text, these problems are usually dealt with by the translator by using specialised dictionaries and other extralinguistic sources such as background literature. The semantic aspect of meaning clearly embraces the concept of informativeness of a text which is fundamental to a scientific text in particular.

2. Pragmatic aspect of meaning: This facet of meaning looks at the correlation between linguistic units and the user of these units within a given communicative situation. Unlike the semantic aspect, pragmatics involves the connotative meaning of any given text. In other words, it embraces the relationship between author and reader and the effect a given linguistic style will have on the reader. Juliane House terms this phenomenon as the 'illocutionary force' which each utterance or text possesses. Problems in this area would mainly include stylistic considerations and it is here that the classification of scientific texts provided by Pinchuck (refer to the Introduction) makes a great contribution. It is obvious that if the translator uses a very high register and high-faluting words in the translation of, say, a popular science text which may perhaps be geared towards the primary school pupil, then

its 'illocutionary force' will be misplaced and this will result in the reader not being capable of understanding the text. In other words, the informativeness of the text will be lost as the level of intelligibility of the text will be very low. In other words, whereas the semantic aspect of meaning embraces 'propositional content' (the purely semantic information contained within a text), pragmatic meaning may be said to represent a broad category of style, as the way the text is written (a rough definition of style) will largely determine to what extent the text will convey its intended meaning to the reader. The pragmatic aspect of meaning is also characterised by a number of linguistic and grammatical features such as word order, the repetition of specific words or fixed expressions and the mood of the verb (for example, the repeated use of the conditional which does not give the text the same force as the use of the indicative).

3. Textual aspect of meaning: Any text will always be composed of a number of sentences and the intelligibility, the informativeness and the overall explicitness of the text will depend on the extent to which these sentence units are logically linked to each other. This aspect of meaning also embraces

a number of stylistic considerations and as it will be seen later (refer to Annotations), it was often necessary to join sentences and omit or add certain words in order to make the meaning of the sentence clear. This aspect of meaning clearly embraces the facet of intelligibility of a text and ensures that the argument keeps a logical structure. However, the extent to which this intelligibility is maintained will largely depend on a logical connectivity between successive sentences and in the case of a translation, will depend on the choices made by the translator which will include both linguistic and stylistic considerations (refer to Annotations).

These detailed descriptions of meaning should now make it easier to attempt a definition of an 'adequate translation'. According to Juliane House, a translation involves 'the replacement of a text in the source language by a semantically and pragmatically equivalent text in the target language' (Juliane House p. 30).

The main aim of this translation project will be to determine whether the translation provided by the author does in fact possess a 'semantic and pragmatic equivalence'. As was stated previously, one of the main

difficulties encountered by the author was the evaluation of his own translation and in order to provide a fair evaluation of both source and target texts, a functional equivalence was established for both. To this end, the dimensions of language user and the dimensions of language use which form the foundations to Juliane House's theory, were used extensively. From a practical point of view, it was felt that the implementation of a graded scale would be well suited as a purely linguistic approach involving, say, mechanical counting (where the repeated use of personal and possessive pronouns, moods of verbs and fixed expressions are recorded) could not be applied in this case due to the length of the translation. Consequently, a graded scale of one to four was used according to the following criteria:

(a) A value of one on any given dimension implies that the text is strongly unmarked and that it does not possess any characteristics which make it different to texts within the same genre.

(b) A value of two still means that the text is fairly neutral but that it does possess very few qualities which may allow it to be differentiated from texts within the same category. Such qualities or literary devices may, for example, include the sporadic use of a cliche or a familiar form such as the personal pronoun 'we'.

(c) A value of three may be said to represent the opposite of a rank of two but this time tending towards the marked characteristic of a text. In this case, personal pronouns which are not commonly found in scientific texts may occur with a certain frequency and even the use of a slang term (such as may be found in the case of popular science texts) may cause the text to acquire a marked characteristic.

(d) Finally, a value of four will be awarded in those cases where the text is considered to be very marked on any one of the eight parameters. For example, a scientific text written in archaic English will be awarded a value of four for the parameter of time. It should however, be borne in mind, that due to the essentially informative nature of any scientific text, it is highly unlikely that this value is given to the text on any of the parameters. Should this value be found in the textual profile of the target text then it will denote an error on the part of the translator (defined by Juliane House as overtly and covertly erroneous errors).

In conclusion, before proceeding to a comparative analysis and a textual profile of both target and source

text, a few comments should be made on the process of a translator having to evaluate his own translation and to what extent the translator is capable of providing an objective evaluation. The author feels that an objective evaluation of one's own work is, by definition, a contradiction in terms. It is obvious that a critical and conscientious translator will always be capable of justifying a choice he made during the process of translations (for example, why he chose to add or omit a word or why he chose to use that specific word instead of another). However, when dealing with stylistic considerations, it is difficult for the translator to see an 'error' or the absence of 'faithfulness' in his translation, when compared to the original as it seems reasonable to assume that he will have tried his best to make his translation as faithful to the original text as he possibly can. Therefore, the author feels that the use of a translation evaluation theory is a basic prerequisite for any evaluation of a translation. It is also the author's opinion that this translation evaluation theory should be capable of being tested empirically as only then will it provide the translator with a good set of 'tools' with which he may attempt to evaluate his own work. A lot of research has been undertaken in the field of translation theory and although a number of eminent scholars and experts on the subject of translation have come up with a number of solutions, it is felt that most of

these methods involve a lengthy and often impractical procedure. For example, Nida and Taber's Cloze technique which examines the degree of comprehensibility vis á vis the degree of predictability would work very well on a short text but in the case of a text such as that translated for the purposes of this translation project, the implementation of this technique would necessitate a very long period of time which the translator does not often have at his disposal. It should be borne in mind that these generalisations do not include all translation evaluation theories ever written and only refer to those few with which the author is well acquainted and it is also beyond the scope of this translation project to examine their validity in great detail. The author feels that Juliane House's translation evaluation theory takes into account all those concepts which he considers important in a translation (intelligibility, informativeness, clarity, conveyance of meaning) and consequently provides the translator with a good basis upon which he may base his findings. It should however, be borne in mind that the exclusive reliance on the part of the translator on any translation evaluation theory will never provide a 'comprehensive' evaluation although it may certainly provide an 'objective' evaluation. A theory is a mere tool and the extent to which the translator applies it,his views and relative findings will ascertain whether or not a translation may be considered as being 'adequate'.

ANALYSIS OF SOURCE TEXT

AND STATEMENT OF FUNCTION

Any objectiv evaluation of a translation will require a fixed set of norms which the translator may use during the process of evaluation. In order to achieve this, the translator must establish the specific 'function' which the text exhibits so that he may have at his disposal a 'yardstick' against which he may evaluate his judgements. This idea was also elaborated upon by Professor Wills who suggested that in order to make a valid contribution towards the criticism of a translation, the translator should consider the concept of 'Gebrauchsnorm'. By this term, Wills implies 'a norm of usage in a given language community with reference to a given situation' (Juliane House p. 21). In this way, the translator will be able to determine whether the translation is adequate or not vis à vis the standard usage of language in that particular communicative situation. However, it must once again be stressed that the final word will be left to the translator who, according to his experience and knowledge will realise in his own mind whether the translation is adequate. Therefore, although Juliane House's theory will be used extensively in the sketching out of the 'textual profiles' of both texts, the comments of the translator will play a great role in determining in what category the text will be slotted.

