# VALIDATING A MODEL OF INFORMATION STRUCTURE IN WRITTEN ENGLISH THROUGH A READING PROTOCOL[1]

Nick Moore
Khalifa University of Science, Technology and Research
United Arab Emirates

This paper investigates reasons for the uneasy relationship between Systemic Functional Linguistics (SFL) and the discipline of psychology. It proposes a role for psychological data in SFL, and describes a case study that attempts to combine the methodology of psychology with SFL's discourse-based approach to language. The case study examines the interpretation of the data obtained from a psychological approach to the SFL puzzle of information structure in written English, and provides evidence to suggest that the SFL notion of information structure has psychological validity.

KEYWORDS: data interpretation, information structure, psychology, phenomenology, Systemic Functional Linguistics (SFL)

## 1 INTRODUCTION

A criticism that is sometimes levelled against Systemic Functional Linguistics (SFL) by other fields of linguistics is its apparent lack of interest in a psychological perspective or desire to develop an underlying psycholinguistic basis to its theories of discourse. While other functional linguistic theories, such as Functional Grammar (FG) and Role and Reference Grammar (RRG), are committed to exploiting psycholinguistic research, this rarely applies to SFL (Butler, 2003; 2008). Notable exceptions that are SFL-inspired often make explicit the lack of psychological theory, or purposefully incorporate psycholinguistic theories (*e.g.* Clark and Chafe for Lassen, 2003, and Grosz and Sidner's Centering theoy for Emmott, 1997). Emmott (1997) notes that SFL takes up an ideological position by leaving its psychological theory of language implicit, particularly in contrast to mainstream linguistic theories which depend heavily on theories of psychology, especially those inspired by Chomsky's view of linguistics as a sub-field of psychology.

[1] My heartfelt thanks go to David Vernon, whose kindness, wisdom and patience sparked my interest in these issues, and whose valuable feedback greatly improved an earlier draft, to Eileen O'Brien for help and encouragement, and to Geoff Thompson and Michael Hoey for guidance and inspiration. None of these people, however, should be held responsible for any errors or omissions in this paper.

This criticism of SFL will be addressed later in this paper. However, before SFL and psychology can converge a number of changes need to be made. The first need for change is for the discipline and sub-disciplines of psychology in general, including many branches of psycholinguistics, to examine a range of questionable premises. An adequate functional theory of language should not be based on psychology until it can trace its theories back to biological descriptions. The developments in neurobiology that demand change in psychological descriptions of language will be reviewed in the following section, before looking at the implications for SFL.

## 2 THE NEED FOR CHANGE IN PSYCHOLOGY

There is little that can be said of psychology's support for the ideological status quo that cannot be said about other social sciences. In my view what distinguishes psychology as a discipline is that it has been more resistant to reflexivity in its methods and beliefs; it has been less willing to examine its philosophical basis in a positivist philosophy than most other disciplines, including those in the "hard" sciences. This has resulted in practices and theories that pay no attention to their ideological basis, and therefore could easily result in theories that are dependent on the current socio-economic historical moment:

> In addition to the challenges about its 'empiricism, objectivism, behaviourism, operationalism, reductionism, materialism, mechanism, universalism' (Gabreyna, 1998, p.50), as well as its ethnocentrism, racism, scientism, and sexism, psychology has recently come in for criticism regarding its individuocentrism. (Holdstock, 2000, p.88)

Without considering the possibility that the search for individual differences, for instance, is a result of modern consumer-driven capitalism and neo-liberal politics, psychological studies that take the individual as an unexamined concept cannot claim universality – the ultimate aim of psychology.

In establishing itself as an academic discipline, mainstream psychology has adopted a positivist deterministic paradigm, fundamentally relying on a Cartesian split between mind and body. With this split, psychology is free to study the mind as a separate entity to biology, sociology and language. A representationist view of language is a natural response to this condition (Thibault, 1999). Thus, most linguists who have adopted a contemporary psychological perspective (pre- or post-behaviourist, or cognitive) have been limited by the representationist paradigm. This partly explains the apparently impoverished view of language taken by many linguists when seen from an SFL perspective. As opposed to the multi-functional nature of language in an SFL paradigm, many linguists restrict themselves to ideational features of syntax, proposing that other features of language belong to non-grammatical domains such as pragmatics because they cannot be explained by the presumed logic-based structures (Thibault, 1999). It must be remembered, however, that logic is an abstraction of one aspect of natural language – the ideational – and so any description derived from logic will be inadequate to represent all language.

Representationist theories of language have been well served by the discipline of psychology, while linguistic theories that adopt a phenomenological paradigm have been left waiting for an adequate psychological explanation for language. It is therefore easy for a linguistic theory based on an inadequate theory of the mind – one that assumes that language is based on representation within a logic-based tradition – to claim 'anti-mentalism' for theories that are waiting for psychology to catch up with a general theory of relativity in physics, autopoiesis in biology, systems theory in sociology and systemic functionalism in linguistics. With the central concept of ideational aspects of language acting to *construe* reality within a social context, SFL has long positioned itself in the phenomenological tradition.

The developments in all natural sciences that are promoting a new perspective, threatening a paradigm shift, include quantam theory in physics, complexity in social science, and autopoiesis in biology. They all have at least two things in common:

1. they deal with interactions, relations and dynamic systems rather than descriptions and states.
2. they are relativistic, in that they see their observer's role as one part of the dynamic – the observer is always a part of the observation. That is, philosophically they are aligned to a phenomenological perspective.

