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ABSTRACT

This collection of papers is from a conference held at Odense University, Denmark on recent research in language acquisition in children. Following an introduction by the editors, it contains the following papers: "Development in a Connectionist Framework: Rethinking the Nature-Nurture Debate" (Kim Plunkett); "Experimental Evidence on the Acquisition of Past Tense Inflection in Danish, Icelandic and Norwegian Children" (Hrafnhildur Ragnarsdottir, Hanne Gram Simonsen, and Dorthe Bleses); "Signifying Subjects" (Chris Sinha); and "Speaking versus Writing--An Experimental Approach to Narrative Discourse Production" (Sven Stromqvist). (NKA)

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Dorthe Bleses
and Johannes Wagner

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Introduction

On September 23, 1996 the Institute of Language and Communication at Odense University held a conference which focused on psycholinguistic research into child language acquisition. The conference was attended by about 50 participants, predominantly from Denmark, but also from the other Nordic countries. The conference was organised by Hans Basbøll, Dorthe Bleses and Johannes Wagner. The aim of the conference was to provide an opportunity for Danish scholars to gain insight into recent research within the area of child language acquisition and, at the same time, present recent Danish language acquisition research to both a national and international audience. Nationally and internationally acclaimed scholars, who have all conducted research on the acquisition of the Nordic languages, presented papers within different areas of the field of language acquisition, and a wide variety of viewpoints and research paradigms were presented. Featured speakers were Kim Plunkett (Oxford), Chris Sinha (Aarhus), Hrafnhildur Ragnarsdóttir (Reykjavik), Hanne Gram Simonsen (Oslo) and Sven Strömqvist (Gothenburg). The papers presented at the conference (except for Hrafnhildur Ragnarsdóttir's paper on children's acquisition of kinship terms) are printed in this volume.

The 1996 conference marked a renewed strength in research within the area of child language research at the Institute of Language and Communication at Odense University. In August 1997, Odense University hosted a large international conference on child language acquisition which was entitled *Language and cognition in language acquisition.* The theme of the conference was the relationship between language acquisition and non-linguistic cognitive capacities, and processes and the conference thereby sought to emphasise the new trend known as 'emergentism', which combines functional and cognitive approaches to linguistic theory with insight and research results from developmental connectionist modelling, developmental cognitive neuroscience and evolutionary theory. The conference was organised by Hans Basbøll, Dorthe Bleses, Rineke Brouwer & Johannes Wagner of the Institute of Language and Communication at Odense University in collaboration with Kristine Jensen de Lopez and Chris Sinha of the Department of Psychology at Aarhus University. The conference was supported financially by The Danish Research Council for the Humanities, the Institute of Language and Communication at Odense University and the Department of Psychology at Aarhus University.

An electronic network called *Language Acquisition and Cognition* (LA&C-net: http://www.psy.aau.dk/ lacnet/) was set up in the beginning of 1998 with financial support from The Danish Research Council for the Humanities. The network was initiated by researchers from University of Aarhus and Odense University (see above) with Chris Sinha of Aarhus University acting as director.

A new project has been funded by The Danish Research Council for the Humanities and will begin in September 1998. The project, *Cognition, Language and Consciousness: An Interaction between Psycholinguistic and Social Psychological Approaches to Language Acquisition and Language Use*, will run for a period of 3 years. The project is affiliated with the Institute of Language and Communication, Odense University. Project leader is Hans Basbøll (hba@language.ou.dk).

Odense, July 1998

Dorthe Bleses

Johannes Wagner

OWPLC 16: 1-22

DEVELOPMENT IN A CONNECTIONIST FRAMEWORK: RETHINKING THE NATURE-NURTURE DEBATE

Kim Plunkett

Abstract

It is often assumed that connectionist models of development take a tabula rasa approach to learning. In fact, all connectionist models involve a strong commitment to innate processing mechanisms and theories about the effective learning environment. Nevertheless, connectionist modelling offers a valuable tool for investigating a wide range of hypotheses about the role of nature and nurture in development. We consider some of the central issues that connectionist modelling has addressed in attempting to understand the mechanisms of development change. These include: the interpretation of dissociations in behaviour as indicating dissociations of underlying mechanism; the view that new behaviours are the result of the emergence of new mechanisms; the assumption that domain specific knowledge demands the application of domain specific learning devices; and the belief that complex problems require complex start states.

1. A Developmental Paradox

Two findings in developmental psychology stand in apparent conflict. Piaget (1952) has shown that at a certain stage in development, children will cease in their attempts to reach for an object when it is partially or fully covered by an occluder. This finding is observed in children up to the age of about 6 months and is interpreted to indicate that the object concept is not well-established in early infancy. The object representations that are necessary to motivate reaching and grasping behavior are absent. In contrast, other studies have shown that young infants will express surprise when a stimulus array is transformed in such a way that the resulting array does not conform to reasonable expectations. For example, change in heart rate, sucking or GSR, is observed when an object, previously visible, fails to block the path of a moving drawbridge or a locomotive fails to reappear from a tunnel, or has changed colour when it reappears (Baillargeon 1993; Spelke et al. 1994). These results are interpreted as indicating that important representations of object properties such as form, shape and the capacity to block the movement of other objects are already in place by 4 months of age. The conflict in these findings can be stated as follows: Why should the infant cease to reach for a partially or fully concealed object when it already controls representational characteristics of objects that confirm the stability of object properties over time, and that predict the interaction of those represented properties with objects that are visible in the perceptual array?

One answer to this conflict is that Piaget grossly underestimated young children's ability to retrieve hidden objects. However, this answer is no resolution to the conflict: Piaget's findings are robust. Alternatively, one might question Piaget's interpretation of his results. Young infants know a lot about the permanent properties of objects but recruiting object representations in the service of a reaching task requires additional sensorimotor skills which have little to do with the infant's understanding of the permanence of objects. Again, this response must be rejected. Young infants who are in full command of the skill to reach and grasp a visible object still fail to retrieve an object which is partially or fully concealed (von Hofsten 1989). Motor skills are not the culprit here. The capacity to relate object knowledge to other domains seems to be an important part of object knowledge itself. Object knowledge has to be accessed and exercised.

1.1. A Resolution

A resolution of the conflict can be found in considering some fundamental differences in the nature of the two types of task that infants are required to perform. In experiments that measure "surprise" reactions to unusual object transformations such as failure to reappear from behind an occluder, the infant is treated as a passive observer (Baillargeon 1993). In essence, the infant is evaluated for its expectations concerning the future state of a stimulus array. Failure of expectation elicits surprise. In the Piagetian task, the infant is required to actively transform the stimulus array. To achieve this, not only must the infant know where the object is but she must be able to coordinate that information with knowledge about the object's identity—typically, the infant reaches for objects she wants. We suppose that this coordination is relatively easy for visible objects, because actions are supported by externally available cues. However, when the object is out of sight, the child has to rely on internal representations of the object's identity and position. We assume that the internal representations for object position and identity develop separately. This assumption is motivated by recent neurological evidence that spatial and featural information is processed in separate channels in the human brain—the so-called 'what' and 'where' channels (Ungerlieder & Mishkin 1982). In principle, the child could demonstrate knowledge of an object's position without demonstrating knowledge about its identity, or *vice versa*. Surprise reactions might be triggered by failure of infant expectations within either of these domains. For example, an object may suddenly change its featural properties or fail to appear in a predicted position. Internal representations are particularly important when the object is out of sight. Hence, we might expect infants to have greater difficulty performing tasks that involve the coordination of spatial and featural representations—such as reaching for hidden objects—when these representations are only partially developed.

1.2. Building a model

The resolution outlined above constitutes a theory about the origins of infants' surprise reactions to objects' properties (spatial or featural) which do not conform to expectations and attempts to explain why these surprise reactions precede the ability to reach for hidden objects even though they possess the motor skills to do so. Mareschal, Plunkett & Harris (1995) have constructed a computational model that implements the ideas outlined in this theory. The model consists of a complex neural network that processes a visual image of an object that can move across a flat plane. Different types of objects distinguished by a small number of features appear on the plane one at a time. These objects may or may not disappear behind an occluder. All objects move with a constant velocity so that if one disappears behind an occluder, it will eventually reappear on the other side. Object velocities can vary from one presentation to the next.

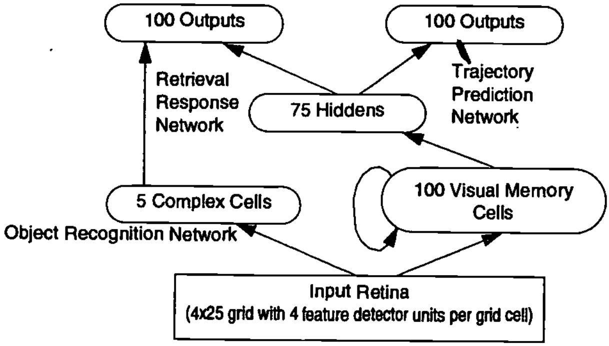


Figure 1: The modular neural network (Mareschal et al., 1995) used to track and initiate reaching responses for visible and hidden objects. An object recognition network and a visual tracking network process information from an input retina. The object recognition network learns spatially invariant representations of the objects that move around the retina. The visual tracking network learns to predict the next position of the object on the retina. The retrieval response network learns to integrate information from the other two modules in order to initiate a reaching response. The complete system succeeds in tracking visible objects before it can predict the reappearance of hidden objects. It also succeeds in initiating a reaching response for visible objects before it learns to reach for hidden objects.

The network is given two tasks. First, it must learn to predict the next position of the moving object, including its position when hidden behind an occluder. Second, the network must learn to initiate a motor response to reach for an object, both when visible and when hidden. The network is endowed with several information processing capacities that enable it fulfil these tasks. The image of the object moving across the plane is processed by two separate modules. One module learns to form a spatially invariant representation of the object so that it can recognise its identity irrespective of its position on the plane (Foldiak 1991). The second module learns to keep track of the object but looses all information about the object's identity (Ungerlieder & Mishkin 1982). This second module does all the work that is required to predict the position of the moving object. However, in order to reach for an object, the network needs to integrate information about the object's identity and its position. Both modules are required for this task. Therefore, the ability to reach can be impeded either because the representations of identity and position are not sufficiently developed or because the network has not yet managed to properly integrate these representations in the service of reaching.

Given the additional task demands imposed on the network for reaching it would seem relatively unsurprising to discover that the network learns to track objects before it learns to reach for them. The crucial test of the model is whether it is able to make the correct predictions about the late onset of reaching for hidden objects relative to visible objects. In fact, the model makes the right predictions for the order of mastery in tracking and reaching for visible and hidden objects. It quickly learns to track and reach for visible objects, tracking being slightly more precocious than retrieval. Next, the network learns to track occluded objects as its internal representations of position are strengthened and it is able to "keep track" of the object in the absence of perceptual input. However, the ability to track hidden objects together with the already mastered ability to reach for visible objects does not guarantee mastery of reaching for hidden objects. The internal representations that control the integration of spatial and featural information require further development before this ability is mastered.

1.3. Evaluating the Model

Notice how this modelling endeavour provides a working implementation of a set of principles that constitute a theory about how infants learn to track and reach for visible and hidden objects. It identifies a set of tasks that the model must perform and the information processing capacities required to perform those tasks. All these constitute a set of assumptions that are not explained by the model. However, given these assumptions, the model is able to make correct predictions about the order of mastery of the different tasks. The model implements a coherent and accurate (not necessarily true—the assumptions might be wrong) theory. However, this model just like any other has a number of free parameters which the modeller may 'tweak' in order to achieve the appropriate predictions. It is necessary to derive some novel predictions which can be tested against new experimental work with infants, in order to evaluate the generality of the solution the model has found. This model makes several interesting predictions including improved tracking skills at higher velocities and imperviousness to unexpected feature changes while tracking. The first experimental prediction has been confirmed (see Mareschal, Harris & Plunkett 1995) while the second prediction is currently being tested. This instance of model building and evaluation thus seems to support the initial insight that children's object representations develop in a fragmentary fashion, and that the development of these fragments of knowledge shape infant performance on various tasks in line with their manner of involvement in the tasks concerned.

2. Connectionist Insights

The model described in the previous section is an example of a computer simulation that uses the learning capabilities of artificial neural networks to construct internal representations of a training environment in the service of several tasks (reaching and tracking). Neural networks are particularly good at extracting the statistical regularities of a training environment and exploiting them in a structured manner to achieve some goal. They consist of a well-specified architecture driven by a learning algorithm. The connections or weights between the simple processing units that make up the network are gradually adapted over time in response to localised messages from the learning algorithm. The final configuration of weights in the network constitutes what it knows about the environment and the tasks it is required to perform.

Connectionist modelling provides a flexible approach to evaluating alternative hypotheses concerning the start state of the organism (or what we may think of as its innate endowment), the effective learning environment that the organism occupies and the nature of the learning procedure for transforming the organism into its mature state. The start state of the organism is modelled by the choice of network architecture and computational properties of the units in the network. There are a wide range of possibilities that the developmentalist can choose between. The effective learning environment is determined by the manner in which the modeller chooses to define the task for the network. For example, the modeller must decide upon a representational format for the pattern of inputs and outputs for the network, and highlight the manner in which the network samples patterns from the environment. These decisions constitute precise hypotheses about the nature of the learning environment. Finally, the modeller must decide how the network will learn. Again, a wide variety of learning algorithms are available to drive weight adaptation in networks. Any particular connectionist model embodies a set of decisions governing all of these factors which are crucial for specifying clearly one's theory of development. Quite small changes in one of the choices can have dramatic changes for the performance of the model—some of them quite unexpected. Connectionist modelling offers a rich space for exploring a wide range of developmental hypotheses.

In the remainder of this article I will briefly review some connectionist modelling work that has explored some important areas in the hypothesis space of developmental theories. I aim to underscore four main lessons or insights that these models have provided:

1. When constructing theories in psychology, we use behavioural data from experiments or naturalistic observation as the objects that our explanations must fit. We attempt to infer underlying mechanisms from overt behaviour. Connectionist modelling encourages us to be suspicious of the explanations we propose. Often, networks surprise us with the simplicity of the solution they discover to apparently complex tasks—sometimes, leading us to the conclusion that learning may not be as difficult as we thought.

2. When we see new forms of behaviour emerging in development, we are tempted to conclude that some radical change has occurred in the mechanisms governing that behaviour. Connectionist modelling has shown us that small and gradual internal changes in an organism can lead to dramatic non-linearities in its overt behaviour—new behaviour need not mean new mechanisms.

3. Theories of development are often domain specific. Behaviours that are discrete and associated with distinguishable modalities, promote explanations that do not reach beyond the specifics of those modalities or domains. These encapsulated accounts often emphasise the impoverished character of the learning environment and lead to complex specifications of the organism's start state. Connectionist models provide a framework for investigating the interaction between modalities and a formalism for entertaining distributed as well as domain specific accounts of developmental change. This approach fosters an appreciation of developing systems in which domain specific representations emerge from a complex interaction of the organism's domain-general learning capacities with a rich learning environment.

4. Complex problems seem to require complex solutions. Mastery of higher cognitive processes appears to require the application of complex learning devices from the very start of development. Connectionist modelling has shown us that placing limitations on the processing capacity of developing systems during early learning can actually enhance their long-term potential. The ignorance and apparent inadequacies of the immature organism may, in fact, be highly beneficial for learning the solutions to complex problems. Small is beautiful.

3. Inferring Mechanisms from Behaviour

Children make mistakes. Developmentalists use these mistakes as clues to discover the nature of the mechanisms that drive correct performance. For example, in learning the past tense forms of irregular verbs or plurals of irregular nouns, English children may sometimes overgeneralise the "-ed" or "s" suffixes to produce incorrect forms like "hitted" or "mans". These errors often occur after the child has already produced the irregular forms correctly, yielding the well-known U-shaped profile of development.

3.1. A Dual-Mechanism Account

A natural interpretation of this pattern of performance is to suggest that early in development, the child learns irregular forms by rote, simply storing in memory the forms that occur in the adult language. At a later stage, the child recognises the regularities inherent in the inflectional system of English and re-organises her representation of the past tense or plural system to include a qualitatively new device that does the work of adding a suffix, obviating the need to memorise new forms. During this stage, some of the original irregular forms may get sucked into this new system and suffer inappropriate generalisation of the regular suffix. Finally, the child must sort out which forms cannot be generated with the new rule-based device. They do this by strengthening their memories for the irregular forms which can thereby block the application of the regular rule and eliminate overgeneralisation errors (Pinker & Prince 1988).

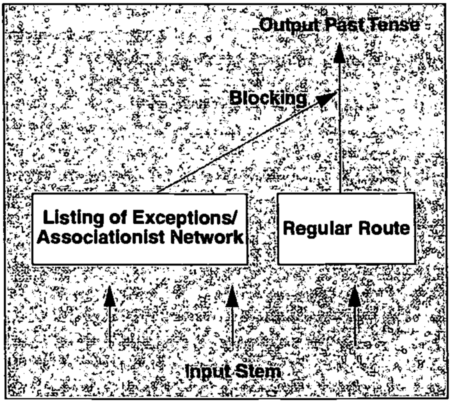


Figure 2: The dual-route model for the English past tense (Pinker & Prince 1988). The model involves a symbolic regular route that is insensitive to the phonological form of the stem and a route for exceptions that is capable of blocking the output from the regular route. Failure to block the regular route produces the correct output for regular verbs but results in overgeneralisation errors for irregular verbs. Children must strengthen their representation of irregular past tense forms to promote correct blocking of the regular route.

This account of the representation and development of past tense and plural inflections in English assumes that two qualitatively different types of mechanism are needed to capture the profile of development in young children—a rote memory system to deal with the irregular forms and a symbolic rule system to deal with the rest. The behavioural dissociation between regular and irregular forms—children make mistakes on irregular forms but not on regular forms—make the idea of two separate mechanisms very appealing. Double dissociations between regular and irregular forms in disordered populations add to the strength of the claim that separate mechanisms are responsible for these different types of forms: in some language disorders children may preserve performance on irregular verbs but not on regulars while in other disorders the opposite pattern is observed.

Although the evidence is consistent with the view that a dual-route mechanism underlies children's acquisition of English inflectional morphology, this is no proof that the theory is correct. There may be other types of mechanistic explanations for these patterns of behaviour and development. Connectionist modelling offers a tool for exploring alternative developmental hypotheses.

3.2.Single-mechanism account

One of the earliest demonstrations of the learning abilities of neural networks was for English past tense acquisition. Rumelhart & McClelland (1986) suggested that the source of children's errors in learning past tense forms was to be found in their attempts to systematise the underlying relationship that holds between the verb's stem and its past tense form. For most verbs in English, the sound of the stem does not affect the past tense form. You just add "ed" on the end. However, there is a small subset of verbs which exhibit a different relationship between stem and past tense form. For example, there is a set of no change verbs where the stem and past tense forms are identical (*hit* → *hit*). All these verbs end in an alveolar consonant (/t/ or /d/). Other verbs undergo a particular type of vowel change (*ring* → *rang*, *sing*→ *sang*), apparently triggered by the presence of the rhyme *-ing* in the stem. Neural networks are particularly good at picking up on these types of regularities, so Rumelhart & McClelland trained a simple network to produce the past tense forms of verbs when presented with their stems. The details of the learning procedure and network architecture are not important here (see Plunkett 1995 for a detailed review of this and related models).

What is important is to note that Rumelhart & McClelland were successful in training the network to perform the task and that *en route* to learning the correct past tense forms of English verbs, the network made mistakes that are similar to the kind of mistakes that children make during the acquisition of inflectional morphology. Furthermore, the network did not partition itself into qualitatively distinct devices during the process of learning—one for regular verbs and one for irregular verbs. The representation of both verb types seemed to be distributed throughout the entire matrix of connections in the network. Nevertheless, a behavioural dissociation between regular and irregular verbs was observed in the network. Most of its errors occurred on irregular verbs.

More recently, Marchman (1993) has shown that damage to a network trained on the past tense problem results in further dissociations between regular and irregular forms: production of irregular forms remains intact while production of regular verbs deteriorates, mimicking patterns of performance observed in disordered populations. As with the Rumelhart & McClelland model, the representation of regular and irregular verbs was distributed throughout the network, i.e., there was no evidence of dissociable mechanisms.

As it turns out, there were a lot of fundamental design problems with the Rumelhart & McClelland model that made it untenable as a realistic model of children's acquisition of the English past tense (Pinker & Prince 1988). Some of these problems have been fixed, some haven't (MacWhinney & Leinbach 1991, Plunkett & Marchman 1991, 1993, Cottrell & Plunkett 1994).

However, the basic insight that the original model offered still remains: The observation of behavioural dissociations in some domain of performance does not necessarily imply the existence of dissociable mechanisms driving those dissociations in behaviour. Behavioural dissociations can emerge as the result of subtle differences in the graded representations constructed by these networks for different types of verbs.

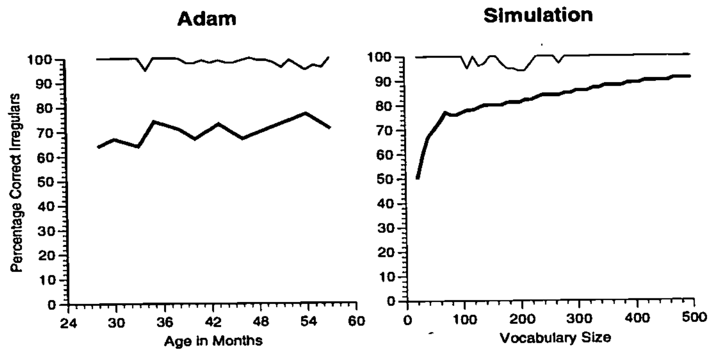


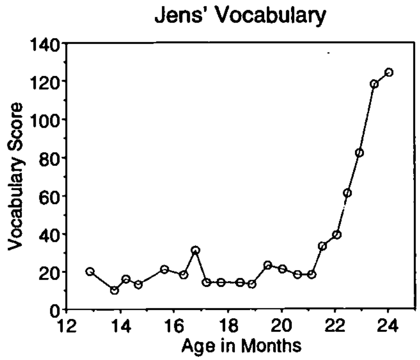
Figure 3: Network overregularization errors on irregular verbs as found in the Plunkett & Marchman (1993) simulation compared to those produced by one of 83 children analysed by Marcus, Ullman, Pinker, Hollander, Rosen & Xu (1992). The thick line indicates the percentage of regular verbs in the child's/network's vocabulary at various points in learning.