Assuming that the translator is now equipped with an adequate set of tools, the next step will be to define what concepts the translator will be examining throughout the evaluation. However, before examining the specific characteristics which the source text may possess, the translator must examine the more general tendencies which the text exhibits. These characteristics may be termed 'functions' and in accordance with Juliane House's theory (the original term was first coined by Halliday)(in Juliane House 1977), any text may be subdivided into two broad functional categories: interpersonal and ideational. By definition, an ideational text is that text which expresses content. This idea is similar to the 'symbolic' function of language (Ogden and Richards 1946) which embraces the 'correctness of the symbolisation and the truth of the references (Juliane House p. 32). Included in this broad category are texts which have a scientific and journalistic nature - in other words, with reference to what was stated previously, these are informative texts. By now, it should have become clear that any clear-cut categorisation is not easy to achieve when dealing with language and that often texts may exhibit both ideational and interpersonal qualities although one will often prevail.

The interpersonal function of a text examines whether or not the text arouses some kind of emotional response in the reader. This concept is the equivalent of Ogden and Richard's idea of the emotive-evocative use of language where 'the character of the attitude aroused in the addressee is of prime importance' (Juliane House p. 32). Texts belonging to this category include fiction (plays, comedies and dialogues) and non-fiction (religious sermons and political speeches where the main aim is not only to inform but to arouse some interest in the reader or listener by playing on his emotions). Whereas ideational texts will be characterised by automatisation where the language is used conventionally so as not to arouse any emotion in the reader, interpersonal texts are characterised by a high frequency of foregrounding where the author will use such linguistic devices which will in themselves attract attention. Most of these devices are to be found in literary texts and include onomatopoeia, assonance, alliteration, puns and the purposeful repetition of specific terms.

From the translation point of view, an ideational text will always result in a covert translation. In other words, due to their high degree of informativeness the main function of the translation, viz. to inform, will remain intact. Conversely, an interpersonal text will result in an overt translation which will only

possess a second level function vis à vis the source text. As such texts are marked by emotive-evocative language and as they transcend the purely informative function, by definition, the achievement of strict functional equivalence will not be possible.

The text analysed in the course of this translation project seems to overlap between these two broad categories. It is obvious that its prime objective is to inform. In other words, on first reading, the text fulfils an ideational purpose as it expounds on a number of highly scientific concepts and at no point is the attention of the reader deviated from the purely informative function by way of any of the aforementioned literary devices. However, upon closer examination, the text exhibits an interpersonal quality although this is not evidenced by the specific usage of language itself. Its slight interpersonal function manifests itself through frequent references on behalf of the authors to experiments they undertook personally. In this case, the personal pronoun 'uns' and the possessive pronoun 'unser' is often used by the authors. However, for a more detailed discussion on the use of the impersonal, reference should be made to the Annotations.

Having briefly examined the two basic functions of any given text, the translator should now attempt to define what position the text occupies within any given situation. Whereas the two broad functions of language have been found to overlap, the situation in which any text is embedded is unique. According to Juliane House any text may only exhibit a set of characteristics which make it typical for one situation and this makes the task of placing a text within any one of the eight parameters a straightforward and reliable procedure. Furthermore, as the concept of the situation may appear a difficult and vague idea to define, the subdivision employed by Juliane House seems to be a very logical step to take.

In accordance with Juliane House's theory, these situational parameters may be divided into two broad categories: dimensions of language user and dimensions of language use. Under the heading of dimensions of language user, the source text will be analysed according to the following three parameters:

1. Geographic - this parameter marks the author's origin, and the use of slang or regional dialect would cause the target text to deviate from a 'conventional use of language'. In the case of the text under discussion, the language is non-

marked, standard high German and this is to be expected of any scientific text which would naturally employ a 'neutral' form of language which is not bound by the origins of the author.

RANK = 1

2. Social Class - this parameter is closely linked to the first, and the author's position on a social scale is measured. The unmarked level is represented by the educated middle class speaker of the standard language. In this case as well, the target text exhibits a totally unmarked characteristic.

RANK = 1

3. Time - this parameter refers to those features which provide clues to the temporal provenance of a text. Register and lexis are important concepts in this area as they define to what extent a text may be classified as modern or slightly archaic. Once again, the text is totally unmarked as the language used is standard modern German.

RANK = 1

It may be seen that the ranking of the target text into these three categories is a straightforward task as far as a scientific text is concerned. This is

mainly due to the tradition followed by authors of such texts. Obviously, the author of a scientific text (and this also refers to authors of popular science texts) will always be part of a social class which is usually above average, at least as far as the educational level is concerned. Consequently, the language used by them will be that of the educated middle class.

The second broad category of situational dimensions comprises the following five parameters:

1. Medium - this dimension may either be simple or complex. It is simple when language is limited to one particular category, in other words, written to be read or spoken to be heard. Conversely, it is complex if the language used throughout the text falls within different categories, in other words, written to be spoken, written to be heard as if spoken, and so on. Under the heading of medium, Juliane House deals with the following concepts: structural completeness and incompleteness of sentences, and specific manner of text constitution.

Also linked to this dimension is the concept of 'theme-dynamics' whose main function is to record

the various semantic patterns which recur in a text (for example, the stress of specific words through repetition, use of synonyms, etc.). Furthermore, Juliane House postulates that any 'utterance' or text will exhibit one of two characteristics: the theme and the rheme. The theme includes that information which is universally known and taken for granted as it is understood by the contents of the text. In the case of a scientific text, the theme makes up the semantic pattern of the text and due to the informative function of the text, it is this theme which conveys the information. On the other hand, the rheme refers to the new information which is to be transmitted. In this case, the theme preceeds the rheme, in other words, the informative function of the text is of primary importance and should be preserved in the translation. As was observed in the dimensions of language user, speech is unmarked and standard language is used. The target text may thus be said to occupy an 'objective' position and because of this, the medium may be categorised as simple - the text conveys information and it has been written to be read. There are a number of lexical means which support this statement such as the absence of colloquialisms, interjections or other subjectivity markers. Furthermore, the text may be considered as being totally emic as

it never relies on the situation of production to convey the meaning, and this accounts for the text's high degree of explicitness in conveying its message.

RANK = 1

2. Participation - this parameter may be simple or complex and examines the degree to which reader participation is elicited. From a linguistic point of view, this manifests itself in the use of personal pronouns, interrogatives and exclamations. In this case, the only linguistic means which point to a slight degree of reader participation, is the use of the personal pronoun 'uns' and the possessive pronoun 'unser'. As such, the text still remains detached from the reader but by using these familiar pronouns, the authors seem to want to elicit some participation on the part of the reader by somehow bringing themselves to the same level of the recipient.

RANK = 2

3. Social Role Relationship - this parameter refers to the relationship between the addresser and addressee and may either by symmetrical or asymmetrical. Symmetrical social role relationship

is characterised by solidarity and equality between the author and the recipient whereas asymmetrical social role relationship is marked by some degree of authoritative relation between the addresser and the addressee. In this case, the social role relationship is clearly asymmetrical as the authors have professional and academic authority over the reader. It should be borne in mind that this statement does not necessarily hold true for all scientific and technical writings. As a matter of fact, most scientific papers are geared to people whose knowledge of the subject is just as expert as the author or authors who originally wrote the paper. However, in the case of the source text employed in this translation project, it may be said that the article is geared to a wider audience, viz. university professors as well as students. This is evidenced by the fact that this article has been taken from a journal which deals with an extremely wide range of topics and is as such not as specialised as a journal which only includes contributions written on say, cellular biology. However, there seems to be a minimal degree of closeness to the reader evidenced by the use of the personal pronoun 'uns'. Furthermore, the closing statement of the source text stating that the research undertaken by the authors is by no means exhaustive seems to place

the authors on a more equal footing with the reader as they do not profess to be the omniscient academics which often write texts of this nature.