That is, these developments are more philosophically aligned to SFL than the previous models of science based on the logical positivism that is still the underlying model of most modern psychology. A phenomenological psychology does not yet seem to have materialised.

Phenomenology is proposed as a solution to the Realism-Idealism impasse. Realists hold that the outside world is all that matters. We perceive reality. Realism says there is a reality out there – all we have to do is try to understand it. In this approach the mind becomes the only reality that we can be sure of. This approach is highly influential in modern society. The idea that a scientist or journalist can possibly be "objective" derives from the assumption that they detach themselves from the situation and comment dispassionately on the situation. In contrast, Idealists claim that reality is defined by our perception of it. We can perceive objects into existence through empirical methods. It claims that all of reality is contingent on our understanding. Therefore, some will argue that there is no objective truth – that there is only your truth and my truth and they are equally valid.

Both extremes present problems. In an idealist doctrine, there can be no mutually-agreed reality. This does not match up to our experience, because we can easily share perceptions that appear to match in all conceivable ways. In a realist doctrine, the mind aims to **represent** external reality. It is thus separate from reality, and so we must account for the mechanisms and processes used for representation. This has yet to be accomplished.

Many linguists automatically speak the Realist language of representation because they are entrenched in the consequent brain-as-computer metaphor, with syntax as the

"operating system" and words as data. To provide just one example, on rejecting Mithen's (2005) thesis that phylogenetically it was the "Singing Neanderthal" that laid the evolutionary foundations for language, Tallerman (2006) seems unable to use any other metaphor to describe the functioning of the linguistic brain:

> Problem number one: each utterance also has to be stored as a single concept in the hominin's mental lexicon, and retrieved from storage to be uttered. (p.106)

It is Realism that has dominated scientific thought through the industrial and post-industrial eras. Classical physics and biology model an external reality and explain *universals* that exist "out there". What is still missing in this framework, however, is a model of the nature, structure, organisation and processes of the mind-as-computer in relation to the body, including the physical brain. Dualism has separated a metaphysical mind from the physical brain – a mystery that has been perpetuated rather than solved by modernist cognitivism.

Phenomonelogy is attributed to Edmund Husserl who developed Kant's division between *noumena* and *phenomena*. Noumena can be glossed as the 'essence' of an object, while phenomena are that part of the object visible to the observer. Consequently, the position of the observer must be taken into account when any observation takes place:

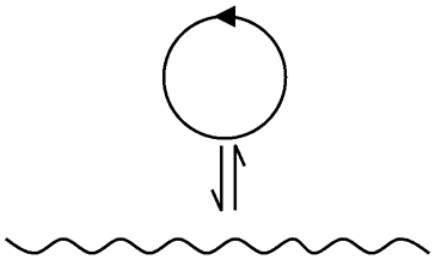
> We play a rôle in defining reality, but only insofar as it affects us as individuals (the idealist aspect), that is, insofar as it affects our experience of reality; the reality that we perceive does exist (the realist aspect) but our perception and conception of it is conditioned by our experience… As perceivers, our perceptions of the world are a function of what we are: reality is conditioned by experience and experience is conditioned by the nature of the system and its history of interaction with reality. (Vernon and Furlong, 2007, p.55)

I would add that as our experience is meaningfully construed through the linguistic system (Halliday and Matthiessen, 1999) it will always be dependent on the personal experience of our culture and linguistic system. While we may be able to have experiences without language, we will not be able to make sense of them without it; 'languaging' is an integral part of our being and doing.

The practical outcome of an interest in phenomenology in the natural sciences is that of enactive systems. Maturana and Varela (1992) use the phenomenological concept of autopoiesis as the cornerstone of their biological theory of cognition, which allows the environment to take up a significant role in the development of an individual. The crucial role of the observer is stated thus: "Behavior is not something that the living being *does* in itself (for in it there are only structural changes) but something we point to." (Maturana and Varela, 1992, p.138) We can only see the effects of structural changes. When someone withdraws their hand from a source of heat, the heat is only a trigger. The behaviour is the observable result of the system seeking to maintain structural balance within itself and with the environment, including other organisms, but we cannot observe the structural change itself. This is described diagrammatically

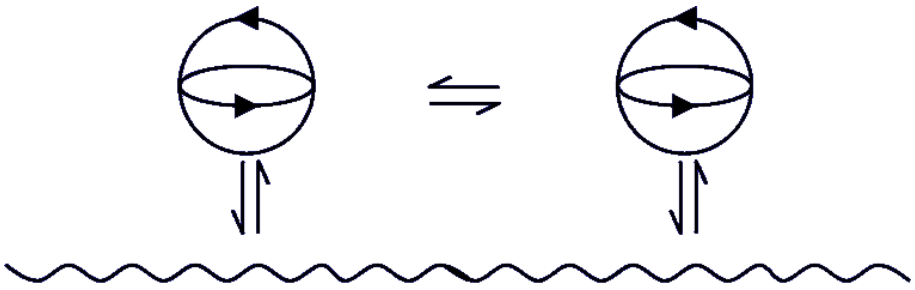
(Fig. 1) as an autopoietic organism (one that is genetically re-constituting) maintaining autonomy in response to a perturbation in the environment.