Of course, just because one can train a network to mimic children's performance in learning the past tense of English verbs, does not mean that children learn them the same way as the network. The relatively simple learning system that Rumelhart & McClelland and other researchers have used to model children's learning may underestimate the complexity of the resources that children bring to bare on this problem. However, the neural network model does show that, in principle, children could use a relatively simple learning system to solve this problem. The modelling work has thereby enriched our understanding of the range and types of mechanism that might drive development in this domain.

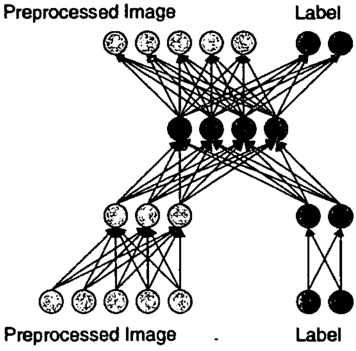
4. Discontinuities in Development

Developmentalists often interpret discontinuities in behaviour as manifesting the onset of a new stage or phase of development (Piaget 1955; Karmiloff-Smith 1979; Siegler 1981). The child's transition to a new stage of development is usually construed as the onset of a new mode of operation of the cognitive system, perhaps as the result of the maturation of some cognitively relevant neural system. For example, the vocabulary spurt that often occurs towards the end of the child's second year has been explained as a naming insight (McShane 1979), in which the child discovers that objects have names. Early in development, the child lacks the necessary conceptual machinery to link object names with their referents. The insight is triggered by a switch that turns on the naming machine. Similar arguments have been offered to explain the developmental stages through which children pass in mastering the object concept, understanding quantity and logical relations.

It is a reasonable supposition that new behaviours are caused by new events in the child, just as it is reasonable to hypothesise that dissociable behaviours imply dissociable mechanisms. However, connectionism teaches us that new behaviours can emerge as a result of gradual changes in a simple learning device. It is well known that the behaviour of dynamical systems unfolds in a non-linear and unpredictable fashion (van Geert 1991). Neural networks are themselves dynamical systems and they exhibit just these non-linear properties. For example, Plunkett, Sinha, Møller & Strandsby (1992) trained a neural network to associate object labels with distinguishable images. The images formed natural (though overlapping) categories so that images that looked similar tended to have similar labels. The network was constructed so that it was possible to interrogate it about the name of an object when only given its image (call this production) or the type of image when only given its name (call this comprehension).



(a)



(b)

Figure 4: (a) Profile of vocabulary scores typical for many children during their second year—taken from Plunkett (1993). Each data point indicates the number of different words used by the child during a recording session. It is usually assumed that the "bumps" in the curve are due to sampling error, though temporary regressions in vocabulary growth cannot be ruled out. The vocabulary spurt that occurs around 22 months is observed in many children (Bates, Bretherton & Snyder 1988). It usually consists of an increased rate of acquisition of nominals—specifically names for objects (McShane 1979). (b) Simplified version of the network architecture used in Plunkett, Sinha, Møller & Strandsby 1992. The image is filtered through a retinal pre-processor prior to presentation to the network. Labels and images are fed into the network through distinct "sensory" channels. The network is trained to reproduce the input patterns at the output—a process known as auto-association. Production corresponds to produce a label at the output when an image is presented at the input. Comprehension corresponds to producing an image at the output when a label is presented at the input.

Network performance during training resembles children's vocabulary development during their second year. During the early stages of training, the network was unable to produce the correct names for objects—it got a few right but improvement was slow. However, with no apparent warning, production of correct names suddenly increased until all the objects in the network's training environment were correctly labelled. In other words, the network went through a vocabulary spurt. The network showed a similar improvement of performance for comprehension, except that the vocabulary spurt for comprehension preceded the productive vocabulary spurt. Last but not least, the network made a series of under- and over-extension errors *en route* to masterful performance—again, a phenomenon observed in young children using new words (Barrett 1995).

There are several important issues that this model highlights: First, the pattern of behaviour exhibited by the model is highly non-linear *despite the* *fact that the network architecture and the training environment remain constant throughout learning*. The only changes that occur in the network are small increments in the connections that strengthen the association between an image and its corresponding label. No new mechanisms are needed to explain the vocabulary spurt. Gradual changes within a single learning device are, in principle, capable of explaining this profile of development. McClelland (1989) has made a similar point in the domain of children's developing understanding of weight/distance relations for solving balance beam problems (Siegler 1981).

Second, the model predicts that comprehension precedes production. This in itself is not a particularly radical prediction to make. However, it is an emergent property of the network that was not "designed in" before the model was built. More important is the network's prediction that there should be a non-linearity in the receptive direction, i.e., a vocabulary spurt in comprehension. When the model was first built, there was no indication in the literature as to the precision of this prediction. The prediction has since been shown to be correct (Reznick & Goldfield 1992). This model provides a good example of how a computational model can be used not only to evaluate hypotheses about the nature of the mechanisms underlying some behaviour but also to generate predictions about the behaviour itself. The ability to generate novel predictions about behaviour is important in simulation work as it offers a way to evaluate the generality of the network model for understanding human performance.

The behavioural characteristics of the model are a direct outcome of the interaction of the linguistic and visual representations that are used as inputs to the network. The non-linear profile of development is a direct consequence of the learning process that sets up the link between the linguistic and visual inputs and the asymmetries in production and comprehension can be traced back to the types of representation used for the two types of input. The essence of the interactive nature of the learning process is underscored by the finding that the network learns less quickly when only required to perform the production task. Learning to comprehend object labels at the same time as learning to label objects enables the model to learn the labels faster.

It is important to keep in mind that this simulation is a considerable simplification of the task that the child has to learn in acquiring a lexicon. Words are not always presented with their referents and even when they are it is not always obvious (for a child who doesn't know the meaning of the word) what the word refers to. Nevertheless, within the constraints imposed upon the model, its message is clear: New behaviours don't necessarily require new mechanisms and systems integrating information across modalities can reveal surprising emergent properties that would not have been predicted on the basis of exposure to one modality alone.

5. Small is Beautiful

The immature state of the developing infant places her at a decided disadvantage in relation to her mature, skilled caregivers. In contrast, the new born of many other species are endowed with precocious skills at birth. Why is homo sapiens not born with a set of cognitive abilities that match the adult of the species? This state of affairs may seem all the more strange given that we grow very few new neurons after birth and even synaptic growth has slowed dramatically by the first birthday. In fact, there may be important computational reasons for favouring a relatively immature brain over a cognitively precocious brain.

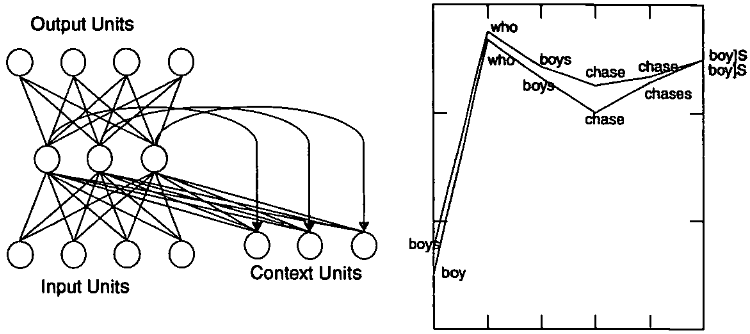
A complete specification of a complex nervous systems would be expensive in genetic resources. The programming required to fully determine the precise connectivity of any adult human brain far exceeds the information capacity in the human genome. Most current research in brain development and developmental neurobiology points to a dramatic genetic underspecification of the detailed architecture of the neural pathways that characterise the mature human brain—particularly in the neo-cortex. So how does the brain know how to develop? It appears that evolution has hit upon a solution that involves a trade-off between nature and nurture: You don't need to encode in the genes what you can extract from the environment. In other words, use the environment as a depository of information that can be relied upon to drive neural development.

The emergence of neural structures in the brain is entirely dependent upon a complex interaction of the organism's environment and the genes' capacity to express themselves in that environment. This evolutionary engineering trick allows the emergence of a complex neural system with a limited investment in genetic pre-wiring. Of course, this can have disastrous consequences when the environment fails to present itself. On the other hand, the flexibility introduced by genetic underspecification can also be advantageous when things go wrong, such as brain damage. Since information is available in the environment to guide neural development, other brain regions can take over the task of the damaged areas. Underspecification and sensitivity to environmental conditions permit a higher degree of individual specialisation and adaptation to changing living conditions. Starting off with a limited amount of built-in knowledge can therefore be an advantage if you're prepared to take the chance that you can find the missing parts elsewhere.

There are, however, other reasons for wanting to start out life with some limits on processing capacity. It turns out that some complex problems are easier to solve if you first tackle them from a over-simplistic point of view. A good example of this is Elman's (1993) simulation of grammar learning in a simple recurrent network. The network's task was to predict the next word in a sequence of words representing a large number of English-like sentences. These sentences included long distance dependencies, i.e., the sentences included embedded clauses which separated the main noun from the main verb. Since English verbs agree with their subject nouns in number, the network must remember the number of the noun all the way through the embedded clause until it reaches the main verb of the sentence. For example, in a sentence like "The boy with the football that his parents gave him on his birthday chases the dog", the network must remember that "boy" and "chases" agree with each other.

After a considerable amount of training, the network did rather poorly at predicting the next word in the sequence—as do humans (cf. "The boy chased the ???"). However, it did rather well at predicting the grammatical category of the next word. For example, it seemed to know when to expect a verb and when to expect a noun, suggesting that it had learnt some fundamental facts about the grammar of the language to which it had been exposed. On the other hand, it did very badly on long distance agreement phenomena, i.e., it could not predict correctly which form of the verb should be used after an intervening embedded clause. This is a serious flaw if the simulation is taken as a model of grammar learning in English speakers, since English speakers clearly are able to master long-distance agreement.

Elman discovered two solutions to this problem: The network could learn to master long-distance dependencies if the sentences to which it was initially exposed did not contain any embedded clauses and consisted only of sequences in which the main verb and its subject were close together. Once the network had learnt the principle governing subject-verb agreement under these simplified circumstances, embedded clauses could be included in the sentences in the training environment and the network would eventually master the long-distance dependencies. Exposure to a limited sample of the language helped the network to decipher the fundamental principles of the grammar which it could then apply to the more complex problem. This demonstration shows how "motherese" might play a facilitatory role in language learning (Snow 1977).



(a) (b)

Figure 5: (a) A simple recurrent network (Elman 1993) is good at making predictions. A sequence of items is presented to the network, one at a time. The network makes a prediction about the identity of the next item in the sequence at the output. Context units provide the network with an internal memory that keeps track of its position in the sequence. If it makes a mistake, the connections in the network are adapted slightly to reduce the error. (b) When the input consists of a sequence of words that make up sentences, the network is able to represent the sequences as trajectories through a state space. Small differences in the trajectories enable the network to keep track of long-distance dependencies.

Elman's second solution was to restrict the memory of the network at the outset of training while keeping the long distance dependencies in the training sentences. The memory constraint made if physically impossible for the network to make predictions about words more than three or four items downstream. This was achieved by resetting what are called context units in recurrent networks and is equivalent to restricting the system's working memory. When the network was constrained in this fashion it was only able to learn the dependencies between words that occurred close together in a sentence. However, this limitation had the advantage of preventing the network from being distracted by the difficult long-distance dependencies. So again the network was able to learn some of the fundamental principles of the grammar. The working memory of the network was then gradually expanded. The network was able to learn the long-distance dependencies. It succeeded in predicting the correct form of verbs after embedded clauses. The initial restriction on the system's working memory turned out to have beneficial effects: Somewhat surprisingly, the network succeeded in learning the grammar underlying word sequences when working memory started off small and was gradually expanded, while it failed when a full working memory was made available to the network at the start of training.

The complementary nature of the solutions that Elman discovered to the problem of learning long-distance dependencies highlights the way that nature and nurture can be traded off against one another in the search for solutions to complex problems. In one case, exogenous environmental factors assists the organism in solving the problem. In the other case, endogenous processing factors point the way to an answer. In both cases, though, the solution involved an initial simplification in the service of long term gain. In development, big does not necessarily mean better.

6. Current Shortcomings

6.1. One trial learning

Children and adults learn quickly. For example, a single reference to a novel object as a *wug* may be sufficient for a child to use and understand the term appropriately on all subsequent occasions. The connectionist models described in this paper use learning algorithms which adjust network connections in a gradualistic, continuous fashion. An outcome of this computational strategy is that new learning is slow. To the extent that one trial learning is an important characteristic of human development, these connectionist models fail to provide a sufficiently broad basis for characterising the mechanisms involved in development.

There are two types of solution that connectionist modellers might adopt in response to these problems. First, it should be noted that connectionist learning algorithms are not inherently incapable of one trial learning. The rate of change in the strength of the connections in a network is determined by a parameter called the learning rate. Turning up the learning rate will result in faster learning for a given input pattern. For example, it is quite easy to demonstrate one trial learning in a network that exploits a Hebbian learning algorithm. However, a side effect of using high learning rates is that individual training patterns can interfere with each other, sometimes resulting in undesirable instabilities in the network. Of course, interference is not always undesirable and may help us explain instabilities in children's performance such as in their acquisition of the English past tense. Generally, though, *catastrophic interference* between training patterns (when training on one pattern completely wipes out the traces of a previously trained pattern) is undesirable. One way to achieve one trial learning without catastrophic interference is to ensure that the training patterns are orthogonal (or dissimilar) to each other. Many models deliberately choose input representations which fulfil this constraint.

An alternative response to the problem of one trial learning in networks is to suggest that one trial learning is illusory, i.e., when individuals demonstrate what is apparently entirely new learning they are really exploiting

exploiting old knowledge in novel ways. Vygotsky (1962) coined the term the *Zone of Proximal Development* to describe areas of learning where change could occur at a fast pace. Piaget (1952) used the notion of *moderate novelty* in a similar fashion. The performance of networks can change dramatically over just a couple of learning trials. For example, the Plunkett et al. (1992) simulation of vocabulary development exhibited rapid vocabulary growth after a prolonged period of slow lexical learning. The McClelland (1989) balance beam simulation shows similar stage-like performance. In both cases, the networks gradually move towards a state of readiness that then suddenly catapults them into higher levels of behaviour. Some one trial learning may be amenable to this kind of analysis. It seems unlikely, however, that all one trial learning is of this kind.

6.2. Defining the task and the teacher

Some network models are trained to carry out a specific task that involve a teacher. For example, the Rumelhart & McClelland model of past tense acquisition is taught to produce the past tense form of the verb when exposed to the corresponding stem. These are called supervised learning systems. It is not always clear where the teacher signal that drives learning in these networks originates or how the task got to be defined in the way it did. Other models use an unsupervised form of learning such as auto-association (Plunkett et al., 1992) or prediction (Elman 1993, Mareschal et al., 1995). In these models, the teacher signal is the input to the network itself. These are called unsupervised learning systems. In general, connectionist modellers prefer to use unsupervised learning algorithms. They involve fewer assumptions about the origins of the signal that drive learning. However, some tasks seem to be inherently supervised. For example, learning that a dog is called a *dog* rather than a *chien* involves exposure to appropriate supervision. Nevertheless, it is unclear how the brain goes about conceptualising the nature of the task to be performed and identifying the appropriate supervisory signal. Clearly, different parts of the brain end up doing different types of things. One of the future challenges facing developmental connectionists is to understand how neural systems are able to define tasks for themselves in a self-supervisory fashion and to orchestrate the functioning of multiple networks in executing complex behaviour.

6.3. Biological plausibility

Throughout this paper I have tried to demonstrate how connectionist models can contribute to our understanding of the mechanisms underlying linguistic and cognitive development. Yet the learning algorithms employed in some of the models described here are assumed to be biologically implausible. For example, the learning algorithm called backpropagation (Rumelhart, Hinton & Williams 1986) involves propagating error backwards through the layers of nodes in the network. However, there is no evidence indicating that the brain propagates error across layers of neurons in this fashion and some have argued that we are unlikely to find such evidence (Crick 1989).

There is a considerable literature concerning the appropriate level of interpretation of neural network simulations. For example, it is often argued that connectionist models can be given an entirely functionalist interpretation and the question of their relation to biological neural networks left open for further research. In other words, the vocabulary of connectionist models is couched at the level of software rather than hardware, much like the classical symbolic approach to cognition. Many developmental connectionists, however, are concerned to understand the nature of the relationship between cognitive development and changes in brain organisation. Connectionist models which admit the use of biologically implausible components appear to undermine this attempt to understand the biological basis of the mechanisms of change.

Given the success of connectionist approaches to modelling development, it would seem wasteful to throw these simulations onto the garbage pile of the biologically implausible. Clearly, the most direct way forward is to implement these models using biologically plausible learning algorithms, such as Hebbian learning. Nevertheless, there are several reasons for tentatively accepting the understanding achieved already through existing models. First, algorithms like backpropagation may not be that implausible. The neuro-transmitters that communicate signals across the synaptic gap are still only poorly understood. It is known that they communicate information in both directions. Information may be fed backwards through the layered system of neurons in the cortex—perhaps also exploiting the little understood back projecting neurons in the process.

A second, less radical proposal assumes that algorithms like backpropagation belong to a family of learning algorithms all of which have similar computational properties and some of which have biologically plausible implementations. The study of networks trained with backpropagation could turn out to yield essentially the same results as networks trained with a biologically plausible counterpart. There is some support for this point of view. For example, Plaut & Shallice (1993) lesioned a connectionist network trained with backpropagation and compared its behaviour with a lesioned network originally trained using a contrastive Hebbian learning algorithm. The pattern of results obtained were essentially the same for both networks. This result does not obviate the need to build connectionist models that honour the rapidly expanding body of knowledge relating to brain structure and systems. However, it does suggest that given the rather large pockets of ignorance concerning brain structure and function, we should be careful about jettisoning our hard won understanding of computational systems that may yet prove to be closely related to the biological mechanisms underlying development.

7. Some Lessons

A commonly held view has been that connectionism involves a *tabula rasa* approach to human learning and development. It is unlikely that any developmental connectionist has ever taken this position. Indeed, it is difficult to imagine what a *tabula rasa* connectionist network might look like. All the models reviewed in this article assume a good deal of built-in architectural and processing constraints to get learning off the ground. In some cases, such as the Rumelhart & McClelland model of the past tense, the initial constraints are relatively minimal. In others, such as the Mareschal et al., model of visual tracking and reaching, the initial architectural and computational assumptions are quite complex. These modelling assumptions, together with the task definition, imply a commitment to the ingredients that are necessary to get learning off the ground.

What is needed to get learning off the ground? We have seen that there are two main sources of constraint:

1. The initial state of the organism embodies a variety of architectural and computational constraints that determine its information processing capabilities.

2. Environmental structure supports the construction of new representational capacities not initially present in the organism itself.

Modelling enables us to determine whether a theory about the initial state of the organism can make the journey to the mature state given a well-defined training environment. Modelling also enables us to investigate the minimal assumptions about the initial state that are needed to make this journey.

A minimalist strategy may not necessarily provide an accurate picture of the actual brain mechanisms that underlie human development. However, it provides an important potential contrast to theories of the initial state that are based on arguments from the poverty of the stimulus. Investigating the richness of the stimulus shifts the burden away from the need to postulate highly complex, hard-wired information processing structures. A minimalist strategy may also provide valuable insights into alternative solutions that the brain may adopt when richer resources fail.

Theories about the initial state of the organism cannot be dissociated from theories about what constitutes the organism's effective environment. Release two otherwise identical organisms in radically different environments and the representations they learn can be quite disparate. Connectionist modelling offers an invaluable tool for investigating these differences as well as examining the necessary conditions that permit the development of the emergent representations that we all share.

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EXPERIMENTAL EVIDENCE ON THE ACQUISITION OF PAST TENSE INFLECTION IN DANISH, ICELANDIC AND NORWEGIAN CHILDREN[1]

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Dorthe Bleses

Abstract

This paper reports a cross-linguistic study of children's acquisition of PT-forms testing the effects of input factors such as phonological properties of verbs and their type and token frequencies. Parallel experiments were conducted for Danish, Icelandic and Norwegian, involving three groups of 30 children aged 4, 6, and 8. PT-forms of 60 verbs were elicited from each child. The results show a clear developmental effect in all three languages. Both frequency and phonological factors clearly play a role, both for correct performance and for error types. Children generalise to all the main inflectional classes, but to a varying degree, and their generalisation patterns change during development. Interesting cross-linguistic differences are also found and the results suggest that phonological complexity is a greater and longer-lasting challenge for children than morphological complexity.

1. Introduction

Recent research in the acquisition of past tense (PT) morphology has focussed on the role played by input factors such as the phonological properties of verbs and their type and token frequencies. This paper reports some aspects of a cross-linguistic, experimental study of the acquisition of PT inflection of Danish, Icelandic and Norwegian, testing the effects of these factors. These three languages are closely related, but show some clear intra-typological differences, making them an interesting field of comparative study. As little is known about the acquisition of verbal morphology in these languages, we also hope to contribute to the current understanding of the morphological development of children learning Danish, Icelandic and Norwegian.