RANK = 2

4. Social Attitude - this parameter examines the degree of social distance or proximity between the author and recipient and distinguishes between the following categories: frozen, formal, consultative, casual and intimate. Although the social attitude is not of the frozen kind, it may be stated with certainty that the text uses a formal style which is marked by a certain degree of social distance and impersonality. This parameter is linked to the aspect of social role relationship and is also characterised by the absence of contractions, vulgarisms and interjections. Furthermore, the formal relationship is evidenced by the student-teacher relationship which exists between addresser and addressee, and it is manifested in a number of textual means such as the detailed nature of the description and explanatory notes on the basic functions of certain cell organelles (for example, microsomes).

RANK = 4

5. Province - this parameter embraces the occupational or professional activity of the text, viz. the text's 'area of operation'. The source text is clearly a scientific text geared to university researchers or professors and this is evidenced by the following lexical means: frequent use of complex terminology in the form of compound nouns, use of high register words which have a Greek or Latin origin and the complete lack of emotive-expressive words such as interjections and clichés.

   RANK = 4

ANALYSIS OF TARGET TEXT

AND STATEMENT OF FUNCTION

For the sake of brevity, this chapter will only concentrate on the analysis of the target text in accordance with the eight dimensions mentioned in Juliane House's translation evaluation theory. Consequently, these parameters will not be discussed in detail as they have already been highlighted in the previous chapter. Furthermore, the author feels that a long discussion involving the function of the target text and its position within a text typology is beyond the scope of this translation project as these two categories are very broad and their analysis would not contribute a lot to the question of stylistic and terminological considerations which form the core of this translation project. It seems reasonable to assume that any 'adequate' translation will successfully retain its original 'flavour', for example, a scientific translation will be recognisable as such by the repeated use of complex terminology, use of the impersonal and other markers which will give it characteristics which are highly different from, say, literary translations (however, for a more detailed outline of the characteristics of scientific and technical texts, reference should be made to the Conclusions). In other words, the information contained in the target text will allow it to retain its general characteristics, and major changes in this area would be a clear sign that the translation is grossly 'inadequate'.

As one of the main aims of this translation project is to examine stylistic peculiarities, one is clearly concerned with the finer points or the nuances of language such as choice of words, range of vocabulary, terminology and even sentence structure. By analysing the target text in accordance with the eight parameters of Juliane House, one can attempt to single out and rectify any 'inadequacy' (or mismatch) found in the target text. Once again, it should be borne in mind that the author will only highlight those points which he considers to be of importance to the translation project and the analysis of the target text is by no means to be considered exhaustive.

Under the heading of dimensions of language user, the target text is analysed according to the following three parameters:

1. Geographic - on this parameter, the target text displays the same characteristics found in the source text. The language used is standard unmarked English and throughout the translation there is a clear lack of colloquialism and regional variations which would confer the text a marked characteristic on this parameter. Furthermore, the register used in the text corresponds with that used by educated, middle class English mother

tongue speakers.

RANK = 1

2. Social Class - once again on this parameter, the target text displays the same characteristics of the source text. Both the target and the source texts are characterised by the absence of dialect and the language used is neutral, concise and extremely objective.

RANK = 1

3. Time - no variations have been registered on this parameter as the language used in the text is unmarked. Consequently, the English used in the translation is current, unmarked English which is characterised by the total absence of any form of archaism.

RANK = 1

The second category of situational dimensions comprises the following five parameters:

1. Medium - the target text seems to display the same characteristics found in the source text. It will be remembered that the source text was

classified as an ideational text displaying very few interpersonal characteristics. Nevertheless, the main function of the text is to inform and to impart knowledge and the author feels that the ideational component has been retained in the translation. The target text, as the source text, passes on a lot of information in an objective and straightforward fashion. In other words, language is used as economically as possible and the target text does not lose itself in empty speculations. Although a few syntactic changes were made (refer to the Annotations), these were made purely for the sake of clarity and style and not for the purpose of wanting to add redundant information to the target text. In these cases, the author felt that unless these syntactic changes were made, the informative component of the text would have been lost as it would not have succeeded in conveying the meaning to the reader. Finally, as far as the 'theme-rheme' sequence is concerned, in the target text, the theme preceeds the rheme, in other words, the informative function of the text is still the primary objective. This is evidenced by the wide usage of terminology and the standard, neutral language used in the target text.

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RANK = 1

2. Participation - on this parameter a slight variation has been observed. Although the source text displayed 'simple participation' in that reader participation was hardly elicited, it still used possessive and personal pronouns ('uns', 'unser', etc.) which seemed to elicit very slight addressee participation. However, in the target text, the author felt that he should use the more classical' approach on which most scientific writers seem to base their style (refer to the Conclusions) and omit the use of personal and possessive pronouns which are found in the source text. Due to this, reader participation is completely unelicited and consequently the target text displays an even less marked characteristic on this parameter.

   RANK = 1

3. Social Role Relationship - as the main objective of the target text is to inform, the role of instructor (the addresser) and student (the addressee) is retained. Once again, however, the omission of the personal and possessive pronouns from the target text seem to make the gap between writer and reader even greater and the social role relationship found in the target text is even more asymmetrical than that found in the source text.

   RANK = 1

4. Social Attitude - on this dimension, the target text displays the same characteristics as those found in the source text. A certain neutral and formal style is used as evidenced by the absence of contractions, vulgarisms, interjections and other subjectivity markers. The formal relationship existing between addresser and addressee is characterised by the highly informative content of the target text as evidenced by a number of textual means such as detailed descriptions of highly scientific concepts.

RANK = 4

5. Province - the target text does not seem to deviate from the source text on this parameter as it displays the same basic characteristics, viz. highly specialised words having Greek or Latin roots and the frequent use of complex terminology. It will, however, be noticed that the target text does not seem to use as many complex nouns as the source text and although this may seem to make the text more 'digestible', it should be borne in mind that this difference does not constitute a mismatch between the source and target texts as it does not stem from the free will of the translator, but rather, it was dictated by the different structures of English and German.

Although compound nouns are very widely used in German and are by no means only used in scientific or other highly specialised texts, the same may not be said for the English language. Although compound nouns may be found in English (hardly, if ever, written as one word as is the case with German), they are hardly used as these may often be substituted by other constructions. Examples would include:

German	English
Enzymproteine	Enzymal proteins
Zonenzentrifugation	Zonal centrifugation
Doppelmembran	Double membrane

These may also be found in complex sentences such as:

German	English
Hochmolekulare neutrale Detergens	Neutral detergent having a high molecular content
Nicht extrahierten Mikrosomen Spuren	Microsomal traces which have not been isolated

The more complex structure found in the German source text would seem to give the text a more

specialised 'area of operation' whereas the English target text seems to simplify these concepts. However, these do not contribute any changes to the target text vis á vis the source text as they were not made by the translator himself.