Fig. 1 Interaction of an individual and the environment (from Maturana and Varela, 1992)



What distinguishes 'lower' (e.g. single-celled organisms) from higher forms of life is the nervous system and so the possibilities for interaction are greatly increased as the picture is made more complex with the addition of an internal central nervous system and other individuals (Fig. 2).

Fig. 2 Interaction of an individual with a central nervous system, the environment and another individual (from Maturana and Varela, 1992)



Maturana and Varela (1992) describe language (specifically, the process of *languaging*) as *linguistic trophallaxis* – it is through language that social interaction and roles are enacted. Trophallaxis is the archetypal process of social interaction whereby social roles (the ontogeny of an individual) are specified and communicated by chemical transfer. For example, in an ant colony a chemical that is passed from one ant to another changes the

structure of the receiving organism, and to maintain balance its behaviour is immediately modified, which benefits the colony as a whole. Many animal species use visual and auditory exchange to achieve ontogeny. Humans probably use language more than any other system to assign and maintain social roles. Most importantly in terms of phenomenological philosophy, the structure of an organism does not require a mind that is separate from a body or from behaviour to enact its social role. Structural closure (maintaining balance) and recursion in the central nervous system (exemplified by Arbib's (2000a, 2000b) mirror neurons and Edelman's (1999) re-entry) result in reflection and, ultimately, a form of consciousness. Consciousness for Maturana and Varela (1992) is achieved through re-entrant languaging. This means that there is no separate module that first 'thinks' and then requires language to transmit that thought to the outside world. Meaningful thought is only achieved through language (Thibault, 1999), and communication is a consequence of the process of languaging.

It is important to remember that this is most definitely not a traditional model of information transfer. For Maturana and Varela the model of

> Signal – Encoding – Transmitter – Medium – Receiver – Decoding – Signal

is "basically false". A signal, or perturbation, created by one organism does not *cause* a change in another. A perturbation in a structure can *trigger* a change if and only if the structure registers the perturbation, so the

> phenomenon of communication depends on not what is transmitted, but on what happens to the person who receives it. And this is a very different matter from "transmitting information". (1992, p.196)

Remembering that the observer can only make an observation from a perspective external to the organism, changes in the balance of the organism with its environment (its 'structural coupling') can be observed, but this is not the same as explaining its behaviour, verbal or non-verbal. Communication as a form of behaviour is thus inherently social and functional, and at best can only function because it is the result of the process of construal by each individual correlating the perturbations of the environment with their own experience, rather than an attempt at reflecting identical representations of reality.

One psychologically-based premise that has recently come in for a lot of criticism is the argument for the "poverty of stimulus" which maintains that the brain must be hard-wired for language structures because there is inadequate environmental input to result in the variety of structures produced by learners. Pullum and Scholz (2002; Scholz and Pullum 2006) review the premises of the argument of the poverty of stimulus and demonstrate that the empirical evidence provided is inadequate, inaccurate or incorrect. The 'poverty of stimulus' arguments are central to the claim that descriptions of the physical brain are inadequate to explain the linguistic mind. As Tomasello (2004) points out, without arguments such as the poverty of stimulus, the Universal Grammar project (the largest most well-supported research project in linguistics) fails to stand up to

scrutiny and as a result there is a lack of agreement on how Universal Grammar could be falsified.

Computer simulations by Luc Steels (1997, 2000) demonstrate convincingly that language emerges within an environment, as organisms are required to interact in order to survive. We therefore no longer need a "Language Acquisition Device", or any kind of 'hard-wiring' in the brain, short of that necessary for learning in general, as phenomenological approaches to artificial intelligence and learning have demonstrated that it is possible for language to develop without any preconditions such as a Universal Grammar.

We may ask why these developments in biology and computer science are significant for a dialogue between psychology and SFL. SFL is essentially neither Realist nor Idealist, but phenomenological in its approach. Through the concepts of ideational construal, interpersonal enaction, and textual interaction (Halliday and Matthiessen, 1999; 2004), SFL takes neither a representationst approach to the mind nor an isolationist approach to culture. Developments in neurobiology and computer science – fields that have traditionally depended on psychology for empirical support – could influence psychology so that it is able to adopt a more phenomenological approach, allowing SFL to integrate psychological arguments and methods more readily than previously. If SFL can ally itself with developments that share a broadly sympathetic philosophical approach (*i.e.* phenomenological), it can start to improve those areas of theory (including psychological implications or sociological models) that have depended in the past on 'external' sources.

## 3 THE NEED FOR CHANGE IN SFL

While the preceding discussion may appear to be dismissive of psychology in general, it would seem unwise to suggest that language is not in some part psychological. However, the preceding discussion demands a psychology based in phenomenology. One must consider, then, the characteristics of such a psychology, and one must attempt to identify those areas of psychology that may be currently incorporated into SFL. One place to look is probably in the area of methodology. This will be investigated later in this section. Other developments in and around SFL also advance changes in the way SFL can legitimise its claims.

The main criticism that needs to be countered by psychological approaches to SFL is that SFL is not psychologically adequate. Butler's (2008) response is to draw inspiration from psychological studies, Dik's Functional Grammar, and van Valin's Role and Reference Grammar in order to find support for SFL concepts and theories. However, as I have tried to demonstrate in this paper, that approach could result in adopting findings that are based on a philosophical stance potentially incompatible with SFL.