2. Verbal morphology of Danish, Icelandic and Norwegian

Danish, Icelandic and Norwegian are Germanic languages, and as such their verbal inflectional systems are in many ways similar to that of English. For instance, they all share a basic distinction between weak (regular) and strong (irregular) verbs. They also differ in interesting ways, as illustrated in Figure 1 below.

ENGLISH	**One weak inflectional class**	
stem (= inf./pres./imp.)	dance	call
-ing-form	dancing	calling
-s form (3rd p. sg. pres.)	dances	calls
-ed form (past/past part.)	danced	called
DANISH	**Two weak inflectional classes**	
	Large	**Small**
stem (= imperative)	kast	råb
infinitive	kaste	råbe
present	kaster	råber
past	kastede	råbte
past participle	kastet	råbt
pres. participle	kastende	råbende
passive	kastes	råbes
NORWEGIAN	**Two weak inflectional classes**	
	Large	**Small**
stem (= imperative)	kast	rop
infinitive	kaste	rope
present	kaster	roper
past	kastet	ropte
past participle	kastet	ropt
pres. participle	kastende	ropende
passive	kastes	ropes
ICELANDIC	**Two weak inflectional classes**	
	Large	**Small**
stem	kast	dæm
infinitive & pres.ind.3. p.pl.	kasta	dæma
pres.ind. 1.p. sg.	kasta	dæmi
pres.ind.2 & 3 p. sg.	kastar	dæmir
pres.ind.&subj. 1.p. pl.	köstum	dæmum
pres.ind.&subj.2.p. pl.	kastið	dæmið
pres.subj.1.&3.p. sg.; 3.p. pl.	kasti	dæmi
pres.subj. 2.p. sg.	kastir	dæmir
past ind.&subj. 1.&3.p. sg.	kastaði	dæmdi
past ind.&subj. 2.p. sg.	kastaðir	dæmdir
past ind.&subj.1.p. pl.	köstuðum	dæmdum
past ind.&subj.2.p. pl.	köstuðuð	dæmduð
past ind.&subj.3.p. pl.	köstuðu	dæmdu
imperative sg.	kastaðu	dæmdu
imperative pl.	kastiði	dæmiði
passive ind. sg./pl.	kastast	dæmast
passive subj. sg./pl.	kastist	dæmist
pres.part.	kastandi	dæmandi
past part. sg.	kastað	dæmt

Figure 1. Weak verb paradigms in English, Danish, Norwegian and Icelandic

The first difference concerns **morphological complexity**. While English verbs have 4 different forms, Danish and Norwegian verbs have 7, and Icelandic verbs have at least 18 in the weak paradigm (over 30 different forms in the strong verbs). Icelandic is more complex not only in the many different suffixes, but also in the vowel changes: while English, Danish and Norwegian keep their stems relatively unchanged all through their weak paradigms, Icelandic incorporates vowel change both in weak and strong verbs. The same type and amount of complexity is found in the other word classes in Icelandic. Due to such morphological complexity, the Icelandic child seems to face a much more complicated task than the Danish, Norwegian (or English) child.

A second, more specific difference concerns the **number of weak classes**. While English has one single weak class, Danish, Icelandic and Norwegian have two. In all three Scandinavian languages one of the weak classes is clearly larger than the other, and is generally productive, while the smaller class is unproductive, or productive only for certain subgroups of verbs (in Norwegian). In Icelandic and Norwegian both weak classes are much larger than any strong class, whereas in Danish there is hardly any difference beween the number of verbs in the small weak class and the number of strong verbs. An approximation of the different proportions of the verb classes, based on the most recent dictionaries for Danish, Icelandic and Norwegian (Retskrivningsordbogen 1986 (RO 86)[2] Íslensk orðtíðnibók 1991[3], Bokmålsordboka 1986) is shown in Figure 2[4]:

	DANISH			ICELANDIC			NORWEGIAN	
Strong	Weak		Strong	Weak		Strong	Weak	
6%	Small	Large	4%	Small	Large	4%	Small	Large
	7%	87%		21%	75%		40%	56%

Figure 2. Verb class proportions in Danish, Icelandic and Norwegian

With their two weak classes, the Scandinavian languages exhibit a less clear dichotomy between regular and irregular categories than the one we find in English. An evaluation of how verbal inflection is acquired in these languages may therefore throw a new light on models that have been put forward mainly on the basis of English.

A crosslinguistic difference which is not apparent in Figure 1 is the difference in **phonological complexity** associated with the inflectional systems. While the inflectional forms in Icelandic and Norwegian are relatively easy to segment and identify, this is not the case in Danish. Spoken Danish is characterised by a very indistinct and reduced pronunciation of weak syllables (and therefore also in the verbal morphology) which presumably makes Danish harder to segment compared to the other Scandinavian languages. In addition to the low segmentability of Danish in general the Funish standard, which is the regional standard spoken by the Danish subjects participating in this study, is even more complex than Standard Danish mainly for two reasons: 1) a larger variation of PT forms in the input due to additional realisations of the PT suffix in the WL paradigm compared to Standard Danish. This implies that the Funish child will hear the same verb inflected with up to 6 different forms. 2) a more ambiguous distribution between the two regular weak classes in the input due to the high similarity and partly overlap between the realisations of the WL and the WS inflections[5] (see Bleses 1998).

In sum, children learning English, Danish, Icelandic and Norwegian seem to be presented with slightly different tasks when learning past tense inflections. In English, the verbs can be divided into two clearly different groups, while the Scandinavian languages show less of a dichotomy. Within the Scandinavian languages, Icelandic is far more morphologically complex than Danish and Norwegian, whereas the latter two differ in phonological complexity, even though they have very similar inflectional classes. Thus, where the Icelandic children seem to have the most difficult task from a morphological point of view, the Danish children seem to meet a problem regarding phonological complexity.

Exploring the natural variation found in Danish, Icelandic and Norwegian children´s learning tasks, we will address the following questions:

i) Do input factors play a role in the acquisition of past tense morphology, and does this change during development?

ii) Are the differences in morphological complexity on the one hand, and phonological complexity on the other, reflected in the children's acquisition process?

3. Method

Parallel experiments were originally designed for Icelandic and Norwegian[6], eliciting past tense forms of cognate or similar verbs in the two languages. The same test was later adapted for Danish. We used a picture elicitation task similar to that of Bybee and Slobin (1982), where the child is presented with a picture of someone performing an action, together with an utterance containing the corresponding verb in the infinitive. The child is then prompted to produce orally an utterance with the past tense of the verb.

For each language, 3 groups of children were tested, aged 4, 6, and 8, with approximately 30 children in each age group and similar numbers of boys and girls.

Each subject was tested individually, on approximately 60 verbs. The verbs were carefully chosen according to both *frequency factors* (*type* and *token* frequency)[7] and *phonological properties* of the verbs. For a detailed description of the choice of Icelandic and Norwegian verbs, see Ragnarsdóttir, Simonsen & Plunkett (1997), for the Danish verbs, see Bleses (1998). As indicated in Figure 2 above, three main classes may be distinguished in these languages, ranked in increasing order of type frequency: Strong verbs (S), the Small Weak class (WS), and the Large Weak class (WL).[8] Verbs from all these classes were included in the test – half of the verbs included were strong, and half were weak, with an equal number from each of the two weak classes. The verbs from the different classes have the same average token frequency.

4. Results

4.1. Correct performance

A clear and statistically significant[9] developmental progression was found in overall correct performance in all three languages as shown in Table 1 below. At age 4, the Norwegian children do better than both the Danish and the Icelandic children, but the difference between Norwegian and Icelandic children has disappeared by age 6, and at ages 6 and 8 both Icelandic and Norwegian children are considerably ahead of the Danish ones.

	Age 4	Age 6	Age 8
Danish	32 %	50 %	68 %
Icelandic	35 %	74 %	87 %
Norwegian	51 %	72 %	90 %

Table 1: Correct PT answers for all verbs by age group and language

Different developmental patterns of acquisition were observed for the three verb groups in all three languages as illustrated in Tables 2, 3, and 4.

	S class	WS class	WL class
Age 4	18 %	32 %	74 %
Age 6	40 %	59 %	81 %
Age 8	61 %	84 %	82 %

Table 2. Correct answers by verb and age groups: Danish children

	S class	WS class	WL class
Age 4	15 %	41 %	88 %
Age 6	71 %	82 %	87 %
Age 8	87 %	87 %	94 %

Table 3. Correct answers by verb and age groups: Icelandic children

	S class	WS class	WL class
Age 4	33 %	47 %	85 %
Age 6	60 %	71 %	94 %
Age 8	86 %	91 %	96 %

Table 4. Correct answers by verb and age groups: Norwegian children

The overall pattern of acquisition is the same in all three languages. The children score highest on the verbs from the large weak class (WL) followed by the verbs from the small weak class (WS) and lowest on the strong verbs (S). The rate of acquisition, on the other hand, is not the same in Danish, Icelandic and Norwegian.

The Danish children (cf. Table 2) have a lower score overall than both the Icelandic and the Norwegian children. The correct performance for the WL-verbs lags considerably behind the other languages and does not seem to have reached a ceiling at age 8.

For the WS-verbs, the Danish children have a very low score (32 %) at age 4, but there are significant improvements in performance both from age 4 to 6 and from age 6 to 8. The WS verbs reach the same level of performance as for the WL-verbs at age 8.

At age 4 the Danish children perform at a very low level for the S-verbs (18 %). Although their increase in performance is significant both at age 6 and at age 8, their performance for these verbs remains as low as 61% correct at age 8.

The Icelandic children´s performance already approaches a ceiling on the WL-verbs at age 4, and remains stable across age groups (cf. Table 3).

Their performance for the WS class lags significantly behind that for the WL class at age 4 with only 41% correct, but already by age 6, performance for WS-verbs has increased significantly (to 82%) and reached the same level of correct performance as the WL- verbs.

Like the Danish children, the Icelandic children perform at a very low level on the S-verbs at age 4 with only 15% correct. But the progress between ages 4 and 6 is dramatic, rising to 71%, and increasing significantly again to 87% at age 8. By age 8, all differences between the three verb classes have evened out in the Icelandic children.

The Norwegian children (cf. Table 4) show significant differences in performance between all age groups for all verb groups except the WL-verbs which reach a ceiling at age 6.

For the WS-verbs the performance improves significantly from 47% at age 4 to 71% at age 6, but it is still significantly behind that on the WL-verbs at this age. It is not until age 8 that the Norwegian children perform equally well on verbs from the two weak classes.

Although the performance of the Norwegian children on the strong verbs is relatively high at age 4 (33%), it lags behind that on the weak verbs in all age groups - at age 4 behind both weak classes, at age 6 clustering with the WS-verbs behind the WL-verbs, and at age 8 still significantly behind the WL-verbs.

Summary: correct performance

The Danish, Icelandic and Norwegian children all show clear progress with age both overall and for each verb class. The verb classes were generally acquired in an order predicted by their type frequency, i.e. the WL first, followed by the WS and finally by the S verbs .

There are also clear crosslinguistic differences. Overall, the Danish children have the lowest correct score. At age 4, the Norwegian children are ahead of both their Icelandic and their Danish peers, but by age 6, the

Icelandic children have made a spurt, and from then on the Danish children are considerably behind both their Icelandic and Norwegian peers.

The cross-linguistic differences in rate of acquisition are most pronounced for the WS- and the S- verbs. While the performance for the WS-verbs is relatively low in all languages at age 4, it catches up with that of the WL-verbs in the Icelandic children already at age 6, but not until age 8 in the Danish and the Norwegian children.

For the strong verbs, the Norwegian children perform significantly better than both their Danish and their Icelandic peers at age 4. The Icelandic children, however, progress dramatically between ages 4 to 6 on the strong verbs, even slightly outperforming the Norwegians at this latter age, whereas the Danish children have a much slower development and continue to lag behind both the Icelandic and the Norwegian children at age 8.

4.2 Errors

The errors the children made were classified into 6 main types:

1. Generalisation of the weak large pattern	(GEN>WL)
2. Generalisation of another weak pattern	(GEN>WS)
3. Generalisation of a strong pattern	(GEN>S)
4. No change of stem	(NO CHANGE)
5. No answer	(NO ANSW)
6. Non-past form	(NON PAST)

In this paper the focus will be on the most frequent error types, i.e. the first three error types, each consisting in generalising one of the main past tense inflectional patterns, and the NON-PAST errors, which turned out to be quite frequent in Danish and Norwegian.

As was found to be the case for the correct responses, developmental as well as cross-linguistic differences were observed in the types of errors children make. Tables 5, 6, and 7 below show the developmental profiles of the three types of generalisation errors in Danish, Icelandic and Norwegian. (The percentages add up to 100% of all errors).

	GEN>WL	GEN>WS	GEN>S
Age 4	34 %	2 %	-
Age 6	39 %	4 %	1 %
Age 8	28 %	8 %	3 %

Table 5: Generalisation errors by age group: Danish children

	GEN>WL	GEN>WS	GEN>S
Age 4	62 %	30 %	1 %
Age 6	22 %	61 %	12 %
Age 8	12 %	75 %	13 %

Table 6: Generalisation errors by age group: Icelandic children

	GEN>WL	GEN>WS	GEN>S
Age 4	44 %	12 %	2 %
Age 6	52 %	27 %	9 %
Age 8	37 %	44 %	13 %

Table 7: Generalisation errors by age group: Norwegian children

Comparing the generalisation errors for all three languages, the first thing to notice is that the proportion of overgeneralisation errors to all three verb classes is strikingly and significantly lower for Danish as compared to the other languages (Danish 40%, Icelandic 96% and Norwegian 80%). Both the Danish and the Norwegian children produced a large number of non-past tense forms substituting the PT forms with an infinitive or a present tense form. However, whereas this error type had more or less disappeared at age 6 in the Norwegian data, it continued to be a very frequent error type in the Danish data even at age 8. The infinitive forms constitute a specific problem in the Danish data and can be interpreted in two different ways: 1. The infinitive forms could be regarded as being a correct past tense form (recall that the infinitive is a possible PT form in Funish, as mentioned in footnote 5). 2. The use of non-past tense forms, including the infinitive forms, is a general error strategy used by the children. Two findings support the latter interpretation. First, the infinitive forms appear in all verb classes (only 35% appear with WL-verbs). Secondly, the infinitive forms appear mainly with infrequent verbs (in WL verbs 60% of the infinitive forms occurred with infrequent verbs). An investigation based on Danish children speaking a regional standard close to that of Standard Danish yields a similar result (see Bleses 1998). The fact that even the Norwegian 4-year-olds had a considerable amount of non-PT forms also supports the error strategy interpretation.

For all three languages, overgeneralisations to the large weak class (GEN>WL) constitute the most frequent generalisation errors. Generalisation errors to the small weak class (GEN>WS) are also frequent both in Icelandic and Norwegian, but less so in Danish. Finally generalisations of strong verbs (GEN>S) do occur – increasingly with age. They are much less frequent than the other generalisation errors, however, and in Danish they are extremely rare.

Taking a closer look at the overgeneralisation errors to the two weak classes, we find significant developmental differences, and in addition crosslinguistic differences are evident.

In the **Icelandic children**, the GEN>WL is the dominant error type at age 4. By age 6, it has decreased from 62% to 22% of all errors. As the proportion of GEN>WL errors decreases, the proportion of overgeneralisations to the less productive weak pattern (GEN>WS) increases, the latter being the dominant error-type at ages 6 and 8.

In the **Norwegian children**, a similar developmental profile is observed, but delayed relative to the Icelandic children. GEN>WL overgeneralisations are the main generalisation errors at age 4. These continue to be dominant at age 6 but decrease by age 8. The GEN>WS increase slowly from age 4 through 6, to become the major error-type at age 8, as compared to age 6 in Icelandic.

When the development of error-types is compared to the development of correct performance for the two weak classes, it appears that these are quite synchronised in these two languages. In Icelandic (cf. Tables 3 and 6), the 4-year-olds perform best on the WL-class, and the children overgeneralise predominantly to this class. At age 6, the performance on the WS-class makes a spurt – synchronically, generalisation errors into this class make an upwards leap, while the GEN>WL errors decrease substantially. This tendency persists in the 8-year-olds.

A similar pattern is observed in Norwegian, only it develops more slowly (cf. Tables 4 and 7). Interestingly, in a replication of this experiment on adult Norwegian subjects, GEN>WS was found to be the dominant error type, accounting for 45% of the errors as compared to 10% of GEN>WL and 20% GEN>S (Bjerkan & Simonsen 1995, 1996).

As for the **Danish children**, the developmental pattern described above for the Icelandic and the Norwegian children is not observed. At age 8 the GEN>WL is still the most frequent type of overgeneralisation, and even more surprisingly, non-past-tense forms are still as frequent as GEN>WL. In spite of the increase from 32% to 59% in correct answers on WS-verbs at age 6, the percentages on GEN>WS only rise from 2% to 4% and the upwards leap in generalisation errors to this class seen in the other languages does not occur. The Danish children continue to make progress at age 8 (84% correct) but still the GEN>WS are very infrequent (9%). However, an analysis of the error patterns matched by level of performance shows that when the Danish children, independently of age, reach an acquisition level of 90 % correct forms, GEN>WS become the major error type (Bleses 1998). Thus, these data suggest a close interaction between level of performance and error patterns: to be able to generalise over (and overgeneralise over) an inflectional class, the class in question must have reached a certain level of mastery, and even have been at this level for some time. Due to the lower performance level of the Danish children, however, the developmental profile is delayed relatively to both the Icelandic and Norwegian.

5. Discussion

The results confirm the importance of input factors for the acquisition of past tense morphology in Danish, Icelandic, and Norwegian. Below, we will discuss the role these factors seems to play during development. We will also discuss the possible effects of the differences in morphological complexity and phonological complexity of the three languages.

5.1. The role of input factors

First, all three major inflectional classes are acquired in an order reflecting their type frequency in the input – WL>WS>S. The larger the number of verbs in an inflectional class (type frequency), the earlier it is acquired. The overgeneralisation errors children make follow the same pattern as the correct performance; all three classes form bases for overgeneralisations, and to a large extent their relative importance as sources of overgeneralisation reflects the type frequency of the classes in the languages. In Icelandic and Norwegian, however, the small weak class becomes increasingly important as a source of generalisation errors with age, while errors of overgeneralisations into the large weak class diminish.

An important cross-linguistic difference concerns the small weak class (WS): it is acquired earliest in Icelandic, somewhat later in

Norwegian, and latest in Danish. Correspondingly, overgeneralisations to the small weak class have become the dominant error type much earlier in Icelandic than in Norwegian, while in Danish GEN>WS never becomes dominant within the age scope of this experiment.

For Danish, the low percentage of GEN>WS (cf. Figure 2) does reflect type frequency, since the WS-class is very small in Danish, containing only 7% of all verbs (but for other suggestions see Bleses 1998 and Basbøll & Bleses in prep). For Norwegian and Icelandic, on the other hand, the relation between type frequency and the productivity of the WS-class is at the first glance not evident. However, a closer look at the composition of small weak class in Norwegian yields a somewhat different picture: the majority of the verbs in this class, in fact 80% of them, belong to a well-defined subgroup of loan verbs ending in the latinate affix *-ere*. These verbs all have a very low token frequency, and probably most of them are rare in the language spoken to children. If these verbs are excluded, the rest of the WS-verbs constitute only 8% of the Norwegian verbs.

Other input factors such as phonological properties also seem to contribute to the pattern of performance. To some extent they support type frequency – that is the case, for instance, concerning the three major verb classes in the Scandinavian languages.

If we put them on a scale according to ease of segmentability of their past tense forms, the classes will be ranked in the same way as a type frequency ranking.

In the large weak class phonological factors support suffix segmentation, making the suffixes in this class more salient than the suffixes in the small weak class, at least in Icelandic and Norwegian. In all three languages, the WL-class suffixes begin with a vowel – probably making it easier to recognise or separate from the stem than a suffix beginning with a consonant. In Icelandic, the "vowel" suffix is even more salient, having two syllables as opposed to one in the consonant suffixes. In this manner, type frequency and phonological factors work together to make the large weak class the easiest one for the children to acquire. In spoken Danish (and even more so in the Funish standard), the indistinct and reduced pronunciation of weak syllables, including the suffix of the large weak class, does not seem to offer support to the same degree as in the other Scandinavian languages. In some cases the segmentation of this suffix is in fact extremely hard due to an obligatory assimilation principle.

The small weak class is also inflected through suffixation, but the suffixes in this class begin with a consonant, and in all three languages segmentation between stem and suffix is made harder in many cases, due to assimilations and other changes in the stem.

At the lowest end of the segmentability scale are the strong verbs, which in all three languages are inflected without a syllabic suffix, but with a change in the stem vowel.

As already mentioned, the small weak class gains ground in the course of development. Phonological cues may be important here, too. While the WL-class assumes the role of the "default" class in all three languages, including verbs of a wide range of phonological patterns, the WS-class seems less open phonologically. In Icelandic and Norwegian, all weak monosyllabic verbs belong to the WS class, and as already mentioned, Norwegian verbs ending in *-ere* belong there, too. But in addition there seem to be some more subtle phonological patterns governing the stems of the small weak class, implying that certain phonological patterns are practically excluded from the WS class. For example, in Norwegian, 80% of the stem vowels in the WS class are long, the set of stem final consonants is more restricted than that of the WL-class, and stem final clusters are very rare in the WS class (Hagen 1994, Bjerkan in preparation). Similar restrictions are found in the patterning of weak verbs in Icelandic (see Gíslason 1992), and also in Danish (see Bleses 1998).