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ANNOTATIONS

For the purposes of this translation project, the annotations have been divided into two broad categories: annotations dealing with stylistic considerations and annotations dealing with terminological issues. All the annotations follow the order of the text and when the reader consults the various sections of the annotations (stylistic annotations have been split into four sections, terminological into one) the numbers will naturally not follow a numerical order as they have been subdivided into two categories and then into subsections. Stylistic annotations were split into four sections reflecting additions, repetitions, syntactic changes and the use of the impersonal to illustrate the variations in style between source and target texts. Although all annotations have been listed, the author felt that for the sake of brevity, only a few would be discussed in order to highlight that specific point, as a discussion of all annotations (a total of 103) would be beyond the scope of this translation project. Finally, it should be borne in mind that all the annotations reflect changes (sometimes minor, sometimes major) which the author felt were necessary in order to improve on the intelligibility of the text, which, as has already been seen, would influence the informativeness of the text.

Annotations of a Stylistic Nature

1. Additions

The author felt that in these cases the translated text would have lacked a logical sequence unless certain 'linking' words were repeated. It was found that the German source text made a wide use of pronouns and it was often difficult to find the word to which the pronoun was referring. In order to make the meaning clearer, the author often substituted these pronouns with the word which they originally replaced. Often this proved to be a difficult task due to the fact that the author is not a mother tongue German speaker who ·en had to rely on the grammatical construction ·ne sentence to work out the word which that ·.c pronoun was replacing. From an 'informative' point of view, the translator felt that these 'disruptions' found in the source text had to be rectified as they could hinder a clear understanding of the pure contextual meaning. However, from the stylistic point of view, these unconnected sentences would often hinder a smooth reading of the text and thus the level of intelligibility in these cases was often very low. The author found that in these cases, the concept of style plays a very important role as it may be argued that the role of the translator is to transpose

meaning from one language into the other without necessarily rewriting certain portions of the text which exhibit some poor stylistic qualities. However, the conveying of meaning from one language into another may often require that the translator move away from the source text and adapt a specific sentence so that it fits the requirements of the language into which he is translating.

The following are examples where the author deemed it fit to bring additions into the text:

11 - Durch die Untersuchungen von Palade und Siekevitz wurder 1956 klar dass diese Mikrosomenfraktion aus dem endoplasmischen Retikulum stammt. Das Retikulum wird beim Homogenisieren der Zellen zerstört.

11 - Due to the experiments carried out by Palade and Siekevitz, it became clear in 1956 that this microsomal fraction originated from the endoplasmic reticulum. In these experiments, the reticulum was destroyed by homogenising cells.

28 - Zu den Letzteren gehören die exkretorischen Proteine in Lumen des endoplasmischen Retikulums.

28 - To the latter class belong those excretory proteins found in the lumen of the endoplasmic reticulum.

51 - Sie zeigen alle etwa den gleichen Verlauf.

51 - All these enzymes seem to show the same tendency.

68 - Semidehydroascorbat-Oxidoreduktase mit der gleichen Kinetik, mit der die phospholipoide gespalten werden.

68 - Semidehydroascorbate-oxyreductase which has the same kinetics as the chemicals used in the separation of phospholipids.

Other additions were made throughout the text and for further examples reference should be made to footnotes 6, 44, 49, 50, 55, 56, 60, 67, 77, 83, 88 and 96.

2. Repetitions

These annotations are very closely linked to the previous ones and share their same objective; to facilitate the conveying of meaning where this

is not clear or where this may lead to possible misunderstandings or misinterpretations from the reader. In these cases, the author felt that from the textual point of view, the 'linkage' of sentences into a larger unit (Juliane House p. 29), in other words, the textual aspect lacked a logical sequence which made the meaning obscure, and as such hindered the text from fulfilling its most important function, viz. to inform. This should once more elucidate on the importance of style in the writing of a scientific article, paper or report.

3 - Sie grenzen ein 'Lumen' vom cytoplasmatischen Raum ab.

3 - These membranes surround a 'lumen' in the cytoplasmic region.

98 - Sie kann induziert werden.

98 - Glucose-6-phosphatase can be induced.

3. Syntactic changes

This probably constitutes the most important section of the stylistic annotations. In these cases, the author felt that the translation into English

necessitated structural changes (mostly a mixture of repetitions, additions, sub-omissions and sometimes changing the order between two or more sentences) if the meaning was to be conveyed in a clear and unequivocal manner, an objective which should occupy a prime position in scientific and technical texts. However, it may often happen that the translator is solely concerned with terminological problems (which form the informative part of the text) and fails to bring about these changes in the translation which often facilitate the understanding of the text (intelligibility). Consequently, although the meaning will be put across, the result is often a clumsy and heavy text which is difficult to read and understand as it does not use that 'flowing style' to which any mother tongue speaker would be accustomed. In the opinion of the author, this forms a very important part of scientific and technical translations as the text should not only be accessible to a certain strata of society (educated university professors and researchers) but it should also read smoothly and clearly to a layman, who may obviously not be in a position where he may understand all the terminology. Furthermore, the author feels that these stylistic considerations are of extreme importance as they may influence the understanding of the pure information which the

text attempts to convey. In fact, it was observed in some cases that these stylistic peculiarities were closely related to problems of terminology:

15 - Die Mikrosomen sind biochemisch das Aquivalent für das endoplasmische Retikulum.

15 - From a biochemical point of view, these microsomes are equal to the endoplasmic reticulum.

In this case, the word 'biochemisch' was not translated literally (biochemically) as this may have led the sentence to acquire an ambiguous meaning.

18 - Das Retikulum wird, so vermuteten schon Palade und Siekevitz, ständig in den zellkernnahen Abschnitten, die die Ribosomen enthalten, neu synthetisiert.

18 - Already Palade and Siekevitz assumed that the reticulum is resynthesized in the nuclear area containing ribosomes.

Here the German 'neu synthetisiert' was not translated literally as the English 'resynthesized' is the accepted word.

26 - 80-85% der Gesamtlipide sind Phosphatide.

26 - 80-85% of the overall lipid content is composed of phosphatides.

Once again, the word 'Gesamtlipide' was not translated literally and the more accepted term was used.

38 - Über die 'Heterogenität' oder 'Homogenität' ist viel Widersprüchliches in der Literatur publiziert worden.

38 - Literature published on 'heterogeneity' and 'homogeneity' often provides contrasting views on the subject.

78 - Das trifft zu für die Enzyme, die äusserlich an der Membran hängen.

78 - This applies to enzymes which are located outside the membrane.

In this case the German 'hängen' was not translated literally as the English 'located' is a more acceptable word to use in this context.

There were naturally a number of instances where the translation clearly differed from the original text because of the different structures of the languages. Although these have been included in the annotations, it should be borne in mind that they do not really stem from the translator but are merely dictated by the different structures of the languages. Because of this characteristic, these stylistic changes are often unconscious as the translator will adapt the syntax of the original to suit the language patterns of the language into which he is translating.

7 - Schon 1938, hat Claude beschrieben ...

7 - As early as 1938, Claude described ...

22 - Chemische Zusammensetzung der Mikrosomenfraktion ('Fraktion' is used in the singular).

22 - Chemical composition of microsomal fractions ('Fractions' is used in the plural).

54 - Nicht jedes Enzym kann also wie zuvor im Mittel in allen Mikrosomen gefunden werden.