In response to the criticism of inadequate attention being paid by SFL to psychological matters, it could be argued that in fact SFL has already started incorporating many concepts that will help it feature both psychological and neurological descriptions,

starting with Halliday's (1995) discussion of Edelman's work. Halliday and Matthiessen (1999) set out a clear and detailed description of a constructivist, phenomenological grammar of the ideational metafunction in English. Thibault (1999; 2004a; 2004b) has also developed various arguments, partly based on Lemke's ecosocial theory (1993, 2000), that demonstrate how a neurologically-based theory of social semiotics can be used to describe language development.

Similarly, linguistic theories that impinge on SFL appear to be converging to develop a more convincing position for a psychological perspective in SFL. Lamb's theory of neural 'pathways' (1999) lends support to a non-representational theory of language that can be modelled in neurological processes. Maturana and Varela's (1980; Maturana and Varela 1992) biology of cognition has had a significant effect on computational cognition and artificial intelligence which is likely to feed back into related disciplines, and an autopoietic linguistics is in development (Kravchenko, 2002; 2006; 2007). Finally, with SFL theorists involved in primate language research (Benson and Greaves, 2005), there seems to be no time like the present for integrating SFL and psychology.

If the philosophical distances between psychology and SFL were not enough, methodological factors have ensured a cool relationship. When psychological experiments use language, (and throughout we are discussing in very general terms even though it may be possible to identify a small number of studies that buck these trends), they traditionally fail to take into account the many aspects of discourse that SFL have shown to be factors in creating meaning. Four representative, rather than exhaustive, examples are given below.

1. Psychology typically models language from a representational viewpoint; language is only seen as representing a separate external reality – language is the mind's 'metalanguage' for ideas that already exist. This is a perspective that does not align with the SFL view that language construes reality, and that ideational meaning is only one function of language (Halliday and Matthiessen, 1999; 2004; Thibault, 1999).
2. From an SFL point of view, psychology generally fails to take discourse into account. Even when it claims to be accounting for context and co-text[2] (a distinction many fail to understand), it generally offers invented mini-texts with no other language features apart from those under study. This patently does not match the role of language in context, which simultaneously operates through the Textual, Interpersonal and Ideational metafunctions.
3. Psychology has traditionally served formal theories of language, often based on a predicate logic and depending on (unspoken and unchallenged) theories of language acquisition (*cf.* Halliday's (1975, 1993) language-based theory of learning) and linguistic transformations. This has not helped to develop a positive relationship between psychology and SFL.

[2] Co-text refers to the surrounding language, while context refers to the broad context of culture, as well as the context of situation including all of the physical and non-verbal elements of the concurrent situation (Halliday and Hasan, 1985).

4. SFL has anthropological and sociological roots. It is a theory of social semiosis; of meaning-making in society (Halliday, 1978). Mainstream psychology is not. There are undoubtedly fears that introducing psychology into SFL, especially in its mainstream individual-centred rather than social-centred form, would dilute this important perspective. That fear must remain, while attempting to show psychological validity for SFL theory.

Assuming, then, that SFL can expect to find more studies in psychology that reflect a phenomenological view of the mind and language, it seems that SFL should establish a range of guidelines that would help to produce studies compatible with SFL theory. For instance, it would be most unfortunate for a phenomenological psychology to continue assuming that a sentence can represent language use in all conditions. A major requirement of a phenomenological psychology would be to regard a text within a specified contextual configuration (Halliday and Hasan, 1985) as the basic unit of language; the Genre and Register of a text are vital to its function and meaning.

An SFL approach to psychology should derive theory from SFL theories, from theories of the mind, body and brain that correlate with neurological findings, and with a phenomenological perspective which recognises the central role of the observer, rather than from formal approaches to language and representationist approaches to psychology.

SFL can benefit from the methods of psychology, while maintaining the important characteristics that distinguish it form other schools of linguistics. SFL will be strengthened with falsifiable, verifiable experiments into discourse processing by human subjects that support SFL theory. While corpus and discourse analysis repeatedly demonstrate the viability of SFL models of analysis, it is difficult for these studies to claim that this is how humans derive meaning from text. Psychology methodology can thus be employed by SFL to enhance its claims, as long as experiments are based on SFL theories of language and are not expected to build SFL theory. This will allow quantitative psychological measures to be used alongside the increasing range of quantitative measures of text analysis used in SFL studies, as well as a wide range of qualitative measures.

The remainder of this paper outlines a project which attempts to combine the linguistic insights of SFL with a methodology derived from psychology. The implications for a theory of information structure in SFL, and for the interpretation of the data derived from the experiment, are also examined.

## 4 CASE STUDY: INVESTIGATING INFORMATION STRUCTURE IN WRITTEN ENGLISH

Various studies have attempted to apply the SFL concept of information structure to written English. Information structure separates the stream of language into meaningful chunks, with New information, realised by the change in intonation contour, as the intended focus of the information unit. The difficulty lies in the fact that information structure was originally devised to describe the meaningfully-structured contribution of

intonation to speech (Halliday, 1967), but intonation is not realised in written English. Davies (*e.g.* 1994) describes the different modes as sharing a prosody, which ultimately relies on the ability to read a text aloud to verify the 'inherent' information structure. Fries (*e.g.* 1992) coined the term N-Rheme to delineate the final main element in the main clause of a complex as the unmarked location of New information in written English, roughly the same position labelled by Martin (1992) as New and Matthiessen (1995) as Culmination. Across clauses, Themes produce a Method of Development (Fries, 1995) and News produce the Point(s) (Martin, 1992) of a text.