These patternings are only tendencies, and it is not possible to define clear subcategories on the basis of these phonological patterns. Subtle tendencies of this kind are probably harder for the children to detect than more clearcut ones, and need longer time (and more verbs) for them to discover and generalise from. The potential role of these patterns in the acquisition process needs further investigation, but they may help explain the developmental profile associated with the small weak class.

Certain language specific phonological features could also contribute to the differences in rate of acquisition of the WS class in Icelandic as compared to Norwegian and Danish. In Icelandic, the present tense suffixes are different in the two weak classes. Whereas the infinitive ends in an /a/ in all verb classes, and this /a/ is maintained in the WL-class in the suffixes for the 1st, 2nd and 3rd pers. sg. both in present and past tense, the corresponding suffixes in the WS-class contain an /i/ (cf. Figure 1). For the Icelandic child the vowel patterning in the present tense may thus function as a cue to class membership of the weak verbs and help distinguish verbs from the small weak class from that of the large weak class. In Danish and Norwegian (at least in the dialect of Norwegian we are investigating), on the other hand, present tense does not differ between the two weak classes, and does not provide the children with such a cue. Furthermore, the Icelandic children have to focus on both the vowel patterns and the consonant patterns to make sense of their language in general - this way they may be more aware of them, and generalise from them more easily. This will be discussed in the following section.

5.2 Role of morphological complexity

Certain cross-linguistic differences between the acquisition of Icelandic past tense morphology on the one hand and Norwegian and Danish on the other appear to be related to the difference in morphological complexity in the verbal paradigms of these languages. Since Norwegian does not have any supplementary complexity like Danish, Norwegian will be used at the basis of comparison here.

There are no differences between correct performances on the WL-class in Icelandic and Norwegian, as both Icelandic and Norwegian subjects are already performing close to ceiling on verbs from this class in the youngest age-group. Overall, however, the Icelandic children are behind the Norwegian ones at age 4 (cf. Table 1), and more so on the S-verbs than on the WS-verbs (cf. Tables 3 and 4). This situation has changed already at age 6. Although the age-range of our subjects does not allow us to verify this as far as the WL-class is concerned, we suggest that the late start of the Icelanders as compared to the Norwegian children is linked to the greater morphological complexity of the Icelandic inflectional system.

Furthermore, we suggest that the greater morphological complexity of Icelandic may subsequently have a facilitatory effect on children's acquisition of morphology, and contribute to the Icelandic children's advantage over the Norwegian children at age 6. This suggestion is inspired by a hypothesis put forward by Fortescue (1992) who proposed that morphophonemic complexity may actually serve a positive function in the acquisition of morphologically complex languages. When children discover that the one form – one meaning principle doesn't work, they must focus on the problem and look for different realisations of the same morpheme in different contexts. Fortescue originally made this proposal in connection with polysynthetic languages, but the same idea may apply to Icelandic: The complex morphology of this language, with a wide variety of suffixes, vowel changes and other morhophonemic patterns, not only in the verbs, but in the other word classes as well, may compel the child to focus on discovering the patterns.

Our findings suggest that morphological complexity may play different roles at different stages in development. At the outset, the greater morphological complexity of Icelandic made the Icelandic children perform less well than their Norwegian peers. At some point before age 6, however, a change has taken place: the challenge offered by the complex morphological structure of Icelandic has actually stimulated their processing resources and driven them to perform better than the Norwegian children, with their less demanding morphological task.

5.3 The role of phonological complexity

If we compare the acquisition of Danish and Norwegian, where the morphological complexity is more or less identical, the phonological complexity of Danish as compared to Norwegian seems to have a great impact on the performance of the Danish children. Danish presents children with an extremely difficult phonological task for identifying the morphological units and patterns in the inflectional system. The indistinct and reduced pronunciation of verbal morphology in Danish results in a very low transparency between the sound string and the morphological segments which makes Danish particularly hard to segment. Due to the larger inflectional variation of the WL class and the partial overlap between the WL and the WS classes, the Funish children face a very difficult task identifying the morphological forms of the weak inflectional system and using them according to the adult standard. An expanded study where the performance of the Funish children was compared to another group of Danish children speaking a more standard like variety revealed similar results (Bleses 1998).[10] These findings suggest that phonological complexity is an even harder task for children to overcome than that of morphological complexity.

6. Conclusion

In our opinion, Danish, Icelandic and Norwegian offer an important addition to the existing database for the acquisition of past tense, providing a new perspective on the nature of the developmental task for the children, on the role of input factors in acquisition, and consequently, on the cross-linguistic validity of acquisition models put forward mainly on the basis of English.

English, with its clear dichotomy into irregular/strong and regular/weak verbs, seems to lend itself relatively well to a model assuming two essentially different mechanisms at work (see e.g. Pinker & Prince 1988; Marcus & al. 1992, 1995; Prasada & Pinker 1993). The Scandinavian languages, with less of a dichotomy between the classes, present a less clearcut picture. Our results indicate that the differences between the verb classes in fact are of a gradual nature, and not a question of either-or. In addition, input factors play an important role for the acquisition of all verb classes, thus lending support to a model assuming that the mechanisms involved are of a more homogeneous nature (see e.g. Plunkett & Marchman 1991, 1993, 1996; Bybee 1988, 1995; Langacker 1987).

In Danish, Icelandic, and Norwegian, the large weak class is clearly the most productive, and should be the most robust one to form generalisations over. This is also what we find in the 4 year olds. However, over the course of development, our data show that both the weak classes, and even strong inflectional patterns are used as bases for generalisation. Gradually more classes are used productively, and their influence on performance changes over time. Type frequency seems to play a central role here, as well as phonological features. The more verbs the child acquires, the larger the basis for generalisation. We also seem to find evidence for a mass action effect in phonology: when the phonological patterns to generalise over are subtle, or when phonological complexity makes them hard to recognise, there is a need to acquire a large mass of forms before generalisations can be drawn.

In addition, the intra-typological differences between the three languages studied constitute an interesting continuum along two dimensions - morphological and phonological complexity. Icelandic is at the one end with high morphological complexity, Danish at the other with high phonological complexity, and Norwegian covers a middle ground both in terms of morphological and phonological complexity. This made it possible to study the effect of language specific factors at a very finegrained level. The differences in complexity seem to be important factors for explaining cross-linguistic differences in acquisition. Our results suggest that phonological complexity is a greater and longer-lasting challenge for children than morphological complexity.

Notes

1. The Icelandic and Norwegian part of this paper is to a large extent based on Ragnarsdóttir, Simonsen & Plunkett 1997. We are grateful to Kim Plunkett, Oxford University, for his contribution to the research behind this article. This research was supported by research grants from NOS-H, University College of Education Research Center, Reykjavík, the Oceania Group, Department of Linguistics, University of Oslo, and the Institute of Language and Communication, Odense University.

2. The estimations are based on RO 86, which is part of the forthcoming Danish dictionary *Den danske ordbog* (The Danish Dictionary) by *Det danske Sprog og Litteraturselskab* (The Danish Language and Literature Society).

3. Thanks to Eiríkur Rögnvaldsson for his unpublished list of Icelandic verbs by classes used in the preparation of this study.

4. Estimations based on PT forms of verbs used in spontaneous speech in adult-child interaction during everyday activities in the home yield a different distribution of verbs by classes (see Ragnarsdóttir 1997 and in preparation for details on Icelandic, and Bleses 1998 and Bleses & Plunkett in preperation) for Danish.

5 The transcriptions of the phonological realisations of the weak paradigm in Standard Danish and the Funish standard respectively (: indicates syllabic lenghtening). Standard Danish: **WL**: 1.*-əðə′* and the very frequent assimilated and reduced realisations *-əð* and *-ð:*. **WS**: *-də* and the very frequent reduced realisation *-d*. Funish standard: **WL**: 1.*-əðə* and the very frequent assimilated and reduced realisations *-əð* and *-ð:*. 2. *-ədə* and the very frequent assimilated and reduced realisations *-əd* and *-d:* and *-d*. 3. *-ə* (which is identical to the infinitive form). **WS**: *-də* and the very frequent reduced realisation *-d*. The stop form realisations of the WL suffix in the Funish standard result in overlap between the WL and the WS classes in this regional standard.

6 Norwegian, like Danish, has several different dialects. The one investigated here is the Bokmål variety of the East Norwegian dialect spoken in and around the capital Oslo.

7 Type frequency refers to the number of verbs belonging to each verb class, while token frequency refers to the frequency of use of each verb. See Ragnarsdóttir, Simonsen and Plunkett 1997; submitted and Bleses 1998 for discussion on the effect of token frequency on the acquisition of past tense morphology in Danish, Icelandic and Norwegian.

8 Verbs from a fourth class (irregular weak verbs) which are included in the Danish and the Icelandic tests, are not included in this cross-linguistic comparison.

9 In testing statistical significance for the Icelandic and Norwegian data, we used ANOVAs and Tukey-b post hoc test for multiple comparisons. Significance level was in all cases less than p .05. For details of the statistical analyses, see Ragnarsdóttir, Simonsen & Plunkett (submitted). The statistical analyses for Danish appear in Bleses (1998).

10 Differences found between the two dialects in the aquisition of the WL and the WS class provided further evidence for the role of phonological complexity in delaying the acquisition of past tense morphology

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SIGNIFYING SUBJECTS

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Abstract
Generativist theories of language acquisition emphasize the discontinuity between 'knowledge of language', and non-linguistic cognition and communication. Cognitive linguists challenge the generativist assumption of the autonomy of syntax. In cognitive linguistics, linguistic expression is regarded as *motivated* by meaning, and grammar and lexicon are viewed as being iconically based in psychological processes of image-schematization. Cognitive linguistics emphasizes, as did Piaget and Vygotsky, the active role of the subject in conceptualization, and the continuing role of embodied experience in human cognition. However, the *embodied* subject is also the *signifying* subject in a universe of intersubjectively shared meaning. Subjectivity is grounded both in embodied, non-discursive schematization, and in discursive signification.

Introduction

Jaan Valsiner (1996), introducing a thematic centennial number of the journal *Culture and Psychology* on the theme Vygotsky-Piaget, points out that the frequently-drawn contrast between the 'social' theorist Vygotsky, and the 'individual' theorist Piaget, is misleading in many respects. Piaget and Vygotsky, he notes, shared a common intellectual heritage in the evolutionary, developmental and semiotic concerns of such writers (amongst others) as James Mark Baldwin, Pierre Janet and Charles Sanders Peirce; and both addressed the development of knowledge in both individuals and societies. To this we may add that both men shared an early formation in a climate of ideas about biological and cultural evolution which owed, perhaps, as much to Lamarck and Häckel as to Darwin, and which Piaget extended and elaborated in his later preoccupation with formulating an epigenetic alternative to both nativism and empiricism.

Mainstream developmental psychology and psycholinguistics in the last thirty years or so, under the influence of a different *zeitgeist* of cognitivism, universalism and biological determinism, have turned away from these ideas. Instead, they have sought to account for the richness of human cognition, and the 'miracle' of children's acquisition of language, by postulating domain-specific innate knowledge. The *locus classicus* of the cognitivist argument to radical nativism is, of course, language itself, where Chomsky's 'Argument from the Poverty of the Stimulus', and its subsequent elaboration in learnability theory, have convinced many researchers that only by ascribing an inborn knowledge of Universal Grammar (UG) to the human infant, can both the facility and the patterned regularity of children's language acquisition be explained. The generativist paradigm, which still holds sway in most North American Departments of Linguistics, and which remains the most influential approach to language acquisition, relegates the linguistic, social and communicative environment of the child to the status of 'input', a necessary but essentially secondary 'trigger' for the setting of 'parameters' of UG inscribed by the genes in the brain of the child. In keeping with the generativist focus upon syntax, 'input' is considered of relevance only inasmuch as it exemplifies the target grammar which the child is acquiring.

What I refer to as the 'patterned regularity' of language acquisition processes is accounted for in generative linguistics exclusively by parameter setting; the equally patterned regularity which has been documented by many developmentalists in the communicative environment of the child—what Bruner (1983) refers to as the 'Language Acquisition Support System'—is ignored, and the contribution of the child's non-linguistic or pre-linguistic cognitive development is restricted to 'bootstrapping' into the lexicon.

So much is common knowledge, and the generativist approach has, for obvious reasons, never appealed either to (neo-)Piagetians or (neo-)Vygotskians. From the other side, generativists have consistently dismissed any suggestion that a *rapprochement* with alternative, developmentally-oriented traditions may be possible or desirable (see, e.g. Piatelli-Palmarini, 1980)—an attitude entirely in keeping with their treatment of non-generativist approaches to linguistic theory (Itkonen, 1996). I am not going to argue here for such a rapprochement. In fact, although I profoundly disagree with the generativist paradigm, and with its account of language acquisition, I agree with its exponents that either you buy it lock, stock and barrel, or (as I do) you reject it.

Rejection brings with it the obligation of having something else, and better, to offer, and I think that those of us in the Piaget-Vygotsky camp of epigenetic constructionism—the advocates of what I have elsewhere (Sinha, 1988) called a 'socio-naturalistic approach'—must concede that, at least until now, a well-worked out alternative to the generativist account of its own 'heartland phenomenon' (the acquisition of language *as such*) has been lacking. I believe, however, that this situation has changed, and that a coherent and comprehensive alternative is within reach. What has changed the situation is a set of developments which, from the middle of the 1980's or so, have between them radically transformed the landscape of the cognitive sciences, in such a way that these need no longer be seen as an 'enemy' of the socio-naturalistic approach. These are:

- The connectionist alternative to the symbolic paradigm
- The 'turn to discourse' and semiotic in the human sciences
- Cognitive semantics and cognitive grammar

Between them, these developments have brought about what has been rather hyperbolically termed a 'second cognitive revolution' (see Harré and Gillett, 1994; who do not, however, mention cognitive semantics and cognitive grammar). Plunkett and Sinha (1992) argue for an epigenetic-developmental interpretation of connectionism, and I shall not address this issue further here, except to say that such an interpretation requires a radical change in the way that 'representation' is conceived; no longer, as we shall see, is 'mental representation' the taken-for-granted (and usually unexplicated) bedrock of both language and cognition.

My main focus here will be on the second and, especially, the third of these developments, beginning with an exposition of cognitive semantics and cognitive grammar. I hope to show that taking up the challenge of accounting for children's language acquisition means abandoning just about every assumption that generativism makes about language. However, it also requires us to reject, equally rigorously, an argument which is often developed by anti-cognitivists, in particular post-structuralist and post-modernist theorists, namely that subjectivity is merely and exclusively an *effect of discourse.* I shall argue, on the contrary, that subjectivity is *grounded* both in non-discursive and in discursive representations and practices. This grounding is possible and comprehensible only in virtue of the *embodiment* of such representations and practices, both in the human body itself, and in the semiotic material sustaining, constraining, supporting and enabling discursive and non-discursive practices.

Not only, as I shall try to show, does this lead us to *re-instate* the subject, and embodied subjectivity, as fundamental in any account of human cognition, language and communication (and their development); but it also leads us to a greater critical understanding of the theoretical blindness to (or prejudice against) the non-discursive shared by, and deeply influential upon, the thinking of both Piaget and Vygotsky. The result will be a richer and more truly human understanding of language and cognition, and their development.

After Generativism: Cognitive Linguistics

Let us begin by examining some premises and assumptions of generative linguistics. It is widely held (including e.g. by Sinha, 1988) that generative linguistics preserves the idea common to all varieties of traditional structuralism, that language is a *system* in which elements exist in rule-governed relationships with each other; while simultaneously 'internalizing' this system, substituting (individual) *competence* or *knowledge of language* for (social-collective) *langue*. Esa Itkonen (1996) demontrates that this is, at best, an over-simplification. He draws attention to the implications for generativism of its commitment to the 'truism that language is an infinite set of sentences' (Chomsky, 1969: 57). Itkonen (1996: 472) comments,

> Far from being a truism ... the decision to view language in this way had far-reaching consequences concerning the overall conception of linguistics. Defining language as a *set* made it natural to think of sentences as *objects*. From this it was only a small step to viewing sentences as *physical* objects. And it goes without saying that physical objects have to be investigated by the methods of the natural sciences ... This reificatory tendency was reinforced by obliterating the distinction between natural languages and artificial languages whose 'sentences' are just strings of *a*'s and *b*'s ... while natural-language sentences may be more or less grammatical (with clear cases of both grammaticalness and ungrammaticalness), formal logic assumes that all formulae are either well-formed or non-well-formed ... In a curious 'backward motion' Chomsky's syntax applies to natural language this two-valued discreteness which was achieved by leaving behind natural language in the first place.

It is, of course, this very dichotomy (along with the reificatory neglect of meaning which I expand on below) which underlies the formulation in the generativist paradigm of the task of language learning as one of distinguishing lawful from unlawful strings; and the whole of learnability theory. I cannot, before moving on, resist one more quotation from Itkonen (1996: 485) on learnability theory:

> It has sometimes been suggested that even if learnability theory rests on a false assumption, the precision which it brings to the study of language acquisition is valuable in itself. My reply to this is that if someone claims to be able to measure the flatness of the earth with nanometric precision I am not impressed.

As is well-known, traditional structuralism viewed language as involving the coupling of (as variously formulated) *signifiant* with *signifié*, sound with meaning, expression with content. As is equally well-known, it was also held by traditional structuralism that the relation between content and expression is *arbitrary*. Generativism broke with the structuralist tradition by *excising content*, and redefining (reifying) the study of language as (in effect) the study of *the form of the signifier* (or more familiarly, the formal properties of physical symbol strings without reference to their meaning). This study was to be modelled on the natural sciences, and their handmaidens, logic and mathematics. There could be, naturally, no place in this enterprise for the study of *meaning* or *content*, since meaning is simply recalcitrant to the methods of the natural sciences.

To justify this restriction of the scope of linguistics, the structuralist principle of 'arbitrariness' (of the relation between meaning and sound) was transformed into the generativist principle of the *autonomy of syntax*, its radical independence of meaning. This concept of autonomous syntax is both *fundamental* to the claims of generativists regarding the innateness of UG, and *unsubstantiated* by empirical evidence in neuroscience (Mueller, in press). Autonomy, as I have put it (Sinha, in press), is the Prime Mover in the generativist Holy Trinity of Innateness, Autonomy and Universality, in that it provides the first and crucial premise in the Argument from the Poverty of the Stimulus; and it lies at the heart of the insistence by generativists on the merely interpretive—i.e. non-constitutive—nature of the 'semantic component' of the grammar.

Whereas for the structuralists, content and (phonological) expression were viewed as being in a relation *mediated* by syntax and morphology (the 'double articulation' of language), for the generativists meaning and sound are merely re-transformed outputs of an autonomous syntactic machine. Within classical, generativist-inspired cognitivism, the problem of meaning is then recast as the issue of how the outputs of one internal symbol system, characterised by the radical independence of syntax from semantics (Dogma 1), can be interpreted into another internal symbol system (the 'Language of Thought'), implemented as 'a *syntactically* driven machine whose state transitions satisfy *semantical* criteria of coherence ... the brain *is* such a machine' (Fodor and Pylyshyn, 1988: 30) (Dogma 2).

This weirdly esoteric theory, with its well-known ramifications such as that all humanly conceivable meanings are innate, is the price paid by a theoretical tradition whose first, supposedly simplifying, assumption was to get rid of meaning altogether. Its tenacious grip on cognitive science and the study of language acquisition is, I think, both a testimony to the undoubted rigour with which it has been pursued by many gifted scholars, and an intellectual 'scandal' of the same order as the solipsism of Bishop Berkeley which prompted Kant's famous 'Critique'.

Most, if not all, socio-culturally inclined developmentalists will concur, I suppose, with this critical evaluation of the generativist tradition and its influence on the sciences of human cognition. They will also, I think, agree that an alternative paradigm to the classical cognitivist, generativist-inspired one should build upon Vygotsky's insistence upon the primacy of *meaning* (and, ultimately, *socially shared meaning*) in the formation of the human psyche; and Piaget's insistence on the *developmental continuity* linking language acquisition and symbolic modes of thinking with the active engagement of the developing human organism with the physical world. Fewer of them may concur with my next proposition, that the intellectual inheritance which these thinkers left to us is, in itself, insufficient to carry through their programme. The reason is that, for all the breadth and depth of their acquaintance with the intellectual milieu of the early and (in the case of Piaget) mid twentieth century, Piaget and Vygotsky simply lacked an adequate account of language and its relationship to non-linguistic cognition and semiosis. I shall argue that such an account now exists (even if it is very much still under construction) in the approach to linguistic theory known as cognitive linguistics.

Let us try to get one problem out of the way before starting the serious business. The term 'cognitive' has not only become ubiquitous, but also functions as a buzz-word which (depending on your point of view) is either a promissory note that the research you are about to hear or read about is properly 'scientific', or a red rag which signals the hopelessly individualistic, Cartesian and mechanistic assumptions of the author/speaker. In case you are of the latter persuasion, just hang on to the point that the 'cognitive' in 'cognitive linguistics' does *not* indicate Cartesianism, or mechanistic reductionism, or individualism, but rather a commitment to analysing human natural language *in the context of and as indissolubly inter-related with the entire complex of human experience and cognitive activity*. This is how George Lakoff (1989: 125) states his interpretation of this commitment:

> 1. *The Generalization Criterion:* The study of language and conceptual structure is primarily concerned with the statement of general principles governing linguistic and conceptual elements and structures.
>
> 2. *The Cognitive Commitment:* One's analysis of natural language and conceptual structure should be consistent with what is known about the mind and the brain generally.