54 - Consequently, not every enzyme could be found in all the microsomes as had been the case previously.

80 - Anders bei den membrangebundenen Enzymen.

80 - This does not apply to membrane-bound enzymes.

102- ... dass aber der umgekehrte Transport durch die Plasmamembran von innen nach aussen bisher nicht beobachtet wurde.

102- ... that although transport ... has been observed, the same may not be said for the reverse process.

Other such 'subconscious' changes may be found in the following footnotes:

8, 9, 15, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 42, 43, 46, 47, 49, 59, 61, 62, 63, 64, 65, 66, 70, 71, 72, 73, 74, 75, 76, 78, 79, 81, 82. 84, 85, 86, 87, 89, 90, 94, 95, 97, 99, 100 and 101.

Although these changes would seem to account for the most number of syntactic changes made by the translator, the most important ones are without any doubt those which have been made out of choice by the translator. In other words, those changes

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Although these changes would seem to account for the most number of syntactic changes made by the translator, the most important ones are without any doubt those which have been made out of choice by the translator. In other words, those changes

consciously made by the translator would indicate that the translator was aware of possible problem areas in the original and adapted his translation to suit certain stylistic requirements, such as logicality between sentences and flow of style. These changes are also of great importance as they clearly indicate that scientific and technical texts must take stylistic considerations into account and that knowledge of the subject matter discussed in the text is not sufficient, as clearly a good command of the target language is required (for a more detailed discussion on this topic, please refer to the Conclusions).

24 - Die Nucleinsäuren kommen im wesentlichen, wenn auch nicht ausschliesslich in den begleitenden Ribosomen vor. Diese gehören nicht eigentlich zur Struktur der Mikrosomen.

24 - The neighbouring ribosomes constitute one of the major sites where nucleic acids are found, yet they are not part of the microsomal structure.

36 - Wenn man sich das elektronenoptische Bild des endoplasmischen Retikulums vor Augen führt, so ergibt sich die Frage, ob die enzy-

matische Ausstattung des Membransystems in den kernnahen rauhen und den kernfernen glatten Abschnitten verschieden ist.

36 - When one examines an electronmicrograph of the endoplasmic reticulum, the question arises as to whether the production of enzymes in the membrane system of the nuclear area differs from the production of enzymes in the smooth areas remote from the nucleus.

63 - Es kann also keine homogene Schicht von Lipiden und Proteinen vorliegen, sondern Proteininseln und Lipidinseln müssen gemeinsam die mikrosomale Membran bilden.

63 - It therefore follows that there can be no homogeneous layer of lipids and proteins and that these only occur in the form of 'islands' thus forming the microsomal membrane.

89 - Sie beträgt etwa 8-10% des gesamten Enzymproteins in Mikrosomen. Ingesamt wurden etwa 50 verschiedene Enzymactivitäten in mikrosomen gefunden. Sollte ihre molekulare Konzentration in den Mikrosomen etwa gleich der der fünf bekannten sein, müssten sie das gesamte mikrosomale Protein ausmachen.

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89 - The concentration of cytochrome-P-450 contains between 8-10% of the overall amount of enzymal proteins found in the microsomes. There are about fifty different enzymal activities located in microsomes. Supposing that their molecular concentration within the microsomes is the same as the concentration of the five known enzymes, it must then follow that these enzymes account for the total amount of microsomal proteins.

99 - Die Glucose-6-phosphatase gehört aber auch zu den enzymen die nur im Verbund mit einer Membranstruktur aktiv sind. Das spricht dafür, dass sie auch ein vektorielles Enzym ist.

99 - Glucose-6-phosphatase, however, belongs to that class of enzymes which are only active in the presence of a membrane structure and this shows that Glucose-6-phosphatase is a vectorial enzyme.

Other changes which belong to this same category may be found in footnotes 23, 25, 26, 34, 35, 37, 38, 62, 66, 71, 73, 74, 76, 79, 81, 85, 90, 94 and 97.

4. Use of the Impersonal

There seems to be some controversy as far as the use of the impersonal in English is concerned but generally as far as scientific texts are concerned, it is better to keep a 'neutral' and 'objective' style. This may be achieved by not eliciting participation on behalf of the reader and by keeping the distance between reader and recipient. This would seem to fall in line with the broad function of a scientific text which is to pass on information and impart knowledge. If this is to be done successfully, it is unavoidable for the writer to assume a position of superiority (at least as far as knowledge is concerned) in conveying that information. From a purely linguistic point of view, it may be argued that the use of the possessive pronoun 'uns' and the use of the personal pronoun 'wir' do not really elicit addressee reponse as they are not strictly used in a familiar sense. However, the author feels that the use of pronouns in English would elicit some kind of familiarity between reader and author and this would be misplaced in a text of this kind. The fact that the authors of the German article are clearly keeping a distance between themselves and their readers is further evidenced by the constant use of the impersonal pronoun 'man' which is a clear sign of the imper-

sonal. Consequently, if the translator were to retain these pronouns in the translation, they would not be in line with the style adopted by writers of scientific and technical reports who nearly always shy away from using personal pronouns. Although this section did not really pose a problem for the translator, the omission of personal pronouns often meant that the sentence structure had to be changed.

The use of the impersonal in the source text does not seem to follow a coherent line as the impersonal form (shown by the use of the word 'man') is only used occasionally, and the same may be said for the personal and possessive pronouns which are only used when the authors referred to their own experiments. The following are examples of sentences where the impersonal in German was used successfully:

2 - Im elektronenoptischen Bild einer Leberzelle, aber auch von anderen Parenchymzellen, sieht man Doppelmembranen, die die Zelle von der Kernmembran bis zur Plasmamembran durchziehen.

2 - In examining electronmicrographs of liver cells and other parenchymal cells, double

membranes which run through the cell, from the cell membrane to the plasma membrane, may be seen.

12 - Es bilden sich kleine, elektronenmikroskipisch nachweisbare Bläschen.

12 - Small vescicles which could only be seen under an electron microscope were formed.

14 - Unter den üblichen Bedingungen erhält man Teilchen mit einem mittleren Durchmesser von 200nm.

14 - Under normal conditions, particles with an average diameter of 200nm were obtained.

44 - Da die Zahl der Mikrosomen pro mg Protein bekannt ist, kann man errechnen, dass jedes Original-Mikrosom mindestens 5 im allgemeinen mehr Moleküle eines Enzymproteins enthält.

44 - As the number of microsomes per mg of protein is known, it follows that every original microsome must contain at least 5 more molecules than an enzymal protein.

56 - Behandelt man die Mikrosomen kürzere Zeit bei dem eben bescriebenen Experiment mit Ultraschall ...

56 - If the microsomes are exposed to ultrasound for a period of time which is shorter than that prescribed in the experiment ...

70 - Man kann auch optisch verfolgen, wie in Gegenwart der höheren, bereits hemmenden Mengen von Detergens sich die Membranen auflösen.

70 - The way in which the membranes dissolve in the presence of higher amounts of detergent which also possesses an inhibitive quality, may also be observed visually.

91 - Man kann aber sich fragen, wie sie in eine gesamte Zellfunktion einzuordnen sind.

91 - Nevertheless, how these activities integrate in the overall cell functions should be investigated.

92 - Macht man sich klar ...

92 - If one accepts ...