While text analyses have often drawn on these concepts, none have been demonstrated to have any real psychological validity. It is not clear in what sense we may say that an intonation contour is inherent in written text, or that we hear intonation when reading, or that the final position in a clause or complex is significant. We can demonstrably recognise intonation in speech, but it is not easy to find psychological experiments that have demonstrated an equivalent device working in human subjects while reading. There is no shortage of studies in reading, some which maintain that we need to 'hear' the sounds to read (Rayner, Pollatsek and Binder, 1998), some which suggest we do not (Jared, Levy and Rayner 1999), and some that suggest we both see and hear when reading (Lee *et al.* 1999). None of these studies, to my knowledge, however, have investigated the SFL insight that the resource of information structure correlates with grammatical structure only in the unmarked case. Neither have the concepts of N-Rheme (Fries, 1992), Culmination (Matthiessen, 1995) or hyper-New (Martin, 1992) been strengthened by psychological investigations into subjects' perceptions of them.

Bearing in mind, then, the hazards, pitfalls, and methodological traps of most psychology experiments, in addition to the philosophical and linguistic requirements described above, the following case study attempts to investigate information structure in written English using a methodology derived from psychology. We are thus attempting to demonstrate the psychological reality of this analytical concept. Initial hypotheses centre on the following issues:

- Is information structure realised in written English?
- If intonation is not realised in written English, how is information structure realised?
- If information structure in written English is realised by sequence, where does that leave the role and functions of Theme and, more importantly, Rheme?
- If information structure and Rheme have the same realisations in written English (as predicted by N-Rheme and Culmination), does this make them the same?
- Does the original functional decoupling Halliday performed when separating Theme from Information Structure for speech no longer apply to written text, because you can no longer combine Theme with New?
- What is the status of the function of information structure – as in the focusing of the reader's attention on *newsworthy* items by the writer – in written text when the more common view of new vs. old information, as understood by

psycholinguists such as Prince (1981) and Clark (and Haviland, 1977), is realised in SFL as Martin's Presenting and Presuming?

- If information structure is not realised in written text, does that mean that written text can function without it? If so, what are the implications for SFL?

The 'standard' approach is to equate New information with final position in a clause (*i.e.* Matthiessen's "Culmination"). One way to validate this view of written information structure would be to ask a number of people to read the text aloud and correlate the intonation patterns produced by different readers (Davies, 1986). However, I would suggest that we approach linguistic meaning differently when reading or listening as a result of the different affordances offered by the constraints of the visual and auditory systems.

Until spaces were inserted between letters to create words in Latin and western European vernaculars, reading in western Europe was never silent (Saenger, 1982, 1997). Our tendency to read in silence is a consequence of both a particular writing technology and widespread literacy. Until relatively recently (*i.e.* 800 years ago), reading was typically a group activity, and meaning could only be accurately derived from a text when it was read aloud in order to sound out its information structure. However, with the introduction of spaces and punctuation, written text took on its own path of development. I would propose that most modern academic texts, for instance, are generally not intended to be read aloud, and an attempt to do so would likely lead to breathlessness. The highly dense nominal phrases in typically relational processes of academic text distinguish them from logically intricate but lexically sparse conversation (Halliday, 1989). These developments allow us to perform different functions with language in the different modes (Vachek, 1987), but are possible because of the different demands placed on the auditory and visual systems. For this reason, I believe it inadequate to depend on a reading aloud of written text to demonstrate information structure. (Davies, *e.g.* 1994, typically requests his subjects to read plays, commentaries and other transcribed or speech-like texts. This reveals how the systems of reading that do not depend on graphological marks for pausing can still function in much the same way as prior to the 12th century.)

We therefore need another way to validate the theory. This can be done by taking methodology from psychology and applying it to an SFL concept in order to discover if information structure actually makes a difference to readers. To do this, I designed an experiment which presented readers with both 'normal' (original) texts and texts whose information structure had been disrupted. I first analysed texts for Theme and for Presenting and Presuming reference (which I will call Participant Tracking). I then made sequencing changes to the text but did not alter Theme or Participant Tracking. In other words, I disturbed the Rheme, attempting to disrupt patterns of Method of Development (Fries, 1995) by attempting to obscure 'the point' (Martin, 1992) of a clause. An example is provided in table 1 which shows the original text on the left and the modified version on the right with the changes highlighted in bold. The changes to the clauses did not appear to 3 volunteers to result in unnatural text. The texts were presented to a variety of readers who were asked to respond. The null hypothesis was

that readers would not respond differently to the altered texts when compared to the original versions. Evidence against this would provide evidence that readers respond to information structure, as described above.