Now, I will concede that 'what is known about the mind and the brain generally' is problematic in more ways than one, suspended as it were between chasms of ignorance and mountain ranges of presupposition, but Lakoff's point is clearly that cognitive linguistics is both a science concerned to generalize over particular areas of inquiry, and a science whose particular generalizations are constrained by other accepted scientific generalizations. He goes on to explain how these commitments conflict with generativist and other classical cognitivist commitments.

And here is an extract from the Editorial statement of the first issue of the journal *Cognitive Linguistics* (Geeraerts, 1990: 1):

> Methodologically speaking, the analysis of the conceptual and experiential basis of linguistic categories and constructs is of primary importance within cognitive linguistics. The formal structures of language are studied not as if they were autonomous, but as reflections of general conceptual organization, categorization principles, processing mechanisms, and experiential and environmental influences.

Again, 'processing mechanisms' may sound suspiciously like bad old box-and-arrow cognitivism, but unless you reject *all and any* theories of cognition which postulate some kind of neuropsychological mechanism (and not just those couched in terms of 'information processing') this too can be generously (and non-cognitivistically) interpreted.

The point, I hope, is clear: cognitive linguistics (unlike generative linguistics) sees *meaning as primary* and attempts to develop consistent and generally applicable theories of language and cognition on this basis. As such, I claim, it is able to offer a degree of specification to an epigenetic-developmental account of language acquisition and development which is not only superior to Piaget's and Vygotsky's own formulations, but (this is, indeed, a promissory note) more plausible, and certainly more in the spirit of Vygotsky and Piaget, than the account offered by generative linguistics. I do not suggest that, viewed from a socio-cultural perspective, cognitive linguistics is entirely unproblematic; but my critical comments can wait until later.

Cognitive linguistics is a fertile research programme conducted by a rapidly expanding international research community, and I cannot hope to do even minimal justice to more than a few selected themes.[1] The themes I focus on here are:

- Embodiment, Experience and Schematization
- Meaning Construction as Signification
- Subjectivity, Universality and Relativity in Language and Cognition

This narrowed focus means that there are a number of important topics of cognitive linguistic inquiry which I shall not be able to address, or will only address briefly. Amongst these are the analysis of metaphor, metonymy and mental spaces in natural language, in relation to literature (Lakoff and Turner, 1989) and understanding and reasoning (Fauconnier and Turner, 1994); the conceptually and metaphorically motivated nature of historical language change (Sweetser, 1990) and typological patterns of grammaticalization (Heine *et al.* 1991); cognitive linguistic approaches to neurolinguistics and structured connectionist simulation of language learning (Deane, 1991; Regier, 1995); and a now very considerable body of analysis in specific areas of cognitive semantics and cognitive grammar. Neither shall I dwell on prototype theory as a major source of thinking about categorization in cognitive linguistics. I shall conclude this section, instead, by pointing out that the first of my topics defines, in the most general way, cognitive semantics, and the second cognitive grammar.

Embodiment, experience and schematization: cognitive semantics

The most fundamental proposition of cognitive semantics is that meaning derives from *embodied experience*; it is given, not in the 'objective' relationship between symbols and world, but in recurrent patterns of bodily experience, and the imaginative projection of these experiential patterns across non-physical domains of understanding. As Mark Johnson (1992: 346-7) puts it,

> meaning and value [note that meaning and value are not, as in formal semantics and all other inheritors of logical positivism, confined to separate spheres—CS] are grounded in the nature of our bodies and brains, and in our interactions with our physical, social and cultural environments ... Human beings are neither lumps of matter, nor disembodied spirits. Rather, human being is a process of organism-environment interactions, in which both the organism and its complex environments mutually co-evolve ... the way things can be meaningfully understood by us depends, in large measure, on the kinds of bodies we have and the ways we interact with our physical and social surroundings.

Furthermore, argues Johnson (1987: 29),

> in order for us to have meaningful, connected experiences that we can comprehend and reason about, there must be pattern and order to our actions, perceptions and conceptions. *A schema is a recurrent pattern, shape, and regularity in, or of, these ongoing ordering activities.*

'Image schemas' so derived from recurrent patterns of bodily experience are, on this view, the ontogenetic *and the continuing* basis of both non-linguistic (or what I shall call non-discursive) cognition, and linguistic meaning. However, if embodied experience is the starting point, it is not the terminus of the construction of meaning.[2] *Imagination* (metaphoric projection, and other defined *image-schema transformations*) enables us to comprehend (and to signify for others) non-physically embodied situations, circumstances and relationships. Johnson (1987) discusses at length the CONTAINER schema which underpins our cognitive grasp of a wide range of physical, social and emotional phenomena. For example,

> [a] common type of metaphorical projection treats social or interpersonal agreements, contracts or obligations as bounded entities. This generates such expressions as,
>
> > Don't you dare back out of our agreement
> > If you want out, bow out now, before we go any further
> > He'll weasel out of the contract, if he can
>
> Being bound in these cases involves something metaphorically akin to being in a physical space where forces act on and constrain you. If you enter *into* an agreement, you become subject to a moral (and legal) force which acts within the abstract space contained by the agreement. (p.35).

As I have said, I shall not discuss metaphor in detail here. The point is that for cognitive semantics, and quite consistently I would suggest with Vygotsky-Piaget, there is a *continuity* between meaning in the broad sense of 'being in' or 'having' a world, and linguistic meaning as a special case. Where generativists see an autonomous, syntactically governed set of strings of univocal symbols, connected, if at all, only remotely by 'bootstrapping' to experience, cognitive linguists see a web of interconnected meanings, without a necessary one-to-one correspondence of lexical form to semantic content, rooted in the dynamic and constructive projection of schematized bodily experience onto our active engagement in a world of socially shared meaning.

This will lead us in a moment to cognitive grammar, but first let us note a crucial point of difference with both Piaget and Vygotsky. Both these theorists posited the existence of what Piaget termed 'sensori-motor intelligence', which can, I think, be equated with what Vygotsky termed the 'natural line of development', and which he assumed to be shared by humans with non-human species. For both of them, then, 'embodiment', and specifically in the case of Piaget, schematized constructions emerging from organism-environment interaction, constituted the starting point of cognitive development. But, almost like the 'boot-strapping' of the generativists, this starting point was no more than that: it was seen as a 'primitive' and 'pre-intellectual' stage or mode of understanding to be superseded by *logical* (Vygotsky) or *logico-mathematical* (Piaget) reasoning. For Vygotsky, this was achieved (crudely speaking) by the internalization of socially-constituted norms of verbal reasoning. For Piaget (for whom natural language was, strangely reminiscently of Chomsky, not pure enough in form) it was achieved by the construction of the abstract logic of operations as formalized in the theory of mathematical groups.

As we know, Vygotsky (and the early, but not the late Piaget) saw similarities between the 'animism', magical thinking and illogic of young children, and the cognitive processes of what were then sometimes called 'natural people' (*Naturvölker*), human groups in a 'pre-civilized' state. This is not the place to examine the role of 'child-primitive comparisons' and the 'Phylocultural Complex' in early twentieth century European human sciences (Scribner, 1985; Wertsch, 1985; Sinha, 1988, 1989). But it is worth pointing out that a common (and derogatory) characterization at that time of 'primitive mentality' emphasized its *metaphoric* (i.e., non-literal, fantastic, illogical, totemic) nature. Civilized man (though not, in the eyes of some theorists, woman) was assumed to have overcome this childish and undeveloped state, in which 'savages' might claim that their people were bears or eagles. Cognitive semantics, however, with its demonstration of the crucial role played by metaphoric and metonymic models in language and reasoning, shows us that not only is the reasoning of indigenous peoples perfectly rationally (though not 'objectivistically') comprehensible, but *it is like that of Western adults*, in underlying process if not in constructed content. To expand briefly on this, let me explain how *metonymic* (as opposed to *metaphoric*) models are seen to work in cognitive semantics.

An example of metonymy (a part or aspect of something standing for the whole thing) in natural language which has been cited almost to death is: one waiter says to another, 'The ham sandwich would like another coffee', where 'the ham sandwich' identifies a particular customer. Lakoff (1987: 77ff) cites other examples of metonymic expressions, such as 'Don't let El Salvador become another Vietnam', and 'Paris is introducing shorter skirts this season.' In these cases, a location is standing for either events known to have taken place at that location, or an institution located at the location.

A slightly different kind of metonymic model underlies the naming of an entire category by reference to a typical or salient sub-category: for example, I might say, 'I'm going to Hoover the living room', irrespective of whether the particular brand of vacuum cleaner I have is a Hoover or not. Suppose now that at a conference a cognitive linguist, noticing a group of generative linguists from various Linguistics Departments, including MIT, remarks to a colleague cognitive linguist 'I wonder what the MIT'ers are discussing?' The characterization of the group (category) to which she is referring as 'MIT'ers', is not objectively correct; but because MIT linguists are a salient sub-category of the general category of generativist linguists, the conceptualization and communication is appropriate, and no-one would suggest the speaker was being 'illogical' or 'childish' or 'primitive'. In the same way, if the category 'bear' within a particular language and culture comprehends bears and members of the bear clan, there is nothing 'illogical' in identifying a member of the bear clan as a bear.

I do not of course claim this to be a serious analysis of what is, after all, a complex form of socio-cultural life about which I am all too ignorant. I use it to exemplify a general principle: Cognitive semantics draws our attention not to a primitive or childish 'residue' of non-discursive, imaginatively based thinking, but to the vital *continuing* basis of all human cognition in embodiment, imagination and imaginative structures of conceptualization and understanding.

Meaning construction as signification: cognitive grammar

How, then, do non-discursive conceptualizations (based in image schemas) receive expression in language, how do they become capable of being *signified* for others (and, in discursive thinking, *for ourselves*), and what might this tell us about how language is acquired? Below I shall choose to explain some basic propositions of cognitive grammar in a way which is to some extent unorthodox, but which I maintain is firmly in the spirit of cognitive linguistics. Critical cognitive grammarians who might read this should also bear in mind that I am not a linguist, but a psycholinguist with a slightly different set of axes to grind. Let us begin, anyway, by citing Ronald W. Langacker (1990a: 5):

> A foundational claim of cognitive semantics is that [contrary to the assumption of formal semantics—CS] an expression's meaning cannot be reduced to an objective characterization of the situation described: equally important for linguistic semantics is how the conceptualizer chooses to *construe* the situation and portray it for expressive purposes. An expression's precise semantic value is determined by numerous facets of construal, including the level of specificity at which the situation is characterized, background assumptions and expectations, the relative prominence accorded to various entities, and the *perspective* taken on the scene.

A reader's first reaction to this might be: 'I thought you were going to talk about grammar now, but this is semantics again'. Her second reaction might be: 'Surely this is not just semantics, but (background assumptions and expectations) pragmatics as well'. These reactions are reasonable and in fact in accordance with the approach of cognitive linguistics. *There is, in cognitive linguistics, no sharp dividing line between pragmatics and semantics, and no sharp dividing line between semantics and the traditional categories (syntax and morphology) of grammar.* This does not mean necessarily (opinions vary on this) that the entire analytic distinction between pragmatics and semantics should be cast aside, nor that cognitive linguists deny that linguistic expressions are constructed from elements of form co-occurring in conventional patterns. However, all cognitive linguists would agree that such conventional patterns are *motivated* by meaning, that meaning involves a speaking subject's *construal* or *conceptualization* of the content which is organized in expression, that this content is not separable into a 'semantic' and a 'pragmatic' component, and that content is expressed by direct construction, not involving an autonomous level of 'meaning-free' grammar.

To put it another way, cognitive linguistics (like structuralism) sees expression as *signifying* content; unlike structuralism, it does *not* see expression in the usual case as bearing an *arbitrary* relation to content. Just as the extension or projection of image-schemata from one cognitive domain to another is *motivated* by experiential analogy (not necessarily by physical or objective likeness—how could an agreement be said to physically resemble a container?), the organisation of content in expression is *motivated* by its conceptualization; and that conceptualization always involves the adoption of a *perspective* or *vantage* upon what is conceptualized.

Cognitive linguistics is not, as I shall argue, a *subjectivist* theory in which 'all meanings are in the head', but it does recognize that meanings are based in non-discursive schemas which, in order to be signified for others, are *constructed* as conceptualizations which depend upon the adoption of specific subjective perspectives. Cognitive linguistics not only places meaning at the heart of language, but it re-instates the point-of-view of a human subject (instead of an abstract processing device) as a constitutive aspect of meaning. Before we get too far ahead of the argument, let's briefly examine the notion of *motivation* which is so fundamental to cognitive semantics and cognitive grammar. Lakoff (1987: 104-109) discusses the application of the Japanese classifier *hon* (Japanese, unlike English or French, for example, does not have a system of definite and indefinite articles, but, like many other languages, employs *classifiers* categorising nouns, to which they may be affixed). Lakoff (1987: 104) says of Japanese *hon* that it:

> in its most common use, classifies long thin objects: sticks, canes, pencils, candles, trees, ropes, hair etc. Of these, the rigid long, thin objects are the best examples. Not surprisingly, *hon* can be used to classify dead snakes and dried fish, both of which are long and thin. But *hon* can be extended to what are presumably less representative cases:

and he goes on to mention martial arts contests, baseball hits, a contest between a Zen master and a student, telephone calls, radio and TV programmes, letters, movies and medical injections. Lakoff (1987: 105) provides a convincing explanation of how processes of imaginative extension result in this complex network of usage:

> Such cases, though not predictable from the central sense of *hon*, are nonetheless not arbitrary. They do not all have something in common with long, thin objects, but it *makes sense* [in an analysis which I have not the space to reproduce here—CS] that they might be classified with long, thin objects.

As Lakoff (1987: 96) points out, 'There is a big difference between giving principles that *motivate,* or *make sense* of, a system, and giving principles that *generate*, or *predict*, the system. Motivation is weaker than determination, but it is non-arbitrary: 'arbitrariness is a last resort' (Lakoff 1987: 107).

Motivation (including, as in the case of Japanese *hon,* motivation by *chained family resemblance*) has as a particular case (in cognitive semantics) the motivation of the various different but related senses of polysemous lexical items by image schema transformations, metaphorical and metonymic models. Here, again, cognitive semantics departs from, in particular, Vygotskian theory. For Vygotsky, the co-categorisation of objects on the basis of 'chained [family resemblance] complexes', was another example of 'pre-conceptual', 'pre-logical' or 'syncretic' thinking, typical of the child and of non-Western adults. Cognitive semantics shows us, once again, that the existence of such apparently unpredictable and unruly categories *makes sense* when the point of view and conceptual processes of a human subject are taken into account.

Only when we try to step 'outside' *human* experience and *human* cognition, and adopt a 'God's-Eye', Objectivist View-from-Nowhere, are we tempted to dismiss these fundamental facts of human *natural* language as evidence of 'illogicality'. And it should be emphasized that polysemy, and its basis in chained metaphoric extension, is in no way confined to non-Indo-European languages. A brief reflection on the many uses of the word *on* (on the table, on the wall, on the line, on Thursday, on strike, on leave, on heroin, on time, on your own, etc., etc.) should convince you of this. Where traditional structuralism sees only arbitrariness, and generativism sees only a host of 'exceptions' to fixed and univocal meanings, cognitive semantics sees experientially and schematically *motivated* (but unpredictable) regularities.

Let us return now to cognitive grammar, and the role in it of motivation. There are three particular aspects of motivation which I shall mention as being of particular relevance here. First, *iconic* motivation, which need not be (and usually is not) based in an obvious physical resemblance between conceptualization (or what is conceptualized) and expression, but which is nonetheless understandable as a reflection in expression of basic cognitive principles of saliency or prominence. For example, the Subject-Verb-Object (SVO) ordering of Agent-Action-Patient in English unmarked, active, declarative sentences may seem 'natural' to English speakers, reflecting a 'how it is' of the world. However, a simple-minded case for its iconic motivation by 'raw reality' is undermined, first by the fact that only a minority of languages have canonical SVO order, and second by the (not self-evident) point that, if one regards the relevant iconic frame as one of temporal order, then in a canonical physical action:

> from the standpoint of an observer, the mover only becomes agent the moment there is contact with the second object. Before the moment of contact, the mover is a *potential* agent at most ... on a physical time scale, the one object assumes the agent role at the very same moment that the other object assumes the patient role (Verfaillie and Daems, 1996: 133).

Nevertheless, there appear to be important semantic and grammatical generalizations across languages (not absolute universals but motivated tendencies) which beg for some kind of iconically-based explanation. For example, agents are typically expressed before patients, subjects in agentive languages are typically agents in unmarked constructions, and the first-occurring noun phrase in unmarked constructions is typically the grammatical subject. Langacker (1990b) argues that a variety of factors contribute to a higher conceptual prominence of grammatical subject over object, specifically, agency, empathy, definiteness and Figure-Ground organization (addressed below). Verfaillie and Daems conclude on the basis of experiments that this prominence is conditioned by non-linguistic and direct perception processes:

> when a prototypical causal relation can be perceived directly and when the participants in the event maintain their role for an extended time interval, agent information is accessed more rapidly than patient information (Verfaillie and Daems, 1991: 144).

Once again, it is important to emphasize that the principles (including iconicity) which underlie conceptualization cannot be derived from just matching 'language' against 'the world', but only by taking into account the active contribution of the subject responsible for conceptualization.

A second important principle of motivation is *Figure-Ground organisation*, which can be understood in essentially the same way as it was by the Gestalt psychologists. Figure-Ground organisation can be regarded in a way as a special case of iconic motivation, but its importance justifies mentioning it separately. The simplest way to illustrate the role of Figure-Ground organisation in linguistic conceptualization is to compare different ways of talking about physically identical spatial scenes, for example:

FIGURE		GROUND
The lamp	is	over the table
The table	is	under the lamp

In the first expression, the lamp is Figure to the Ground provided by its relation to the table; Figure is conceptualized as potentially mobile in relation to the Ground, it is where it is and not somewhere else, and it is *prominent* in attention; whereas the Ground is conceptually fixed and less prominent. For this reason Langacker calls the Figure the Trajector, and the entity in relation to which Figure's location is specified the Landmark. Figure (Trajector) is also canonically the entity whose *location* is known to speaker but unknown to hearer; Landmark is canonically the entity whose location is known to both speaker and hearer. In the second expression, the roles of Figure and Ground are reversed: the table is the Trajector and the lamp is the Landmark.

Figure-Ground organization is not a theoretical construct which is original to cognitive linguistics. Apart from its central status in Gestalt psychology, Prague School functional linguistics employed it, as do contemporary approaches to discourse semantics and pragmatics, in the analysis of the structuring in expression of Theme (topic, given information) and Rheme (comment, new information). There are considerable complexities in relating Figure-Ground structuring of conceptualized content to Theme-Rheme or Given-New structuring of presupposed and foregrounded information. In the above examples, the new information (Location of Figure) is Ground and Rheme, but this need not be the case, as can be seen by comparing them with:

GROUND		FIGURE
Over the table	is	the lamp

In the above example, Figure's location in relation to Ground is *thematized.* This specific issue need not detain us, though it is an important one in the further development of cognitive linguistics and the exploration of the relationship of linguistic conceptualization to discourse structuring and, not least, to language variation. The important point for current purposes is the fundamental importance for cognitive linguistics of the recognition that speakers have access to *alternative linguistic conceptualizations* of referential situations. 'Objective reality' does not uniquely force one or other conceptualization, although conceptualizations are partly determined by our entire background of schematized understanding. It would be odd, for example, in most circumstances, to say 'The table is under the vase' rather than 'the vase is on the table', because it is inconsistent with our experientially-based understanding of tables, vases and the moveability of objects in space, to view a table as a moving Figure and a vase as a fixed Ground.

Figure-Ground organization is one, but not the only, principle of conceptualization whose contextually and discursively motivated deployment enables speaking subjects to flexibly construe or conceptualize content, in turn motivating speaker's expression. Another important principle (more accurately, a category of closely related but distinct principles) is *perspectivization.* The perspective of the speaker upon the situational context which is conceptualized may vary, and shifts in perspective may result in different conceptualizations and, in turn, different choices of expression. A simple example is:

The boat is *on* the lake
The boat is *in* the lake

Although the second expression permits the reading that the boat is completely submerged in the lake, assume here that in both cases the boat is floating on the surface of (and partly submerged in) the lake. The two expressions conceptualize the same referential situation, but they differently *profile* the spatial relationship of Figure to Ground. In particular, the first expression involves a profiling of the visible parts of the boat supported by the surface of the lake, and the second expression profiles the partially submerged buoyancy of the boat in the medium of the lakewater. The first expression would more naturally be used by a speaker with a perspective *far* from the boat and the lake, the second by a speaker *near* to the boat and lake.

Now suppose that you phone a colleague, and get her secretary on the line. The secretary informs you in one of two ways:

She's *in* a meeting
She's *at* a meeting

If you hear the first expression, you may conclude that your colleague is meeting at a location *near* to the secretary (in the same building perhaps); if you hear the second expression, you may conclude that she is meeting at a location *far* from the secretary (outside the building, perhaps). It is not, it is important to emphasize, that the fixed or 'stored' meanings of the lexical items *in* and *at* 'encode' respectively *near* and *far* perspective, since 'in' can be used perfectly well (in contrast with the boat and meeting examples) to express a conceptualization of location *far* from speaker: 'He's in Paris' (speaker in London). For this reason (and because such examples involve 'defeasible implicature', i.e. you cannot rigorously *predict* or *infer* the *near* or *far* perspective of speaker, in the same way that you can infer from 'He's in Paris' that 'He's not in London'), traditional linguistics would say that these phenomena are part of pragmatics and not of semantics or construction.