It may be seen from the abovementioned examples that it was quite simple to keep the use of the impersonal in English, provided that this was also used in German, however, a few changes had to be made in cases where the English retained the use of the impersonal despite the fact that the German used another, more casual form (such as the use of personal and possessive pronouns):

41 - Um die theoretische und experimentelle Grundlage unserer Untersuchungen zu erläutern, sie zunächst auf Tabelle 2 hingewiesen.

41 - In order to explain the theoretical and experimental criteria employed in the experiments carried out by the authors, Table two should be examined.

52 - Um diesem Einwand zu begegnen, haben wir weitere Versuche gemacht.

52 - ... to prove that it is, further research was undertaken.

53 - Wir hatten, wie erwähnt, berechnet, dass pro Original-Mikrosom mindestens 5 Moleküle eines Enzyms vorkommen.

53 - As expected, it was calculated that at least five enzymal molecules would be found for every original microsome.

72 - Wir haben versucht, die durch Detergentien inaktivierten Mikrosomensuspensionen zu reaktivieren, indem wir andere, enzymatisch inaktive, Membranstrukturen zusetzen.

72 - Microsomal suspensions which had been previously de-activated by using detergents, were tentatively re-activated by adding other membrane structures which are enzymatically inactive.

Annotations of a Terminological Nature

Whereas the stylistic peculiarities exhibited by both source and target texts mainly deal with the intelligibility of the text (although as we have seen the concepts of intelligibility and informativeness overlap and go hand in hand when it comes to an overall understanding of the target text), terminological problems may be said to affect the informative function of the text. The reader should not presume at this point that terminological mismatches between the target and the source text are not important simply because so much has been said about style and the general char-

acteristics exhibited by a scientific text. In fact, unless the translator has some knowledge on the subject matter discussed in the source text, it would be very difficult for him to achieve an adequate translation. Naturally a translator cannot be expected to be familiar with a large number of scientific concepts and phenomena and it will often be necessary for the translator to acquire some background information on the subject before even attempting to translate a scientific text.

In the case of this translation, the author was more or less familiar with the subject matter discussed in the source text although frequent reference had to be made to extralinguistic sources in the form of specialised textbooks, reports dealing with related topics and expert advice. Although the translator's reliance on extralinguistic sources is not a novel idea, it forms the basis for the translation of scientific and technical papers as these are often characterised by a number of highly specialised terms which even the best bilingual dictionary may not list. Interestingly enough, terminological problems involving difficult or very complex terms were easily solved by the translator by either reading up on related topics or seeking expert advice. It was however found, that often simple words would acquire a totally different meaning when viewed in the specialised context of the

source text. Pinchuck states that: "the dictionary can also inform us of the different meanings of words that stand for more than one thing, but it cannot tell us how to select the right meaning when the word occurs in a text for translation" (Pinchuck 1977). Consequently, not much may be said about complex terminology as a good text book will often solve the problem. The table below lists those words which may acquire a dual meaning according to the context in which they are used and also includes those words or terms which necessitated the help of extralinguistic sources. The definition is given in German, and then a comparison is drawn between the meaning found in a 'normal' dictionary and the acceptable translated term. The brackets show how the author arrived at the final version. Where the term was not found in the 'normal' dictionary (Collins or Langenscheidt), the words 'NOT FOUND' have been listed under that specific entry. Where the author felt that that was the best term to use in view of the 'area of operation' of the text, the term 'acceptable term' has been added in brackets. Finally, it should be borne in mind that the list is by no means exhaustive as it only delineates some of the more common examples found in the text. The number in the margin refers to the footnote.

German Term	Collins/ Langenscheidt	Final Version
1 - Elektronop-tischen Bild	NOT FOUND	Electron micrographs (GENERAL BIOLOGY TEXTBOOK and also ACCEPTABIE TERM)
4 - Nähe des Kernes	Vicinity of the nucleus	Nuclear area/ region (ACCEPT-ABLE TERM)
5 - Rauhes (endo-plasmatisches Retikulum)	Rough/Raw/Hard (endoplasmic reticulum)	Rough (endoplas-mic reticulum) (ACCEPTABLE TERM)
10- Untersuchung	Examination/ investigation	Experiment (ACCEPTABLE TERM)
13- Kunstprodukt	Artificial product	Synthetic pro-duct (SPECIALI-SED TEXT BOOK)
16- Auf und Abbau	Buildup and Breakdown	Ageing and Regeneration (SPECIALISED TEXT BOOK)

19 - Peripherie	Periphey/ Circumference/ Outskirts	Exterior/outside of the cell (GENERAL BIOLOGY TEXT BOOK AND ACCEPTED TERM)
26 - Gesamtlipide	Total (lipid)	Overall (lipid contents) (GENERAL BIOLOGY TEXT BOOK AND ACCEPTED TERM)
58 - Enzymaktivität	Enzymal activity	Enzymal function (GENERAL BIOLOGY TEXTBOOK AND ACCEPTED TERM)
66 - Mizellar	NOT FOUND	Micellar (SPECIALISED TEXTBOOK)
69 - Detergens	NOT FOUND	Detergent (SPECIALISED TEXT BOOK)
93 - Stoff-transport	Substance (transport)	Transportation of metabolites (SPECIALISED TEXTBOOK AND EXPERT ADVICE)

103 - Glucuron-säure	NOT FOUND	Glycolic acid (EXPERT ADVICE)

C O N C L U S I O N S

During the course of this translation project, some of the more important aspects of technical and scientific translations were highlighted. However, at this point, a few comments should be made concerning the salient features of technical and scientific writings. It was seen in the Introduction that Pinchuck offered a valid categorisation of scientific texts and subdivided them into the broad categories which allow the translator to facilitate the difficult task of categorising the text. The author feels that this probably constitutes one of the most fundamental principles of translation, as only after knowing what kind of text he is dealing with, will he be capable of attempting a translation which is 'adequate' and which displays 'equivalence of meaning' (a very important concept, particularly in the field of scientific and technical translations). Throughout the process of translation, the translator should remember that the text does not exist 'per se' as any text will always be geared to a specific addressee. With this in mind, it is important that the translator conceptualise the form which the translation is going to take, not only from an 'informativeness' point of view, but also taking the 'intelligibility' of the text into consideration. This translation project has attempted to highlight the salient components of which the translator should be aware and these include features such as stylistic considerations (how the text is written), the register

used in the text, simple or complex conveying of meaning (evidenced, for example, by complex terminology and involved grammatical constructions), range of vocabulary and choice of words) as well as purely terminological problems. To this end, the translator must carefully analyse the source text even before attempting a translation and this may prove to be a difficult task unless a rigorous and coherent method is used. This translation project has attempted to show the validity of Juliane House's translation evaluation theory for these purposes and the author believes that the categorisation of first source and then target texts according to the eight situation dimensions outlined in the theory, provide the translator with an adequate 'yardstick' against which he may measure these characteristics (in other words, the text's 'area of operation') and come up with a 'textual profile' for the text. Nevertheless, the final word must be left to the translator and this may prove difficult especially when the translator is left with the task of having to evaluate his own work. This problem has already been mentioned in this translation project and a number of theories and ideas have been developed to help the translator who is faced with this predicament. These methods include the Cloze technique elaborated by Nida and Taber which measures the degree of 'predictability' of the text, but perhaps reference should be made to a rather interesting study undertaken by Carroll in

1966. Carroll gave a number of scientific passages translated from Russian into English to two groups of subjects so that they could analyse its 'informativeness' and its 'intelligibility'. The former was analysed by people having a high degree of knowledge in the subject matter while the latter was analysed by people who displayed high verbal intelligence and excellent proficiency of the target language (all were in fact English mother tongue speakers). Such a method seems to test both the structural adequacy of the translation (from a stylistic point of view) as well as equivalence of meaning (from a terminological point of view). However, there are a few drawbacks in the employment of this technique, the most important being that it is a time consuming effort especially when dealing with very long translations. Furthermore, the availability of suitable subjects also poses a great problem. The translation evaluation theory elaborated by Juliane House seems to provide a coherent and practical method by which the translator may be made aware of possible problem areas in the source text. This allows the translator to predict the possible pitfalls which lie ahead and be aware of them during the actual process of translation.