Table 1 Original text and modified version with changes to information structure highlighted

| Original | Adapted |
|---|---|
| Security measures must be incorporated into computer systems whenever they are potential targets for malicious or mischievous attacks. This is especially so for systems that handle financial transactions or **confidential, classified or other *information* whose secrecy and integrity are critical**. In Figure 7.1, we summarize **the evolution of security needs in computer systems** since they first arose with the advent of shared data in multi-user timesharing systems of **the 1960s and 70s**. **Today** the advent of wide-area, open distributed systems has resulted in a wide range of security issues | Security measures must be incorporated into computer systems whenever they are potential targets for attacks that are malicious or mischievous. This is especially so for systems that handle confidential, classified or other *information* whose secrecy and integrity are critical, **or financial transactions**. In Figure 7.1, we summarize **the evolution of computer system security needs** since they first arose in the 1960s and 70s with the **advent of multi-user timesharing systems with shared data**. **Today** the advent of wide-area, open distributed systems has resulted in a wide range of security issues. |

The experimental design allowed for naïve subjects to respond to the same set of questions for 4 texts from the same register, all of which were introducing a section of a textbook in engineering. 2 texts were adapted (Texts A & B) and 2 were original (Texts C & D). 1 original (Text C) and 1 adapted text (Text D) were the same for all readers. 2 of the texts (A & B) were either presented in the original form or the adapted form. The ordering of texts also varied across readers. Some of the questions were 'distractors' in that they appeared to be more typical comprehension-type questions with a 'correct' answer, in order to detract the readers from the aim of the experiment. The target items required readers to indicate how much they agreed that the text is easy to read because it gets its ideas across well ("*The text presents its main points clearly*"), and that it progresses well because ideas easily flow from one to the next ("*The text progresses easily from one point to the next*"). Without their knowledge, volunteer readers, who were assigned different conditions based on demographic factors (*e.g.* age, gender, expertise in the field of the texts, reading habits), were also timed on the task.

In many important respects this trial reflected a typical psychology experiment. Control and experimental procedures were administered across populations, independent variables were accounted for, human responses were quantified, results could be statistically analysed and volunteers remained largely naïve of the aim of the experiment.
However, a number of important factors distinguished it. Texts were complete and between 300 and 600 words. All original texts were published in a particular register

and remained to some extent contextualised, even though they were removed from their original context; the texts were not created for the purpose of the experiment and so exhibit natural features of all metafunctions of language. Readers were not placed in a laboratory setting, as this is a social context of its own which bears little or no relation to real reading practices. All of the reading was done online, and the volunteers participated under relatively normal reading conditions. The experiment was based on a theory of language and was designed to evaluate the psychological validity of linguistic theory, rather than using language to validate a psychological theory. The linguistic theory is fundamentally a phenomenological theory; it assumes that readers will construe meaning, that they will see the text as belonging to a particular social context of which they will have different degrees of experience, and they will respond to the context that they construe through the text. The experiment assumes that participants will construe their own meanings from the text within an appropriate context rather than attempting to reconstruct **the** intended meaning of the author. Thus, the experiment differs from many psychological experiments designed on the premise of a metaphysical mind separated from a physical brain.

## 5 RESULTS AND INTERPRETATION

After running a pilot and a full survey online for about two months each, 372 subjects had volunteered to take part, and 198 had provided responses for all 4 reading texts. From these 198, a small number were removed due to the lack of control over the subjects. If a subject finished reading and responding to a text in less than one minute or more than ten minutes, the responses were judged unreliable. Although these times are ultimately arbitrary, they are based on 'walk-through' trials with a small number of respondents.

Table 2 illustrates the results subjected to hypothesis-testing statistics. A t-test measures hypotheses for sample sizes greater than 30, and so is suitable for this study (Bowerman and O'Connell, 2003). Using the t-test we discover that between the original and modified versions of text A, there is a small but significant difference in readers' perception of ease of reading; there is some evidence that readers found the original version easier to read. Across other measures we do not have sufficient evidence to reject the null hypothesis, and must say that it is likely that readers did not notice a difference in the progression of ideas, and that their reading speed seems unaffected by the changes made to the text.

Comparing the original and modified versions of text B we also find a significant difference, but in the contrary direction for both ease of reading and progress of ideas. That is, there is strong evidence that readers judged the modified version of text B to progress between ideas and to present its main points more effectively than the original, and yet there is some evidence that the original took less time to read than the modified version.

Table 2 T-test scores showing a significant difference at a confidence level of ***99%, **95%, *90% or below.

| Comparison for / of | ease | progress | time |
|---|---|---|---|
| A+(original) & A-(modified) | 2.045** | 1.284 | 0.923 |
| B+(original) & B-(modified) | -3.318*** | -3.874*** | -1.157* |
| C+(original) & D-(modified) | 6.832*** | 6.479*** | -2.729*** |
| All+(original) & All-(modified) | 3.953*** | 4.092*** | -2.459*** |

The comparison between the original version of text C and the modified version of text D showed consistently across all conditions that there was a significant difference between the scores in favour of text C for both types of reader preference and for reading speed. There is very strong evidence that the null hypothesis, (that there is no difference between the original and modified version), is false and with the scores all pointing towards reader preferences as well as faster reading speed in favour of the original version, there seems to be very strong evidence that the modifications made to the texts, however slight, made a significant difference. Finally, combining the scores for all texts provides very strong evidence to reject all of the null hypotheses. It appears that the modifications made to the texts made a difference to readers' perceptions and reading speeds of the texts.

There was, however, one significant factor that consistently revealed itself across the different conditions: as subjects became more familiar with the experiment, they became more efficient at completing the task; there was a strong 'rehearsal' effect. Thus, the experiment itself had the greatest influence on the readers. The unnatural practice of reading four texts in a row accompanied by identical questions was possibly more significant than the variable under study. This demonstrates one major flaw of the methodology in psychology experiments.

According to these results, then, we can say that the results offer very strong evidence to reject the null hypothesis. That is, there is strong evidence to suggest that when the original (nominal) group that is presumed to be the New information in the Rheme of a text (when there is more than one) is moved to another rhematic position, the change can be perceived by readers in how they judge the text and it can take them longer to read the text.