Cognitive grammar claims, on the contrary, that even if the relationship between perspective and expression does not permit strict *inference* from the latter to the former, nonetheless the latter is *motivated* by the former. And this motivating relationship is *mediated* by conceptualization: the hearer can reconstruct the *conceptualization* which is signified by the speaker's expression, and from this the speaker's *perspective* on the referential situation is recognized. There is no clear dividing line between semantics and pragmatics; it is only because traditional linguistics *ignores* the speaker's active and meaningful conceptualization, and bases its theory of meaning on the assumption of a direct and 'objective' relationship between 'code' and 'world', that it is compelled to distinguish the 'contextual' and pragmatic from the 'truth-based' semantic aspects of meaning.

Sinha and Kuteva (1995) argue, from a consideration of a wide number of examples such as this, and other kinds of examples, that at least some aspects of meaning (in particular, spatial or locational meaning) cannot be seen as being 'represented' or 'encoded', as in traditional semantic theory, by single isolable units of expression. Rather, spatial meaning is *distributed* over the entire utterance or expression (or at least, over many parts of it which are traditionally not thought to have anything to do with spatial meaning at all). If this is so, cognitive semantics and cognitive grammar provide evidence that meanings (at least, some kinds of meanings) are *not*, as is assumed by the entire tradition of formal semantics (and by generative linguistics) *compositional* (a conclusion also arrived at, on the basis of an entirely independent and different analysis, by Turner and Fauconnier, in press).

Meanings, I am arguing, do not come parcelled into discrete 'atoms' which map one-to-one onto items of expression. *The relationship of meaning to expression is not one-to-one, it is not even just (as in the case of polysemy) many-to-one, it is many-to-many.* The implications of this are devastating for formal semantics, generative linguistics and classical cognitivism, including its theory of 'mental representation', as I try to explain in the Appendix.

Cognitive semantics and cognitive grammar do not require meanings to be strictly compositional, since they do not regard meaning as based in an objective and unmediated correspondence relationship between symbol and world. This leads us to another important point of divergence between cognitive linguistics and generative linguistics, namely their respective views of the relationship between lexicon and grammar. Generative linguistics views the lexicon as being composed of discrete items which have certain semantically-based constraints (selectional restrictions) on how they may be combined. The form of the sentence is generated by the grammar, and the selection restrictions come into play when the lexical items are added to the sentence strings. Cognitive linguistics[3] does not take this view, and does not employ a strict or dichotomous distinction between grammar and lexicon. Both lexical items and grammatical forms (inflections, affixes etc.) are considered to be construction units whose arrangement is equally motivated by conceptualization.

This point of view is strengthened by an increasing body of work in *grammaticalization theory*, which analyzes how, in historical language change, lexical items take on new roles and are constructed in new contexts, as a result of extensions in conceptualization, leading to them becoming 'frozen' in specific kinds of constructions bearing grammaticalized meanings. In other words, although cognitive linguists do not deny that there is a difference in the types of meanings typically carried by lexicon and grammar, this difference is not absolute, but rather a 'cline' or continuous range, from lexical items with relatively free possibilities of co-construction at one end, to grammatical structures with highly constrained conventional rules of construction at the other end. Hence, in cognitive linguistics, both lexical items and grammatical constructions are seen as expressional elements and structures which are organized in the service of, and which signify, linguistic conceptualization.

Subjectivity, Universality and Relativity in Language and Cognition

The crucial issue which we now have to face is: if expression is constructed so as to signify, and is hence motivated by conceptualization, and if conceptualization is based in image schematization, *does this mean that meanings are simply image schemas, and hence subjective—are meanings 'in the head'?*

My short answer to this question is 'No, it don't, and (following Putnam, 1975) they ain't'; although some cognitive linguists do indeed seem to assume (wrongly, I think), that meaning is as essentially subjective as its experiential basis (see Harder, 1996, for an excellent critical discussion). My view is that what I have called *construction* should be seen as an *active process under subjective control* whereby items with conventional significations are (motivatedly) organized in such a way that they *refer* to some aspect(s) of an intersubjectively shared world (or universe of discourse); and in such a way that both the referred to aspect(s), and the speaker's perspective and purpose in making such reference, are *signified* for a hearer.

In other words, it is my view that linguistic (or discursive) meaning is *essentially* social and intersubjective in nature. Furthermore, I think that the act of referring (selecting and constructing certain conceptualized aspects of the universe of discourse so that they are signified by expression) is *also* irreducibly intersubjective in its fundamental structure: I refer to something *for you*, in such a way that *you can grasp* my reference. Now, what is referred to, on this view, is indeed a world 'outside the head': it is the world which I share with my conversational partner. It is also, however, and simultaneously, the world which is *constructed in the language which I use to signify it.*

Reference is irreducibly *intentional*, it involves the relationship of 'aboutness' (Searle, 1983) which I call *signifying*. John Searle believes (if I can simplify his arguments considerably) that the signifying 'aboutness' of a linguistic expression derives, essentially, from the same source as the 'aboutness' of perceptions. So, claims Searle, my expression 'the lamp is over the table' is *about* the lamp, the table and their relationship in space in the same way that my perceiving a lamp is *about* the lamp which I perceive and which is the 'ground' of my perception. I think this is only half the story, at most, and that cognitive linguistics and its philosophy of language can gain a vital and important insight into why this is so from developmental psychology.

I will certainly grant—insist, even—that there need to be a perceptible world (or surround) for reference to make any sense at all, and that our subjectivity is in an important sense *grounded* in this perceptible world—grounded in our direct perceptions and in our non-discursive 'representation' or interactive organization of embodied experience, in the form of image schematization. To *refer*, however, implies the *picking out* or *figuration* of some aspect(s) of this schematized perception, in such a way that *the figured aspect is a topic of joint and shared attention.*

We know that this ability (while it may be assumed to be epigenetically based in innate initial states in the human perceptual and attentional system) is not present from birth, and that its construction *crucially implicates* *interactions between the infant and other human beings.* To cut a long, and fascinating, story short, *joint reference develops* during infancy, so that at around nine or ten months of age infants

> begin to engage with adults in relatively extended bouts of joint attention to objects ... In these triadic interactions infants actively coordinate their visual attention to person and object, for example by looking to an adult periodically as the two of them play together with a toy, or by following the adults gaze. Infants also become capable at this age of intentionally communicating to adults their desire to obtain an object or to share attention to an object, usually through non-linguistic gestures such as pointing or showing, often accompanied by gaze alternation between object and person. (Tomasello, 1996: 310; see also Bruner, 1975; Bates, 1976; Lock, 1978, 1980; Trevarthen and Hubley, 1978).

The construction of joint reference in infancy is, I claim, a fundamental precondition for being able to *signify* semantic content in language: pre-linguistic signification in an intersubjective context of shared goals, attention and communication, lays the foundation for the discursive sharing of thought—the acquisition of linguistic meaning and the means for its expression.

The acquisition of language, in this view, is a process whereby actively signifying human subjects come to *appropriate* the means afforded by the language which they are learning to *linguistically conceptualize* schematized content, and conventionally (but motivatedly) *signify* linguistically conceptualized content (for communicative partners) in expression. The learning of expression, and the appropriation of the discursive conceptualizations inherent in language, are not two separate processes, but a seamless whole process. *This process is continuous with both the development of pre-linguistic non-discursive schematization of experience, and the development of pre-linguistic means for sharing reference.*

Linguistic meaning, then, is *continuous* with *both* the embodied 'having of a world', in subjective experience; *and* the referential 'sharing of a world', in intersubjective experience. Continuity (and motivation), however, do not mean the same as identity. The speaking subject's significations 'point outwards' to pick out some aspect(s) of the shared universe of discourse, for a hearer, but they do so *through the medium* of expression, in such a way that this expression *organises* and *signifies* the *conceptualization* in language of the picked-out aspects of the universe of discourse. Linguistic conceptualization is rooted in non-linguistic schematization, but not identical with it. Linguistic conceptualization (and reference) is *conceptualization of the world signified, not of the non-discursive schematizations which underpin the conceptualizations.*

Discursive or linguistic meanings *are not in the head: they are not identifiable with or reducible to non-discursive schematizations,* though non-discursive schematizations make them possible. Linguistic meanings are *not objects*, either in the head or in objective reality. They *are relationships,* but *not* between 'mental objects' and 'objects in the world'. The relationship which *is* linguistic meaning, is between linguistic conceptualization, and the linguistic expression by which the conceptualization is signified, and over which the conceptualization is distributed. *Discursive meaning is a signifying relationship between conceptualized content and motivated expression, enabling the hearer to reconstruct, with reference to the universe of discourse, the conceptualization intended by the speaker.*

At this point, it is possible to unpack more thoroughly the notion of *signification,* and to specify more accurately the crucial role of the *subject* in it. I have said that *expression* signifies conceptualized content, and I have also said that *subjects* signify picked-out and conceptualized aspects of the universe of discourse. *Both these aspects of signification are crucial.* There can be no signified content without a signifying subject, and there can be no *conceptualization* (as opposed, I emphasize, to non-discursive schematization) without an expressive *medium* of signification. We can now re-examine the ideas of Vygotsky and Piaget in the light of this analysis.

I believe that Vygotsky was in one sense fundamentally right in his notion of the 'semiotic mediation' of thought. He was *wrong*, however, to think that semiotically mediated, or signified, discursive thought, *replaces* non-discursive modes of understanding. We have seen this in our analysis of the image-schematic basis for linguistic conceptualization. He was also wrong in thinking that linguistic meanings are the kind of things or 'objects' which can be directly 'internalized' as the foundation of 'verbal thought', because he was unable to understand the intersubjectively outward-pointing nature of linguistic signification, and the importance in it of embodied subjectivity.

Piaget was right in believing that non-discursive schematizations lay the basis for discursive thinking, but he was *wrong* in thinking both (like Vygotsky) that this was a mere stepping stone to a higher form of (in Piaget's case, logico-mathematical) reasoning, and in believing (as he did) that the child's early utterances signify the sensori-motor schematizations themselves. They do not: like the utterances of adults, they are based in schematizations, but (also like the utterances of adults) they signify aspects of an intersubjectively shared universe of discourse. *Language does not signify 'individual thoughts' but signifies the thought-about, conceptualized world or universe of discourse.*

Both the 'individual' theorist Piaget, and the 'socio-cultural' theorist Vygotsky, if I am right, and strangely enough, undervalued, or were unable fully to accommodate, three things:

- The active and constitutive role of the embodied and signifying subject
- The crucial and continuing role of non-discursive schematization in underpinning linguistic conceptualization, and its basis in embodied experience
- The fundamentally socially-shared, intersubjective nature of linguistic meaning and reference.

If you have followed me so far, you will have grasped that the fundamental deficiency of traditional views of meaning is that they *ignore the embodied and signifying subject*, leaving 'mental representation' as the only (and mysterious) principle which can be evoked in explaining both the acquisition and the working of meaning in language. You will also have grasped that I am advancing a view which sees linguistic meaning as socially and discursively constructed on the basis of both subjective, schematized experience, and intersubjective, shared reference. But where, you might ask, is the Real World in all this talk of a Universe of Discourse and a world signified?

I cannot do full justice to this extremely difficult issue in this paper. However, I shall try to sketch the outline of an answer (for some elaboration, see Sinha, 1988, Ch. 2). The view which I am advancing does not at all deny that there is a real, material (and in some ontological sense 'mind-independent') world constraining both our non-discursive schematizations and our linguistic conceptualizations. It *does*, however, deny that we can *think* and *communicate* about the world as something either mind- (and body-) independent, or discourse-independent. First, because the first and fundamental basis of meaning is *embodied human* experience, and second because having *discursive* thought and language is dependent on having some *signifying material* by means of which conceptualizations can be constructed. This view is therefore constructionist, but not on that account anti-realist.

The interpretation of meaning that I am advancing, in the context of an approach which is both cognitive linguistic and epigenetic-developmental, is consonant with the 'experiential realism' advocated by Lakoff (1987), but adds a further (social-discursive) dimension to this, which is that the *embodied* subject is simultaneously the *signifying* subject, *embedded and situated within an intersubjectively constituted universe of discourse.*

It is important to emphasize that what I am calling 'subjective', embodied, non-discursive or schematic understanding, and 'intersubjective', discursive understanding should not be seen as independent of each other. Rather, in language and cognition (and development) they dialectically inter-penetrate each other: both are fundamental aspects of subjectivity, and both are fundamentally implicated in speaking and communicating. However, I suspect that they are at the root of, or in some sense underpin, two different *modes* of human understanding. The former may underlie what is sometimes (in many ways misleadingly) thought of as a universal 'core' of human cognition; while the latter, because languages as well as speakers have *preferences* for certain specific kinds of figuration, adopted perspectives and vantages, may be responsible for what is linguistically variable in human cognition. In learning to speak, as Slobin (1990) puts it, children are also 'learning to think for speaking', to adopt the conceptualizations and perspectivizations which characterize their mother tongue.

There is also evidence (Levinson, 1996) for Whorfian effects: that different modes of linguistic conceptualization (in this case, of space and spatial relationships) can influence non-linguistic or non-discursive strategies of reasoning, reinforcing my point above that we are not talking about separate 'systems' or 'modules', but intimately interconnected aspects of the construction of meaning and construal of experience.[4] We do not yet know enough about these issues. For example, we do not properly understand what the relationship is, either in adult language and cognition or in development, between even such basic processes as Figure-Ground organization in linguistic conceptualization, and Figure-Ground organization in non-linguistic perception and cognition. Understanding the relationship between universality and relativity in language and cognition is a matter for empirical investigation, not for *a-priori* pronouncements.

We should not, however, be seduced into assuming that discursive understanding is a 'more advanced' mode of cognition than non-discursive schematic understanding, nor that non-discursive understanding does not have its own developmental and socio-culturally influenced specification. In a sense, the very dichotomy between the discursive and the non-discursive is problematic, especially if we consider the way in which visual media construct 'discourses' of imagery. Our contemporary world, and its technology, is as much one of visualization and directly iconically-motivated conceptualization, as of text and language. Here and elsewhere, I think, and despite my criticism of him, Vygotsky has something vital to offer to the sciences of cognition, and that is his insight that natural language is not the *only* material means of semiotic mediation. That, however, is a topic which I cannot elaborate on here.

Conclusion: Grounding the subject

The point of view which I have advanced finds retrospective inspiration in the work of another great psycholinguist of the first half of the twentieth century, Karl Bühler. Bühler, who began his career as a Gestalt psychologist, was thoroughly familiar with the path-breaking work of the Prague Linguistic Circle, of which he was a member. He concerned himself not only with language, but also with visual perception and visual art, and the semiotics of film. In all his work, but especially his linguistic analyses, Bühler emphasized both the essential 'subject-relatedness' of meaning, and the outward-pointing or intersubjectively 'positing' nature of language and cognition. Bühler's psycholinguistic theory (although it perhaps made a more strict demarcation between lexicon and grammar than does cognitive linguistics) was remarkably prescient in many respects of the basic notions of cognitive linguistics. He wrote:

> language rests not on one but (at least) on two classes of posits (conventions) and contains, accordingly, two classes of language structures ... The one class of posits [lexicon] proceeds as if it were alright to cut the world up into particles or to dissolve it into *isolatable moments* and to assign each of them a sign, while the other class [grammar] is concerned with making the appropriate sign-media available for *a systematic construal of the same world* [my emphasis—CS] (which is to be represented) according to relations. (Bühler, 1933; in Innis, 1982: 140-143).

Bühler was also very clear in rejecting an 'objectivist' interpretation of linguistic meaning or sense, in favour of one based in the 'intersubjectively social moment' of language:

> Plato called objects that manifest [similarities to linguistic meanings] *ideas* ... That we have transformed the 'eternal and immutable' into 'intersubjective' and thereby find this sufficient and simply cancel out a supersensible homeland in the fashion of Aristotle only needs to be said in order to exclude misunderstandings. (*ibid.* p. 125).

Bühler, in other words, understood and argued that the alternative to Objectivism is not a solipsistic Subjectivism, but a theory of meaning and conceptualization which *grounds* the vital and constitutive role of the subject in the social and intersubjective world of discourse.

If the analysis I have advanced (and for which I have sought support in the theories of Karl Bühler) is correct, then much of current cognitive science is in the grip of a deep misunderstanding. Cognitive scientists tend not only to ignore the point of view of the human subject, but even when they do recognize the need to ground cognition and representation in experience, they take into account only one aspect of Grounding, namely 'perception'. The other aspect of Grounding—in discourse and intersubjectivity—is neglected. My claim is that the development of language and cognition is not only *schematically , iconically, and non-discursively Grounded* in embodied experience; it is *also discursively Grounded* in an intersubjectively constructed and socially-shared, signified world.

In conclusion, I want very briefly to contrast this view of the subject, and subjectivity, with a point of view which has become influential in post-structuralist and post-modernist theories. In these approaches, the 'originating' subject of Cartesian rationalism is deconstructed, and in its place emerges a de-centered network, or shifting complex, of subject *positions,* constructed in and through discourse. The subject is no longer seen as the *locus* of meaning, representation and intentional agency, but as an *effect* inscribed in social and discursive practices. The subject, on this view, is *empty*, and characterized in its relationship to what is 'known' and what is 'desired' by its *lack*. The subject is the mere 'signified' of the signifying practices which inscribe it.

Although I do accept that the *signifying* subject which I describe in this paper is always, and simultaneously, a *signified* subject occupying specific positions in language and discourse—most self-evidently, in terms of its deictic positioning in discourse—I do not think that its ultimate deconstruction can lead anywhere but to a dead end. The very notion of 'positioning' itself can, it seems to me, only fully be appreciated by seeing that it *implicates* a subject embodied as well as signified: *Positioning implies perspectivization, and perspectivization implies a non-discursive schematization of what is perspectivized.* Furthermore, as I have, I hope, made clear, signification is not a 'process without a subject', but an *intersubjective* process wherein the subject is (at least) as much constitutive as constituted. Just as I argued at the end of Sinha (1988) that the notion of Representation requires reconstruction, not just deconstruction, I would argue that the embodied, signifying Subject needs to be re-instated, not deleted.

Subjects, then, are Grounded, in embodied experience and in discourse, but they are *not* artefacts of grounding, either in perception or in discourse. Human beings, to return to Mark Johnson's formulation, are neither lumps of matter, nor disembodied spirits. Nor are they either abstract 'information processing mechanisms' or 'empty' effects of language and discourse. Without taking the point of view of the *Developing, Embodied, Signifying* human Subject, we cannot begin to comprehend the meaningful basis of human cognition and human language.

Appendix
Why objectivism needs compositionality.

It should not surprise us that formal semantics and generative linguistics view meanings as discrete 'objects' or atoms mapping one-to-one onto forms. Formal semantics is based upon an Objectivist theory in which meaning is defined in terms of valid correspondence between symbol strings, and 'states of affairs' in a mind-independent, 'raw' reality. How can this be formalized except by postulating an isomorphic mapping of the objects and relationships making up 'states of affairs' in the world, onto the symbols which (mysteriously) 'represent' them? And if, as in classical cognitivism, we substitute for the 'physical symbols' (in language) of an *external* code, the 'physical symbols' (in the brain) of an *internal* code (thereby claiming, somehow, to have clarified the mystery of representation by calling it 'mental representation'—a move about as illuminating as ascribing the sleep-inducing effects of opium to its 'dormitive virtue'), what alternative is there to assuming the *same* isomorphic relationship between these mental-physical symbols (in the mind-brain, whatever that is), and those same mind-independent objects and relationships?

Remember now the Chomskyan 'truism' that 'language is an infinite set of sentences', and try to envisage 'the world' as an infinite set of possible arrangements of objects in relationships. The problem for the Objectivist is to hook up the infinite set of symbol-strings to the infinite set of possible 'states of affairs' in a one-to-one fashion. You can only do this if the rules which govern the internal (combinatorial) arrangements of the symbols *exactly* match up with (or 'generate') the patterns they have to take up to represent (correspond with) *all* the infinite number of possible states of affairs. *That's* what Fodor and Pylyshyn mean by 'a *syntactically* driven machine whose state transitions satisfy *semantical* criteria of coherence', and *that's* what they claim the human brain (or its 'representational system') *does*.

Now if, to this already alarmingly complicated scenario, we add the twist that the syntax of natural language is *stipulated* (by generative linguistics) to be autonomous—governed by principles entirely *independent* of semantics—then there can be no way of getting from 'the world' to 'natural language' except *via* the 'Language of Thought'. This will (in principle) work, but only on one condition: *you have to be able to translate between the Language of Thought and the semantic interpreter of the generative grammar of natural language.* And to do this you *have* to have compositionality of the *meanings* of symbols all the way up and all the way down, so that the representational *format* or syntax may be transformed while preserving its *content* or *semantic value.*

Even *with* compositionality the account is amazingly implausible, as Chomsky probably realizes, and therefore continues to steer clear of semantics. *Without* compositionality, it's impossible, even in the fairy-tale world of Objectivist cognitivism. The moral of the story is pretty clear. Generative linguistics, which started off by ignoring meaning, cannot do without compositionality if it is to have any theory of meaning at all, and if natural language is not compositional, then it never will have a theory of meaning. It's first simplifying move (ignore meaning) condemns it to perpetual isolation in a self-enclosed syntactic module on an alien planet on which no human has ever set foot. If you start by treating sentences as objects, or as objects 'representing' objects, or objects 'representing' objects 'representing' objects, you will never (however much you protest your 'realist' credentials) emerge from the symbolic tunnel.

Notes

1. Foundational and representative texts are, amongst others, Lakoff and Johnson, 1980; Johnson, 1987; Lakoff, 1987; Langacker, 1987; Taylor, 1989; Sweetser, 1990; Geiger and Rudzka-Ostyn, 1993; Fauconnier, 1994; current work is well represented in the journal *Cognitive Linguistics*.