In the case of the translation discussed in the course of this translation process, the text displayed the

same characteristics found in scientific texts of the same kind, and after a careful analysis of both source and target texts, the following conclusions could be drawn about the salient features of such texts:

1. The text is highly specialised and has a high degree of informativeness.

2. In line with texts of this kind, the source and target texts made use of unmarked, standard language, free from any subjectivity markers.

3. The main aim of the text was to convey meaning. In this light, language was used economically and any redundancies or repetitions in the language were avoided at all costs.

4. The conveying of meaning was done in an impersonal, uninterrupted way. In other words, the text displayed a non-alternating passing on of information.

5. Finally, the text displayed a high level of complex terminology which clearly defined the text's 'area

of operation', viz. scientific, and more specifically, cellular biology. Due to the frequent use of specialised terminology, the text was straightforward and brief in its conveying of information.

This translation project also attempted to highlight the fact that 'mismatches' from a stylistic point of view (intelligibility of text), may also often affect the informativeness of the text (such as the understanding of specific concepts which may be obscured by stylistically clumsy sentences or the inappropriate choice of words. In the sections on 'analysis of source text and statement of function' and 'analysis of target text and statement of function', the texts were analysed and the annotations highlighted some of the mismatches which existed between the source and the target texts, and in conclusion, it would be interesting to display these 'mismatches' visually by means of graphs. To this end, four graphs were drawn: two displaying the three parameters for the dimensions of language user for target and source texts, and two displaying the five parameters for the dimensions of language use also for both source and target texts. It will be noticed that as far as the dimensions of language user were concerned, no changes were recorded. This does not necessarily mean that the translation did not ex-

hibit mismatches vis à vis the source text, instead, it seems to corroborate the idea that any scientific or technical text is characterised by the absence of external influences such as dialect, archaisms, etc. (Refer to Graphs one and two.)

On the other hand, the dimensions of language use show some mismatches between the source and target texts. It should however, be borne in mind that these changes were made by the translator because he deemed fit. In other words, they were his own choice (for example, the different way in which the impersonal is used in the target text vis à vis the source text, syntactic changes, etc.). As such, these only constitute mismatches from a structural point of view and not from an informative point of view. (Refer to Graphs three and four.)

Finally, the importance of style is further backed by the fact that only 13 out of 103 annotations dealt with terminological problems.

In conclusion, it seems that the extent to which any translation may be classified as adequate, will depend on choices made by the translator, whether these include

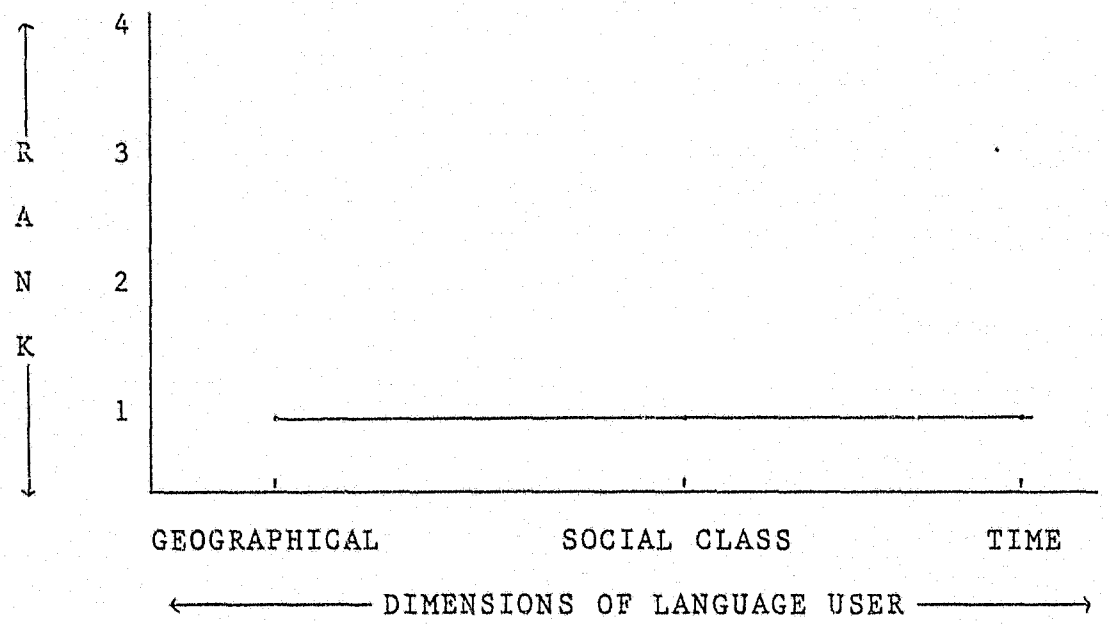
the choice of a specific word (terminology) or the restructuring of a sentence of a paragraph (stylistic). Ideally, the translator should reach an equilibrium between these two important components, and in the case of a scientific translation, the translator will be more limited in the choices he may make due to the highly rigid structure of the text (mainly from a terminological point of view, but also from a scientific one). This translation project attempted to show that if the translator is familiar with the subject matter discussed in the text, he will possess more 'freedom' in the translating process and will not always be bound by terminological problems. This statement leads to a final controversy existing in the field of scientific and technical translations: 'In the final analysis, who may be considered the most competent person to tackle a scientific translation - a scientist or a translator?'. Views differ greatly on this subject but the author strongly feels that the task of translating rests ultimately with the translator, who, in cases such as these will have to familiarise himself with the subject matter under discussion before even attempting a translation. As has been seen, this may be done in a number of ways: specialised dictionaries and extralinguistic sources such as specialised text books and expert advice. The author believes that a translator who has acquired the necessary background information will possess the skill to detect nuances

within the language and to render a translation which is "adequate vis à vis the normal standard usage of native speakers in a given situational context" (Juliane House p. 21).