However, although the t-test statistics provide evidence for a significant difference in both readers' perceptions and reading times, more rigorous statistics do not provide significant results. A chi-square test, designed to measure the inter-relatedness of the different variables (Bowerman and O'Connell, 2003), applied to the same set of results does not provide evidence for a significant correlation between the manipulation of the Rheme of a clause and readers' perceptions or reading speed. Here the question of interpretation becomes most pertinent. While we may be able to demonstrate a higher-

than-chance probability of readers being affected by the changes in the text, we have not demonstrated a causal link between the text manipulation and both the changes in readers' perceptions and reading time. This supports the view that the text does not cause meaning in the reader (as in the traditional 'transmission of information' model of communication), but the changes in the environment that result from the text trigger changes in the reader. It would be unwise, therefore, to suggest that the changes in the text cause the changes in the reader, since we cannot observe the structural changes in the reader; we can only observe their effects. Artefacts of the process of communication, in this case the written text, are only triggers for structural change.

## 6 CONCLUSION

The early discussion in this paper addresses some of the very real differences that need to be overcome if SFL is to adopt a more psychological perspective in its approach to language. While some commentators have noted the need for this perspective to be included, I have outlined some reasons that have resulted in an almost hostile approach to psychology in SFL. I have explained that this different approach to language is, literally, a philosophical matter, namely phenomenology. My hope is that in the future psychology in general will adapt to recent developments in cognitive neuroscience and neurobiology, which share a great deal of philosophical assumptions with SFL. I have attempted to demonstrate that SFL can start to adopt psychological methods without abandoning its phenomenological and sociological positions, even before mainstream psychology has changed. In the process I hope also to have shown that there is evidence that readers can recognise the effects of information structure in written English, providing some indication that information structure has psychological validity. Further investigation would help clarify and validate these findings.

It could be argued that I have exaggerated the case, stereotyped, over-generalised, and 'painted with broad brush strokes', particularly in my characterisation of mainstream psychology. My aim here is not to suggest that everybody working in psychology is unaware of issues raised in this paper. My aim has been to highlight the differences by exaggerating them in order to promote discussion and dialogue. I hope that my attempt at demonstrating how SFL and psychology could be harmonised is testament to my desire to see such harmony.

## REFERENCES

Arbib, M. 2000a. The mirror system, imitation and language. In C. Nehaniv, and K. Dautenhahn (eds.) *Imitation in Animals and Artefacts*. Cambridge: MIT Press.

Arbib, M. 2000b. Computational models of monkey mechanisms for the control of grasping: grounding the mirror system hypothesis for the evolution of the language-ready brain. In A. Cangelosi and D. Parisi (eds.) *Simulating the Evolution of Language*. Berlin: Springer-Verlag.

Benson, J.D. and Greaves, W.S. (eds.) 2005. *Functional Dimensions of Ape-Human Discourse*. London: Equinox.
Bowerman, B.L. and O'Connell, R.T. 2003. *Business Statistics in Practice. Third Edition*. Boston: McGraw-Hill Irwin.
Butler, C.S. 2003. *Structure and Function Part 2: From Clause to Discourse and Beyond*. Amsterdam: John Benjamins.
Butler, C.S. 2008. Cognitive adequacy in structural-functional theories of language. *Language Sciences 30/1 p.1-30*.
Clark, H., and Haviland, S. 1977. Comprehension and the Given-New contract. In R. Freedle (ed.). *Discourse Production and Comprehension*. New Jersey: Ablex.
Coulouris, G., Dollimore, J. & Kindberg, T. 2001. *Distributed Systems: Concepts and Design. 3rd Edition*. Harlow: Pearson.
Davies, M. 1986. Literacy and intonation. In B. Couture (ed). *Functional Approaches to Writing*. London: Frances Pinter.
Davies, M. 1994. Intonation IS visible in written English. In S. Čmejrkova, F. Daneš, and E. Havlova (eds.), *Writing vs. Speaking: Language, Text, Discourse Communication*. Tübingen: Gunter Narr Verlag.
Edelman, G. M. 1999. Building a picture of the brain. *Annals of the New York Academy of Sciences 882, June 1999, p.68-89*.
Emmott, C. 1997. *Narrative Comprehension - A Discourse Perspective*. Oxford: Clarendon Press.
Fries, P.H. 1992. The structuring of information in written text. *Language Sciences 14/4 p.461-488*.
Fries, P.H. 1995. Themes, Methods of Development and Texts. In R. Hasan & P. Fries (eds.). *On Subject and Theme*. Amsterdam: John Benjamins.
Halliday, M.A.K. 1967. Notes on transitivity and theme part 2. *Journal of Linguistics 3/2 p.199-244*.
Halliday, M.A.K. 1975. *Learning How to Mean: Explorations in the Development of Language*. London: Edward Arnold.
Halliday, M.A.K. 1978. *Language as Social Semiotic*. London: Edward Arnold.
Halliday, M.A.K. 1989. *Spoken and Written Language*. Oxford: Oxford University Press.
Halliday, M.A.K. 1993. Towards a language-based theory of learning. *Linguistics and Education 5 p.93-116*.
Halliday, M.A.K. 1995. On language in relation to the evolution of human consciousness. In S. Allén (ed.). *Of Thoughts and Words - Proceedings of Nobel Symposium '92*. London: Imperial College Press.
Halliday, M. & Hasan, R. 1985. *Language, Context and Text: Aspects of Language in a Social-Semiotic Perspective*. Victoria: Deakin University Press.
Halliday, M.A.K. and Matthiessen, CM.I.M. 1999. *Construing Experience Through Meaning*. London: Continuum.
Halliday, M.A.K. and Matthiessen, C.M.I.M. 2004. *An Introduction to Functional Grammar. Third Edition*. London: Arnold.
Holdstock, T.L. 2000. *Re-Examining Psychology: Critical Perspectives and African Insights*. London: Routledge.
Jared, D., Levey, B.A and Rayner, K. 1999. The role of phonology in the activation of word meanings during reading: Evidence from proofreading and eye movements. *Journal of Experimental Psychology: General 128/3 p.219-264*.