2. Two common and equally pernicious misunderstandings are that either (a) "everything is metaphor" in cognitive semantics, or (b) "all meaning is *directly* or *unmediatedly* referred to the body".

3. There are other linguistic theories which consider grammar and lexicon as a unified system, but we shall not go into that here.

4. Steve Levinson would probably not agree with this interpretation of his and his colleagues' findings, but I do not have space to get into this issue.

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SPEAKING VERSUS WRITING - AN EXPERIMENTAL APPROACH TO NARRATIVE DISCOURSE PRODUCTION

Sven Strömqvist

Abstract

This paper is concerned with the contrastive study of discourse production in speech and writing. It proposes ways of combining analyses of the flow of speech and the flow of writing with analyses of linguistic information structuring. The paper describes in detail an experimental design together with methods of data registration and analysis. Some results are presented concerning pausing and editing rate and the linguistic encoding of causal relations in narration by 30 subjects in a written and a spoken condition. The order of the two conditions was controlled for, and order effects on content structure or production rate are also analysed.

Introduction

Language appears in a variety of forms, including spoken, signed and written forms. These forms of language are shaped and modified under the constraints and principles of human information processing (e.g., principles of clarity, speed, effort/economy, and expressiveness) to serve a variety of social and cognitive functions. Previous research has shown samples of speech and writing to vary with respect to a number of linguistic/stylistic and functional dimensions (see, e.g., Biber, 1988; Chafe, 1994). Critically, spoken and written language tend to be associated with different communicative conditions and processing constraints. Spoken communication typically allows for mutual adaptation on-line between speaker and addressee (see, e.g., Allwood et al., 1992). In contrast, written language is typically used for communication where sender and receiver are located at different points in time. Further, spoken language is processed under strict on-line constraints: spoken discourse must be perceived on-line just as it is produced on-line (see Strömqvist, 1994). In written communication, these on-line constraints can be lifted. A written document is typically produced on the assumption that it is only the finally edited version that is to be perceived and understood by the addressee. (See Strömqvist, 1996 for a more detailed argument.)

At the foundation of the research enterprise reported on in this paper lies the assumption that there is a causal interrelationship between communicative conditions, information processing constraints and linguistic ways of structuring information. By implication, it is hypothesized that the differences in communicative conditions and processing constraints between speech and writing are conducive to a differentiation in terms of linguistic information structuring between spoken and written language.

The present paper is concerned with the contrastive study of discourse production in speech and writing, proposing ways of combining analyses of the flow of speech and the flow of writing with analyses of linguistic information structuring. The paper describes in detail an experimental design together with methods of data registration and analysis.

Some results are presented concerning pausing and editing rate and the linguistic encoding of causal relations in narrations by 30 subjects in a written and a spoken condition. The order of the two conditions was controlled for, and order effects in terms of content structure or production rate are also analysed (how is a spoken version affected by a prior written one, and how is a written version affected by a previous spoken one?).

(Parts of) the methodology here described is currently being applied in developmental studies of spoken and written narratives in school children, in studies of writing strategies of disabled groups (aphasics, deaf, dyslexics), and in crosslinguistic comparisons of speech and writing (see Strömqvist, 1996; Strömqvist et al., 1998; Wengelin, 1997; Nordqvist, 1995; Strömqvist, 1997). Here we will provide examples and illustrations focussing on narratives elicited from a group of 15 years old Swedish school children. A developmental perspective is briefly outlined towards the end of the paper.

Linguistic information structuring and the flow of discourse

Linguistic information structuring

Language supports cognitive operations, such as, for example, abstraction, and makes thoughts intersubjectively available. And putting ideas into words means structuring mental information in a number of ways. Linguistic information structuring includes, among other things, encoding information in a lexical, morphological, or syntactic form, or distributing it more extensively across a wider fragment of discourse; constructing propositional content; foregrounding or backgrounding information; structuring information according to a certain perspective; etc. For the present purposes we shall distinguish four gross types of information structuring operations or dimensions, all of which will be more carefully characterized below. Following Berman and Slobin (1994) we will term the first two *Packaging* and *Filtering*. The third one is termed *Connectivizing* (accomplishing connectivity), and the fourth *Perspectivizing* (structuring information according to a certain perspective). Typically, constructing an utterance involves structuring information along all four dimensions. That is, an utterance is typically multifunctional in that it structures information along all four dimensions rather than just one or two of them.

Packaging First, let us briefly consider linear versus simultaneous ways of packaging information. Spoken face–to–face interaction allows for communication in more than one sensory modality (spoken communication is usually *poly–modal*, see, e.g., Andersson, 1992, McGurk and MacDonald, 1976). This allows for a considerable extent of simultaneously distributed information, for example, smiling and using manual gestures while talking. Also, there are simultaneously distributed dimensions of information in the vocal/auditory channel. At the same time as words are articulated, intonation gestures and voice quality contribute important information. Most probably, these ways of packaging information are interrelated with the on–line constraints of speech. The pressure towards high speed in spoken communication makes the simultaneous distribution of information a more attractive solution to the packaging problem than a strictly linear, mono–modal distribution. In contrast, written language is almost exclusively confined to a linear distribution of information.

Second, languages are flexible in the sense that they, as a rule, provide more than one solution to the problem of packaging the same or very similar concepts into a linguistic form. This is illustrated by the example in table 1. The starting point is the concept of being mentally or physically well, which is lexicalized as *frisk* in Swedish and (among other words) *well* in English. The packaging problem posed is how to encode into a linguistic form the combination of this concept with the notion of inchoativity or the notion of causativity. Lexical, morphological and syntactic solutions are distinguished. The example further illustrates the fact that different languages tend to provide partly different solutions to one and the same packaging problem. Thus, Swedish provides a morphological and a syntactic solution to the inchoative problem, where English provides a lexical and a syntactic solution.

CONCEPT	MEANS OF ENCODING	SWEDISH	ENGLISH
inchoative	lexical	–	*recover*
inchoative	morphological	*tillfrisk–na*	–
inchoative	syntactic	*bli frisk*	*become/get well*
causative	lexical	*bota*	*cure*
causative	morphological	–	–
causative	syntactic	*göra frisk*	*make well*

Table 1: An example of different ways of packaging information

Information can also be distributed on a discourse level. Consider, for example, the span of two sentences *The doctor gave him medicine. He recovered.* From the information explicitly encoded in the two sentences it can be inferred that the doctor caused the patient to become well. The causative relationship, however, gets much more backgrounded when it has to be inferred than when it is, e.g., lexically encoded.

The relation between lower level and higher level operations of linguistic information structuring is an important issue for further research. What are the implications (tendencies) of packaging constraints on a lexical or grammatical level for linguistic information structuring on a discourse level?

Filtering Assume that the linguistic encoding of information about a scenario necessarily means selecting certain aspects of that scenario while leaving other aspects out. What factors govern that selection? Surely *relevance* is one major factor and *mutual understanding* (the sender's assumptions about mutual understanding between himsef and the addressee) is another one (see, e.g., Grice, 1975, Allwood, 1986). Still another factor is *accessibility* of linguistic forms. Thus, some concepts may be easier to encode into a linguistic form than others. Also, the languages of the world differ in terms of accessibility of forms tailored to talk about a given concept or conceptual domain (see, e.g., Whorf, 1956, Choi and Bowerman, 1991, Berman and Slobin, 1994). We will refer to this process as *filtering*. In particular, we will subject to contrastive analysis spoken and written discourse about very similar content domains and ask: What information filters through into the linguistic descriptions and what information is filtered out? The detection of filtering effects is partly a function of the size of the linguistic units or the width of the discourse "window" observed/analyzed (see further

Strömqvist, 1996). What is filtered out on a lexical level may filter through on a syntactic level or a discourse level.

Connectivizing By a *connectivizing* information structuring operation we understand any operation that functions to accomplish connectivity of discourse, that is, to interrelate two or more utterances or fragments of discourse into a meaningful whole. Examples of concepts in the literature that fall under the broad concept of connectivizing are *coherence* and *cohesion* (see, e.g., Halliday and Hasan, 1989), *connectors* (see, e.g., Strömqvist and Day, 1993), *anaphoric devices* (see, e.g., Karmiloff-Smith, 1981), and *implicatures* (Grice, 1975).

Perspectivizing By *perspectivizing* information we mean structuring an array of information from a certain point of view. In linguistic communication information is perspectivized in relation to the sender and the addressee. More precisely, the information is structured in a way that is determined or guided by where the sender is, — physically or deictically (c.f. Jarvella and Klein, 1982), as well as knowledge-wise and in terms of world view and value systems — and where the sender assumes the receiver to be. Information can furthermore be perspectivized in relation to a third person, that is, a person talked about or with whom the speaker identifies, and the like. One consequence (among many) of perspectivizing information is that some information gets foregrounded and other backgrounded. (C.f. also (Anderson and Pichert, 1978.)

The flow of discourse

Psycholinguistic analyses of the speech production process have explored the flow of speech as a source of information about planning, execution and monitoring activity. The flow of speech contains a number of clues to the interplay between these sub-processes, such as, for example, pauses, stutterings, self-repairs etc (see, e.g., Goldman-Eisler, 1968; Clark and Clark, 1977; Levelt, 1989; Levelt, 1983).

The flow of discourse is also sensitive to discourse type or type of communicative activity. Analysing the "the flow of thought and the flow of language" in relation to spoken narrative discourse in English, Chafe (1979) finds the sentence or clause to be a unit which is more seldom broken up internally by pauses. Instead pauses tend to come in the boundary between sentences or clauses. Chafe argues that the sentence/clause provides an adequate unit for encoding information about an event and that the flow of speaking — reflecting the flow of thought — therefore tends to proceed sentence-wise when a narrator is relating an event. And Beattie (1980), measuring the flow of language (production rate) in spoken interaction, found a cyclic arrangement of hesitant and fluent phases corresponding roughly to a turn in the conversation: at the beginning of a turn there tended to be a more hesitant phase, followed by a more fluent phase; then, again, at the beginning of the next turn, there is a more hesitant phase etc.

Further, the flow of discourse also seems to vary with different types of languages. In their pioneering analysis of American Sign Language (ASL) Klima and Bellugi (1979) include a study of the production rate in 3 bilingual speakers/signers of Am. English/ASL (ibid.:181 ff). Among other things, the subjects were asked to relate a special episode they had experienced. The story-telling was performed under three conditions: spoken only, signed only, and simultaneously spoken and signed. The results from the spoken only and signed only conditions are summarized in the first two columns in Table 2. The third column summarizes results from a similar narrative task with six monolingual (normally hearing) Swedish subjects in writing (Strömqvist, 1994).

Klima and Bellugi		Strömqvist
3 bilingual subjects		6 monolingual subjects
speaking	signing	writing
words per sec	signs per sec	words per sec
$\bar{x}$	$\bar{x}$	$\bar{x}$
4.70	2.37	0.1
proposition rate (mean secs per proposition)		
1.40	1.47	55.59

Table 2: Production rate, pausing rate, and proposition rate in speech, sign, and writing

Let us first briefly comment upon the figures on production rate in the conditions speaking and signing. The difference in production rate between speaking and signing tends to level out as the window of analysis is broadened from words and signs to propositions (sentences/clauses). This conclusion parallells our earlier conclusion (in relation to linguistic information structuring) that the detection of filtering effects partly seems to be a function of the size of the linguistic units or the width of the discourse "window" observed/analyzed. That is, that the wider the analysis window, the greater the extent to which similar information can get encoded across different languages. Put somewhat differently, local level effects on linguistic information structuring or on the flow of language can be compensated for, and a more balanced picture shows up at a higher discourse level.

In order to extend the comparison of production rate to written language, written narratives were drawn from an archive of computer-logged stories[1] and subjected to the same types of analysis as Klima and Bellugi's spoken and signed stories. The results (taken from Strömqvist, 1994) are shown in the third column of Table 2. As can be seen, the figures for writing are different from both speech and sign and the differences are immense. First, 0.1 words per second means that it takes on average 10 seconds to produce a word (including planning) and the proposition rate of 55.59 seconds means that it takes a little less than a minute to produce a proposition in writing. What is the explanation for these differences between speaking and signing on the one hand and writing on the other? Writing on a computer (as well as hand writing) is associated with more effort and is more time consuming than speaking or signing. However, although effort most probably explains some of the differences observed, it is unlikely that it explains the better part of them. We propose the constraints of on-line interaction to be mainly responsible for the high rate of production in speech and sign and that the much lower rate in writing can be afforded when these constraints are lifted. This hypothesis gains further support from the difference in pausing rate. The pausing rate during writing was 61.2%[2], that is, more than two times higher than for speaking (27.8%) and more than four times higher than for signing (14.6%). In on-line interaction a pausing rate of that magnitude would make the flow of discourse tiresome for the addressee to process and would quickly lead to the sender's loss of the turn.

Sven Strömqvist

Experimental design

A picture story task in speech and writing

In a series of narrative tasks, spoken and written narrations were elicited from 15 9-year-olds, 20 12-year-olds, 30 15-year-olds and a control group of 20 adults. The total data collection design included composition tasks with a pre-set topic ("I was never so afraid") as well as more carefully controlled experimental tasks. In one of the experiments, Mercer Mayer's wordless picture story book "Frog, where are you?" (Mayer, 1969), was used as an elicitation instrument.

The booklet depicts the adventures of a little boy and his dog as they go out into the woods to search for a frog which has disappeared from the boy's room. Each subject was asked to narrate the story, picture by picture, in his own words, once in speech and once in writing. Every second subject told the story first in speech and later in writing, and every second subject in the reverse order, so as to control for order effects. In effect, 4 conditions are obtained: SP,WR:*SP*[3]; SP,WR:*WR*; WR,SP:*SP*; and WR,SP:*WR*. The narrative task was monological in character in the sense that there was no listener present, neither in the speaking condition (the subject told the story to a camera) nor in the writing condition.

For the purpose of analysing the written narrations on the level of on-line events, a computer tool was constructed which operates behind a seemingly standard word processor and stores every event on the keyboard as a point in time, a screen position and the identity of the key pressed. From the resultant log file, not only the finally edited text, but also the "linear" text with its temporal patterning and all editing operations can be derived.[4] The 30 15 year old subjects were all versatile users of a word processor and all of them wrote their frog stories on a computer, whereas a majority of the written stories from the 9- and 12-year-olds were written with paper and pencil. The spoken stories were all video-taped. The subjects who used a computer were all given a short training period with the particular word processor before entering the experiment proper.

Before telling the story for the first time (whether in the speaking or in the writing condition), the subjects were invited to look through the picture book, so as to get acquainted with its content. The story telling instruction was administered to the subjects contingent upon their having browsed through the booklet. The instruction was, literally, *Kan du berätta vad som händer på dom här bilderna* 'Can you relate what is happening in these pictures'.

The spoken and written narratives were subjected to three main types of analysis: 1) analyses of linguistic information structuring in terms of *packaging* and *filtering*, 2) analyses of the flow of speech and the flow of writing (production rate, pauses, amount and types of editing operations), and 3) effects of the order of the experimental conditions (how is writing affected by a prior spoken narration, and how is speaking affected by a prior written narration?).

In the following sections some of the findings from each of these three areas of analysis will be presented and discussed in greater detail. In our presentation we will focus on the data from the 15-year-old subjects.

A sample of narratives

An overview of the size of the data set from the 30 15–year–olds in the frog story task is given in table 3. The table summarizes the number of words and clauses in the four elicitation conditions.

	15 years, 30 subjects (writing = key board)							
	15 subjects				15 subjects			
	SP,WR:*SP*		SP,WR:*WR*		WR,SP:*SP*		WR,SP:*WR*	
	types	tokens	types	tokens	types	tokens	types	tokens
N word forms	782	5764	823	4972	916	7162	1009	6184
averages		*384*		*331*		*477*		*412*
N clauses		733		657		777		663
averages		*49*		*44*		*52*		*44*

Table 3: The data set from a group of 30 15–year–olds in the frog story task

Analyses of the frequency distribution of word forms in language corpora in general show that the accumulated share of the total corpus by the first few word forms is very big. Thus, in a frequency dictionary of spoken Swedish (Allwood, 1996) based on around 250.000 tokens of word forms derived from transcripts of adult–adult conversations, Allwood presents an analysis showing that the first 50 types of word forms (frequency rank order 1–50) exhaust around 50% of all tokens of word forms in the entire corpus. The same analysis of a similarly sized corpus composed of written Swedish texts yields a similar distribution. There the top 50 types, however, exhaust a smaller proportion of the total number of tokens. That is, the most frequent words prove to be more frequent in speech than in writing.

An exhaustive analysis of the relation between frequency rank order and accumulated share of the total number of word forms in the spoken and written frog stories by the 30 15–year–olds is presented in figure 1. The solid line in the figure describes the spoken data/corpus (the combined word frequencies from the two speaking conditions SP,WR:*SP* and WR,SP:*SP*) and the dotted line the written data/corpus (the combined word frequencies from the two writing conditions WR,SP: *WR* and SP,WR: *WR*).

Basically, the analysis in figure 1 replicates the finding by Allwood (1996). The solid curve (speaking) shows a steeper rise than the dotted curve (writing), reflecting the fact that the narrators use a small number of words more frequently when they tell the story in speech as compared to when they tell it in writing. Also, a somewhat larger number of types of word forms are used in writing as compared to speaking. Already these overall differences in frequency distributions between the spoken and written frog stories lend themselves to the general line of explanation at the foundation of our research enterprise. Making frequent usage of a small set of words facilitates the management of spoken narration under on–line constraints. And, conversely, usage of a broader range of lexical items and grammatical forms can more easily be afforded, when these constraints are lifted in writing. In effect, differences in information structuring between the spoken and the written narratives emerge.

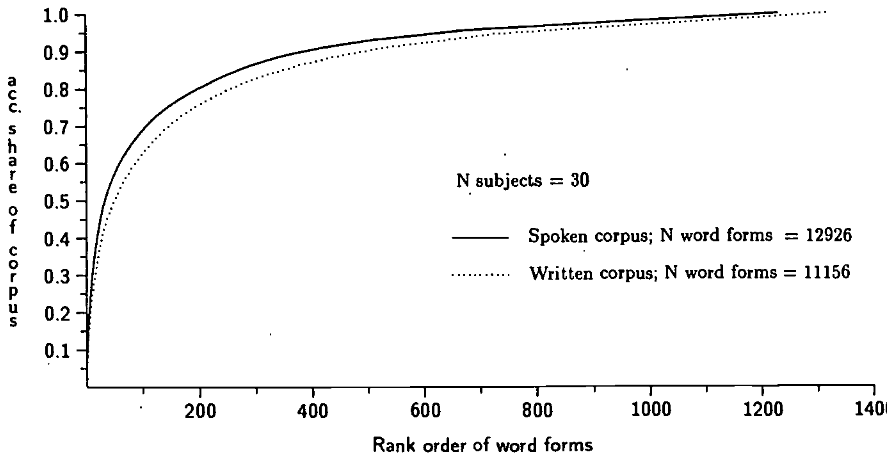

Figure 1: Frequency rank order and accumulated share of tot N word forms in spoken and written frog stories by 30 15–year–olds

Some results

Linguistic information structuring: the encoding of causal relations

In this section, two analyses concerned with the encoding of causal relations are presented. First, a general analysis of collocations and connectors is given, and second, an analysis of a motion event focussing on the usage of intransitive and transitive (causative) verbs of motion.

Collocations and connectors

In the preceding section we contrasted the overall frequency distribution of word forms in the spoken and written narratives. Let us now briefly analyse the frequency distribution of collocations of word forms.[5] More specifically, we derive all pairs of word forms with a token frequency of at least 2 from the corpora from the four conditions SP,WR:*SP*, SP,WR:*WR*, WR,SP:*SP*, and WR,SP:*WR*. The proportion of such collocations proves to be very similar across the conditions (they constitute between 13 and 15% of all word forms in the respective corpora), whereas the relative frequency of the most frequent collocations is higher for the spoken narratives than for the written ones: the top ten collocations (pairs) make up 36% of all collocations in SP,WR:*SP*, 25% in SP,WR:*WR*, 30% in WR,SP:*SP*, and 27% in WR,SP:*WR*. The top ten pairs are listed in table 4.

Now, consider the connectivizing devices *och så* 'and then' and *för att* 'because/in order to'. On the assumption that SP,WR:*SP* represents the preeminently spoken condition and WR,SP:*WR* the preeminently written one, *och så* emerges as the connectivizing device typical of spoken narratives (*och så* has rank order 1 in SP,WR:*SP* and rank order 672 (!) in

	15 years, 30 subjects (writing = key board)							
	15 subjects				15 subjects			
	SP,WR:*SP*		SP,WR:*WR*		WR,SP:*SP*		WR,SP:*WR*	
rank order	word pair	token freq	word pair	token freq	word pair	token freq	word pair	token freq
1	och hunden	56	efter grodan	25	och så	57	för att	48
2	och så	53	det var	24	och hunden	38	det var	31
3	och han	38	i ett	21	och då	36	att han	21
4	i ett	26	på en	17	för att	32	och hunden	20
5	det var	23	i en	15	en liten	26	efter grodan	19
6	i en	21	på grodan	15	det var	25	på en	17
7	det är	18	och tittar	14	så han	24	på grodan	17
8	efter grodan	17	att grodan	13	efter grodan	23	att leta	16
9	på en	17	en groda	13	i ett	21	en stor	16
10	ner i	16	för att	13	när han	20	och ropade	16

Table 4: The frequency distributions of the top 10 word pairs in spoken and written frog stories by 30 15–year–olds

WR,SP: *WR*), and *för att* emerges as the connectivizing device typical of written narratives (rank order 1 in WR,SP: *WR* and rank order 34 in SP,WR:*SP*). In effect, as far as connectors are concerned, narrators encode causal or purposive relations to a greater extent when they write than when they speak.