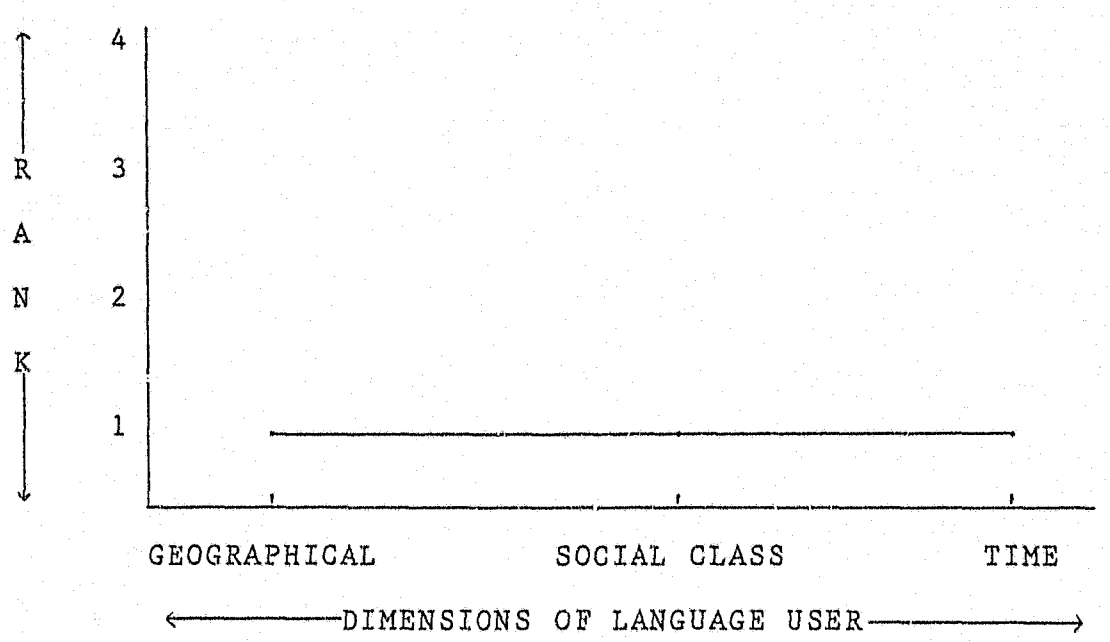
In the final analysis, translation is not a strict science but rather: "a creative process which always leaves the translator a freedom of choice between several approximately equivalent possibilities of realising situation meaning" (Levy, in Juliane House p. 21).

A P P E N D I X

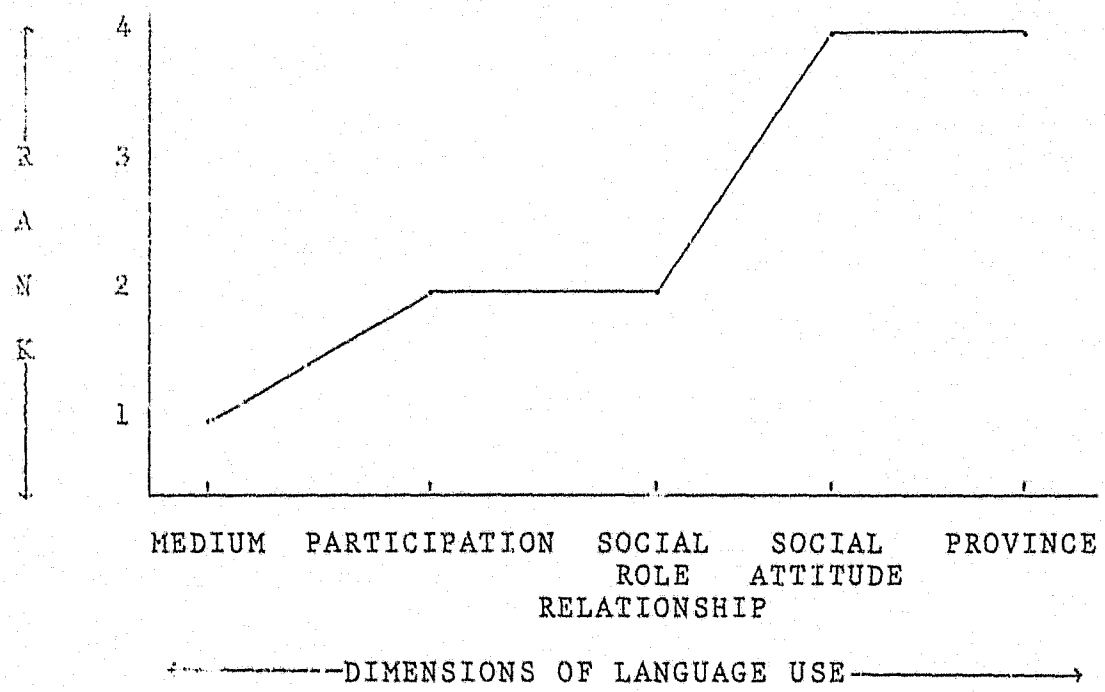
GRAPH 1 : SOURCE TEXT



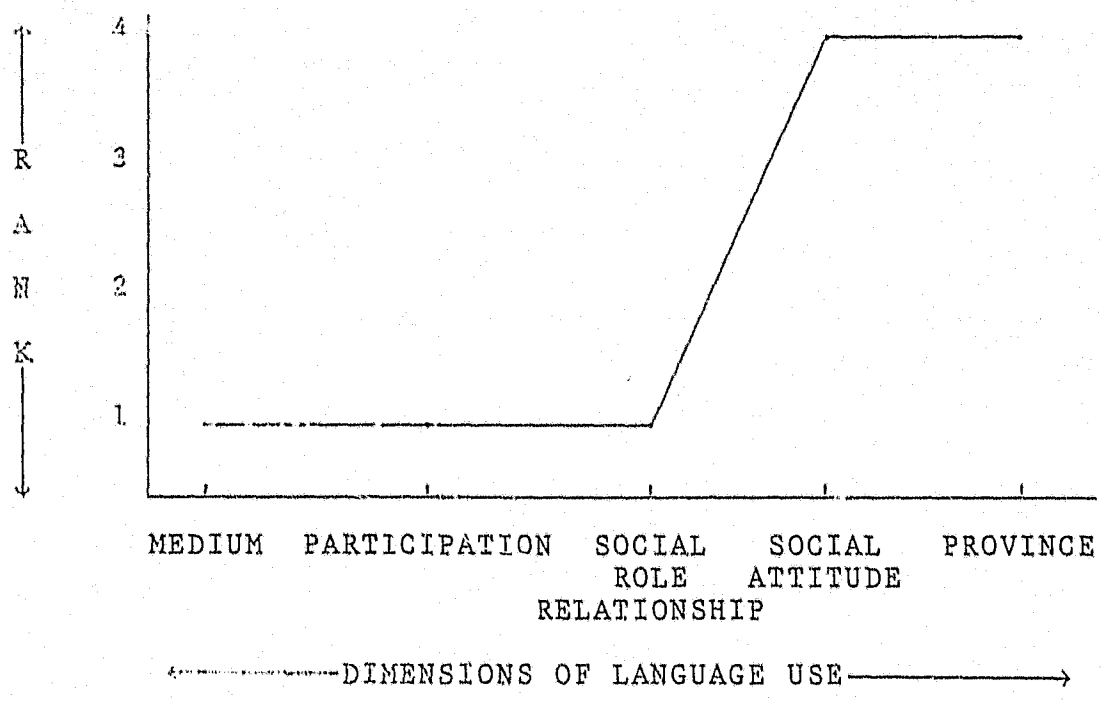
GRAPH 2 : TARGET TEXT



GRAPH 3 : SOURCE TEXT



GRAPH 4 : TARGET TEXT



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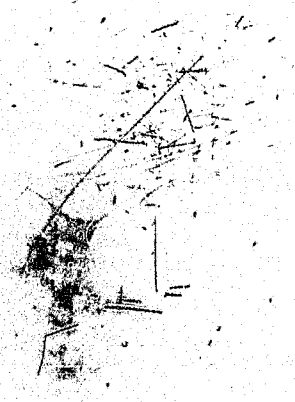
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