Kravchenko, A. 2002. Towards a bio-cognitive philosophy of language. *Perspectives - Journal for Interdisciplinary Work in the Humanities 1/4*.
Kravchenko, A. 2006. Cognitive linguistics, biology of cognition and biosemiotics: Briding the gaps. *Language Sciences 28 p.51-75*.
Kravchenko, A. 2007. Essential properties of language, or, why language is not a code. *Language Sciences 29/5 p.650-671*.
Lamb, S.M. 1999. *Pathways of the Brain: The Neurocognitive Basis of Language*. Amsterdam: John Benjamins.
Lassen, I. 2003. *Accessibility and Acceptability in Technical Manuals* Amsterdam: John Benjamins.
Lee, Y-A, Binder, K.S., Kim, J-O, Pollatsek, A. & Rayner, K. 1999. Activation of phonological codes during eye fixations in reading. *Journal of Experimental Psychology: Human Perception and Performance 25/4 p.948-964*.
Lemke, J.L. 1993. Discourse, dynamics and social change. *Cultural Dynamics 6/1 p.243-275*.
Lemke, J.L. 2000. Across the scales of time: Artefacts, activities, and meanings in ecosocial systems. *Mind, Culture, and Activity 7/4 p.273-290*.
Martin, J.R. 1992. *English Text: System and Structure*. Amsterdam: John Benjamins.
Matthiessen, C.M.I.M. 1995. *Lexicogrammatical Cartography: English Systems*. Tokyo: International Language Science Publishers.
Maturana, H.R. and Varela, F.J. 1980. *Autopoiesis and Cognition: The Realization of the Living*. Dordecht: D. Reidel Publishing Co.
Maturana, H.R. and Varela, F.J. 1992. *The Tree of Knowledge: The Biological Roots of Human Understanding*. Boston: Shambhala.
Mithen, S. 2005. *The Singing Neanderthals: The Origins of Music, Language, Mind and Body*. London: Weidenfeld & Nicholson.
Prince, E. 1981. Toward a taxonomy of given-new information. In P. Cole (ed.). *Radical Pragmatics*. New York: Academic Press.
Pullum, G.K. & Scholz, B.C. 2002. Empirical assessment of poverty of stimulus arguments. *The Linguistic Review 19 p.9-50*.
Rayner, K., Pollatsek, A. & Binder, K.S. 1998. Phonological codes and eye movements in reading. *Journal of Experimental Psychology: Learning, Memory and Cognition 24/2 p.476-497*.
Saenger, P. 1982. Silent reading: Its impact on late medieval script and society. *Viator 13 p.367-414*.
Saenger, P. 1997. *Space Between Words*: *The Origins of Silent Reading*. Stanford: Stanford University Press.
Scholz, B.C. & Pullum, G.K. 2006. Irrational nativist exuberance. In R. Stainton (ed.) *Contemporary Debates in Cognitive Science*. Oxford: Basil Blackwell.
Steels, L. 1997. The synthetic modeling of language origins. *Evolution of Communication 1 p.1-34*.
Steels, L. 2000. Language as a complex adaptive system. In M. Shoenhauer *et al.* (eds.) *Parallel Problem Solving from Nature*. Lecture Notes in Computer Science Vol. 1917. Berlin: Springer-Verlag.
Tallerman, M. 2006. Abracadabra! Early Hominin for 'I think my humming's out of tune with the rest of the world!' *Cambridge Archaeological Journal 16/1 p.106-107*.

Thibault, P.J. 1999. Communicating and interpreting relevance through discourse negotiation: An alternative to relevance theory. *Journal of Pragmatics 31 p.557-594.*
Thibault, P.J. 2004a. *Brain, Mind and the Signifying Body*. London: Continuum.
Thibault, P.J. 2004b. *Agency and Consciousness in Discourse*. London: Continuum.
Tomasello, M. 2004. What kind of evidence could refute the UG hypothesis? *Studies in Language 28/3 p.642-645.*
Vachek, J. 1987. Written language seen from the functionalist angle. In R. Dirven & V. Fried (eds.), *Functionalism in Linguistics*. Amsterdam: John Benjamins.
Vernon, D. and Furlong, D. 2007. Philosophical Foundations of A.I. In M. Lungarella, F. Iida, J. Bongard and R. Pfeifer (Eds.) *50 Years of Artificial Intelligence*. Berlin: Springer-Verlag.

Nick Moore
Khalifa University of Science, Technology and Research
PO Box 573
Sharjah
United Arab Emirates
najm@kustar.ac.ae