The distributions in conditions WR,SP:*SP* and SP,WR: *WR* will be discussed in the section "Order effects ".

The linguistic encoding of aspects of a motion event

Conceptual frameworks for analyzing language for spatial relations and motion events have been proposed in the area of semantics and cognitive linguistics (e.g., Miller and Johnson-Laird, 1976; Talmy, 1983; Langacker, 1987). For example, given a situation where an object X is moving from a point or region Y towards another point or region Z, X would, in Langacker's terminology, be termed "trajector" and Y and Z "landmarks". Although no natural language makes the encoding of certain aspects of a spatial scenario strictly obligatory, there are typical tendencies concerning what information gets encoded. For example, the linguistic encoding of the above scenario would typically involve making the trajector (X) the grammatical subject of a sentence describing the situation. If the situation was, say, a person coming into your office from the hall, then a sentence describing aspects of that situation could be *he came in*, where *he* encodes the trajector, *came* the motion, *in* the direction, and the landmarks are left implied and not explicitly encoded. The linguistic encoding of the landmarks would take the form of prepositional phrases, for example, *from the hall* and *into the office*.

In the sentence *he came in*, the motion verb *came* is an intransitive verb which takes the trajector as subject. In contrast, in the sentence *they pushed him into the office* the trajector appears as the grammatical object *him* of a transitive verb, *push*. Following a terminology used by, among others, Viberg (1993), we will make a distinction between *reflexive* and *objective* verbs of motion. The first category refers to verbs where the moving entity appears as subject (e.g., *go, come, fall*), and the second to verbs where it appears as object (e.g., *put, open, throw*).

The data drawn from the picture story experiment for the analysis of descriptions of a motion event relate to an episode in the frog story, which we will refer to as "the fall from the cliff": a deer with the boy on his antlers stops abruptly at the edge of a cliff so that the boy falls down from the cliff into a water pond. This motion scenario has an agent/cause (the deer), a trajector (the boy) and two landmarks (the antlers/edge of the cliff and the pond)[6]. In particular, the agent (deer) and the trajector (boy) compete for getting encoded as grammatical subject (c.f. Langacker, 1987). One solution to this encoding problem is to select the trajector as subject and to disregard the agent. This solution also encompasses the choice of an intransitive verb, more precisely, a reflexive motion verb. We will refer to this solution as the "intransitive" solution or strategy. The intransitive strategy is illustrated in example 1.

Another solution is to encode the agent as grammatical subject and the trajector as object. This requires a transitive verb, more precisely, an objective motion verb. We will refer to this solution as the "transitive" solution or strategy. The transitive strategy is illustrated in example 2.

(1) [Swedish, 15 years, SPEAKING]

pic description

17 *å så kommer dom väldigt väldigt nära ett stup då*
'and so they come very very close to a cliff then'
å precis då stannar hjorten
'and just then the deer stops'
så Pelle å både Pelle å Ior ramlar ner
'so Peter and both Peter and Eeyore fall down'

(2) [Swedish, 15 years, WRITING]

pic description

17 *och tippar sedan av Pär ner i en damm*
'and then throws Peter off down into a pond'

An analysis of the 30 spoken and the 30 written narratives shows that the transitive solution is taken by a greater number of narrators in the writing condition (N=13) than in the speaking condition (N=5), and that more narrators go for the intransitive solution in the speaking condition (N=29) than in the writing condition (N=24). The differences are summarized in table 5.

Again, the tendency to solve the linguistic encoding problem with different strategies in speech and writing can be interpreted as a contribution to a differentiation between the spoken and the written narratives in terms of linguistic information structuring. It should be noted that the two strategies are not merely two different ways of encoding the same aspects of the spatial scenario (i.e., a packaging effect), — they actually lead to the encoding of partly different aspects of that scenario (i.e., a filtering effect). With the transitive strategy, the causal relation between the deer and the boy's fall gets explicitly expressed (see example 2). With the intransitive strategy, the causal relation has to be inferred (see example 1).

The intransitive strategy is consistent with a larger, overall strategy for the speaker's (as distinct from the writer's) solution to the story telling task. Operating under on-line

Swedish 15–year–olds, N=30[7]

Speaking		Writing	
transitive	intransitive	transitive	intransitive
5	29	13	24

Table 5: Intransitive versus transitive strategies in the group of 15-year-olds

constraints in the speaking condition, the subjects tended to use simple sentences, often with intransitive verbs, that move narrative time forward (what we shall term narrative "foreground sentences"). With this strategy, the narrator moves through the story step by step, event by event, by adding one foreground sentence to the other. This strategy is illustrated in example 1, which contains 3 simple sentences, each with a reflexive motion verb and each describing an event (or sub-event). The strategy presents a quick and easy solution to the speaker's story telling problem. (C.f., Levelt, 1981; Labov and Waletzky, 1967; Chafe, 1979; Reinhart, 1984; Strömqvist and Day, 1993; Ragnarsdóttir, 1992.) In contrast, it is conceivable that the transitive solution, encompassing the construction of a causal perspective and a search for semantically more complex verbs, presents less of a quick and easy way of solving the narration task, a way which the subjects were more prone to take when the on–line constraints were lifted in the writing condition.

The flow of discourse: pausing rate

The argument that the differentiation between speaking and writing in terms of linguistic information structuring is supported by information processing constraints rests, crucially, on the assumption that the narrators did indeed spend more time on planning their written narrations than on planning their spoken ones. Our data collection methodology makes it possible to test this assumption. The spoken narrations were video–taped and the written ones were computer–logged. When writing, the subject activated a picture in the left half of the screen by clicking the mouse, and proceeded by writing in a text window (the right half of the screen). For the present purposes we shall focus on the pauses the narrators made just before they started to describe a new picture (c.f., Strömqvist, 1994). By virtue of their picture initial position these pauses are functionally associated with planning (what aspects of the picture to talk about and how to verbalize these aspects) rather than monitoring. In the speaking condition, a picture initial pause was operationalized as the time elapsing between gaze onset (when the subject starts looking at a new picture) and voice onset (when the subject starts to speak in relation to a new picture). In the writing condition, this pause was operationalized as the time elapsing between the mouse click (activation of a new picture) and the first pressing of a button on the keyboard (starting to write in relation to the new picture). Figure 2 shows the average pausing time for the 30 subjects in the two conditions.[8]

The difference between speech and writing is huge. The fact that the constraints of on–line interaction are lifted in writing allows for a considerable freedom for, among other things, planning. And the picture–initial planning pauses in writing vary between 7 and as

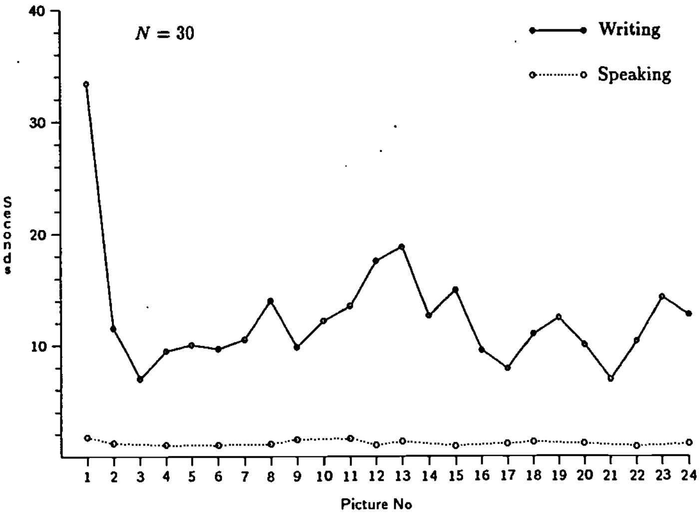

Figure 2: Planning pauses in a picture story task

much as 34 seconds (averages across subjects). When speaking, the narrators never allowed for picture–initial planning pauses longer than 2 seconds.

In conclusion, then, the assumption that the narrators spent more time planning when they were writing than when they were speaking is confirmed.

The flow of writing and the global progression of information

Figure 2 was constructed to demonstrate an important difference between speaking and writing. Let us now look more closely at some aspects of the flow of writing only. For this purpose, we will concentrate on the written narratives in the frog story task by the 15 15–year–olds who performed the narrative task first in writing and second in speech.

An analysis of the total amount of pausing time spent during the description of an individual picture/event (initial, medial, and final pauses) tends to decrease from the beginning towards the end of the story. We suggest that this decrease reflects the increasing ease with which the linguistic information structuring of the events is performed as a function of the overall progression of information in the narrative. This tendency is depicted in figure 3. In order to highlight the overall tendency, the statistical technique of so–called moving averages was used.[9]

The relation between the flow of discourse on the one hand and the overall progression of information on the other appears to be a strong one. The pattern tends to emerge also when we analyse data from other narrative tasks. Moreover, the pattern also emerges when rate of self–editing (and not pausing rate) is used as a paramater/operationalization of the flow of discourse. Consider, for example, figure 4 where the distribution of self-editings by the subject "jenol" in the composition task "I was never so afraid" is plotted. The figure depicts the number of self-editings per clause from the first clause to the last (moving averages).

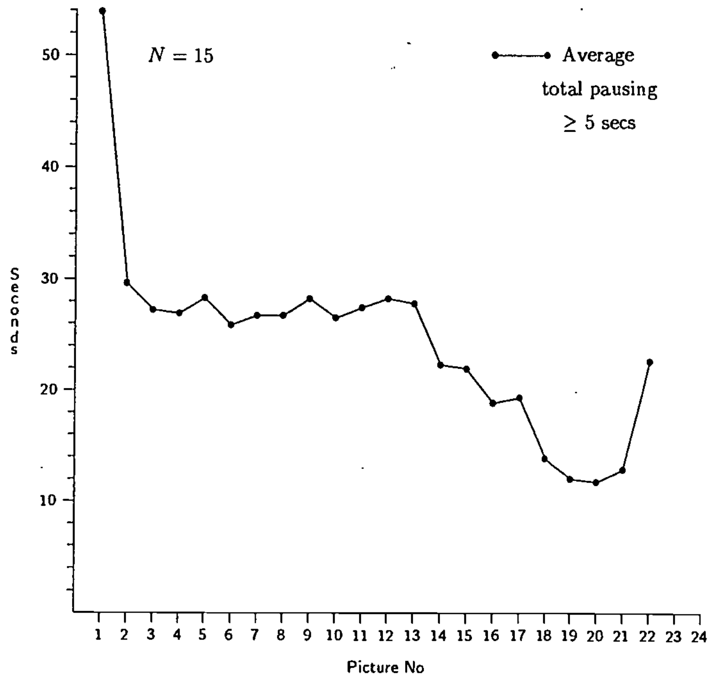

Figure 3: Total pauses in a picture story task

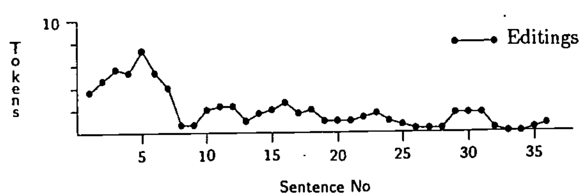

Figure 4: Editings in a composition task by a Swedish 15-year-old

Connectors

Let us return to table 4, which shows the top ten collocations (pairs of word forms) in the four conditions SP,WR:*SP*, SP,WR:*WR*, WR,SP:*SP*, and WR,SP:*WR*. In relation to table 4 we observed that the connectivizing device *och så* 'and then' had rank order 1 in the preeminently spoken condition SP,WR:*SP* (and rank order 672 in WR,SP:*WR*), and that *för att* 'because/in order to' had rank order 1 in the preeminently written condition WR,SP:*WR* (and rank order 34 in SP,WR:*SP*).

Now, can any order effects be detected? In condition SP,WR:*WR* 0 (zero!) tokens of *och så* were encountered in the collocation analysis. That is, there is no evidence whatsoever of *och så* "spilling over" from the previous spoken to the subsequent written condition. In contrast, in condition WR,SP:*SP för att* is the fourth most frequent collocation (see table 4). That is, *för att* seems to have spilled over from the previous written condition to the subsequent spoken one. In terms of linguistic information structuring, that spill over means an increase in the linguistic encoding of causal or purposive relations as compared to the corresponding encoding evidenced in the control condition SP,WR:*SP*.

Self editings

Further, order effects can be demonstrated for aspects of the flow of discourse. A case in point is the distribution of self editings. By self editing we here understand the substitution, deletion or addition of a morpheme, a word or a syntactic construction. In the present context of analysis, we thus rule out phonological self repairs and corrections of spelling mistakes. Example 3, which contains two instances of self editing, provides an illustration. Both instances are associated with the linguistic information structuring of an event with two (not just one) undergoers (the boy and the dog, who fall into a pond). In the first instance, the narrator shifts from constructing the boy as subject to constructing both boy and dog as subject (coordinated subject): *han* 'he' → *han och hunden* 'he and the dog'. In the second instance, the narrator shifts from constructing the dog as subject to constructing both dog and boy as subject: *hun(d)* 'do(g)' → *de* 'they'.

(3) [Swedish, 15 years, SPEAKING]
pic description
18 *han landar i vattnet*
'he's landing in the water'
han och hunden
'he and the dog'

hun(d) de blir jätteväta
'do(g) they get soaking wet'

Now, the distribution of all self editings in the entire frog stories by the 30 15 year old subjects across the four conditions (SP,WR:*SP*; SP,WR:*WR*; WR,SP:*SP*; and WR,SP:*WR*) is summarized in table 6.

Order	SPEAKING, WRITING N=15		WRITING, SPEAKING N=15		Total N=30
Condition	*Speaking*	*Writing*	*Speaking*	*Writing*	
N subjects making at least 1 repair	13	**9**	14	15	
N self repairs	61	**21**	78	64	
per word	1.06%	**0.42%**	1.08%	1.03%	
per clause	7.56%	**2.94%**	9.13%	8.89%	

Table 6: The distribution of self editings in speech and writing

The amount or share of self repairs is similar across the conditions (on average, a little less than 10% of all clauses are subjected to editing) with the noticeable exception of SP,WR: *WR*, that is, the condition of telling the story in writing after first having told it in speech (only 2.94% of the clauses produced in this particular condition are subjected to editing!). On the assumption that the amount or share of self repairs reflects the degree of effort or difficulty in linguistic information structuring, it seems, then, that a prior accomplishment of linguistic information structuring in speech facilitates the process of linguistic information structuring in writing (the share decreases from 7.56% in SP,WR:*SP* to 2.94% in SP,WR: *WR*). In contrast, a prior accomplishment of linguistic information structuring in writing does not seem to facilitate the process of linguistic information structuring in speech (the share increases insignificantly from 8.89% in WR,SP: *WR* to 9.13% in WR,SP:*SP*).

The "facilitation hypothesis" gains further support from an analysis of the distribution of pausing time on the two writing conditions (pause criterion $\geq$ 5 secs). The 15 subjects in WR,SP: *WR* spent, on average, 1314.73 seconds pausing, whereas the 15 subjects in SP,WR: *WR* spent, on average, only 734.33 seconds pausing, a decrease by almost 50%.

A developmental perspective

A theory of language development based on a human information processing perspective is put forward by Slobin (see, e.g., Slobin, 1971 and Slobin, 1985). On the basis of cross–linguistically attested generalizations concerning the structure of (early) language acquisition Slobin formulates a set of operational principles ("OPs") in the form of imperative clauses to the learner (for example, "Pay attention to the ends of words!"). In Slobin (1977), a study investigating principles guiding language change in childhood and in history, a small set of truly general information processing constraints and principles guiding both language learning and linguistic communication are formulated as the following four OPs (ibid. page 186–188):

1. *Be clear!*
2. *Be processible!*
3. *Be quick and easy!*
4. *Be expressive!*

The first and second OPs are assumed to have a greater relative weight in early phases of development (mapping out form–content relations and making yourself understood are priorities in early language acquisition), whereas the third and fourth OPs have a greater relative weight in later phases of development (fluency, richness of information and rhetorical moves).

Further, the OPs can come into conflict, for example, *Be quick and easy!* can put *Be processible!* at risk. And conflicts between principles can trigger developmental change insofar that the learner strives to resolve the conflict (c.f. MacWhinney and Bates, 1989).

In Strömqvist et al. (1998) it is argued that also the two latter OPs, that is, *Be quick and easy!* and *Be expressive!*, can come into conflict and that the acquisition of written language (so that the learner comes to possess both spoken and written language) can provide a means for resolving that conflict.

Strömqvist (1996) presents age-group comparisons of tendencies to a linguistic/stylistic differentiation (in terms of the four dimensions of linguistic information structuring: Packaging, Filtering, Connectivizing and Perspectivizing) between spoken and written narratives. These comparative analyses show that there is not yet any differentiated usage evidenced in the 9-year-olds. For example, the greater tendency to encode causal relations (through connectors and transitive motion verbs) in writing than in speaking evidenced in the data from the 15 year old subjects is not yet present in the data from the 9-year-olds (instead, the 9-year-olds show a fifty/fifty distribution of these traits; see Strömqvist, 1996).

The differentiation is the outcome of a long term process, which is shaped by the child's growing insight into the functional and physical properties of speech and writing and by the child's ways of adapting to and exploring these properties. Learning to write is something much more than a process by which the learner merely adds knowledge of written language to his previously acquired knowledge of spoken language. When written language enters the scene of language development in a learner, it will affect the learner's conception and usage also of spoken language, and his spoken and written language will continue to develop in a dynamic interrelationship, mutually influencing each other.

Conclusions

The theoretical perspective guiding the approach outlined in this paper is closely affiliated with the tenants of functionalism and human information processing. The emphasis of the paper has been on methodology and various ways of exploring linguistic information processing and the flow of discourse in speech and writing, especially in writing. The analyses presented were largely exploratory in nature, serving the purpose of illustrating the methods proposed rather than constituting conclusive or large scale evidence of differences between speaking and writing. A lot of work remains to be done. In particular, other genres or discourse types need to be investigated, for example, argumentative discourse. Also, our focus on motion events in narrative discourse should make obvious the need for analyses of other semantic fields and linguistic domains. This situation, in its own right, has to a large extent motivated our emphasis on methodology. If the framework (or frameworks) we have suggested can inspire more studies along similar lines, one important goal of the present paper will have been achieved.

Although the analyses in the previous sections are admittedly exploratory and based on a limited empirical material, we feel that there are a few general conclusions to be drawn from them. One is that the analysis of linguistic information structuring and on–line flow should proceed from a discourse level. For example, the finding that the local pausing and editing rate tends to be determined by the global progression of information in narrative discourse would have passed unnoticed, if the analysis had been strictly confined to, say, sentence level structures. Another general conclusion is that the constraints of what we have termed "on–line interaction" are a very powerful determinant both to aspects of linguistic information structuring and to aspects of the flow of discourse.

Our experimental design makes possible analyses of order effects, and a small number of phenomena — connectors, and self editings — were tested for such effects. From these analyses, effects on linguistic information structuring were found in the direction from writing to speech (but not from speech to writing), and effects on fluency were found from speech to writing (but not from writing to speech).

Finally, the acquisition of a written language is seen as a long term process, where spoken and written language are developing in a dynamic interrelationship, mutually influencing each other, as a function of the learner's continuous experiences with both spoken and written language.

Notes

1. The archive relates to the Swedish project "Tala och skriva i lingvistiskt och didaktiskt perspektiv". The archive contains, among other things, stories from a composition task with a pre–set topic, "I was never so afraid", where the subjects were asked to relate an episode from their own lives. Six written stories from this composition task were sampled for analysis.

2. A pause was operationally defined as keyboard inactivity $\geq$ 2 seconds. In our estimation the 2 second criterion probably underspecifies rather than overspecifies the actual pausing rate.

3. 'SP,WR:*SP*' reads "in the order SPEAKING first and WRITING second, the *SPeaking* condition"

4. More precisely, we have constructed two tools for the computer–aided analysis of writing: "Scriptlog" and "Textlogger". Scriptlog can be used for logging "free writing" or it can be used with an elicitation instrument (such as a picture story). See Strömqvist and Malmsten (1998) for a User's manual, or visit our home page

   http://www.ling.gu.se/~wengelin/projects/r&r/

5. In deriving collocations, we use the same procedure as specified in Allwood (1996).

6. In fact, the scenario has three landmarks to the extent that the cliff is seen as a PATH along which the fall is taking place.

7. The figures in the speaking condition add up to more than 30. The reason for this is that some of the subjects used more than one sentence on describing the fall from the cliff, for example *Hjorten kastade ner Pelle och han föll rakt ner i en damm* 'The deer threw Peter down and he fell right down into a pond'.

8. In the speaking condition, a copy of the original picture book was used. When opened, this book sometimes presents two pictures (one on the left page and one on the right) and sometimes only one (a double-paged picture). In the writing condition, by contrast, one and only one picture was shown at a time (there was not enough space for double-paged pictures on the left half of the computer screen). As a result, the writing graph (solid) in Figure 2 has 24 relevant points for measuring, whereas the speaking graph (dotted) has 15.

9. Moving averages are used to smoothen the overall profile by calculating averages over a certain interval, in our case 3 points of measurement. Thus, the sum of the measurements for points (= pictures) 1, 2 and 3 (each of them constituting an average across the 15 subjects) was divided by 3 and the resultant value was entered for picture 1. Next, the sum of the measurements for 2, 3 and 4 was divided by 3 and entered for picture 2, etc. The pausing criterion was ≥ 5 seconds.

   A moving average implies that the number of points of measurements decreases by the number of the size of the interval + 1. Thus, for our interval of 3, and 24 points of measurements, there will be $24 - (3 + 1)$ new points for the moving average = 22.

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