CONCEPT FORMATION OF LATIN PREFIXES IN STUDENTS WITH LEARNING DISABILITIES

by

Seanna Takacs
B.A., McMaster University 1997, B.Ed, OISE/UT 2001

THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

In the Faculty of Education

Educational Psychology

SIMON FRASER UNIVERSITY

Summer 2007

APPROVAL

Name: Seanna Leigh Joanne Takacs

Degree: Master of Arts

Title of Research Project: Concept Formation of Latin Prefixes in Students with Learning Disabilities

Examining Committee:

Chair: Ann Chinnery, Assistant Professor

_____

Paul Neufeld, Assistant Professor
Senior Supervisor

_____

Jeff Sugarman, Associate Professor

_____

Lucy LeMare Associate Professor Education

Internal/External Examiner

Date: July 30, 2007

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

STATEMENT OF ETHICS APPROVAL

The author, whose name appears on the title page of this work, has obtained, for the research described in this work, either:

(a) Human research ethics approval from the Simon Fraser University Office of Research Ethics,

or

(b) Advance approval of the animal care protocol from the University Animal Care Committee of Simon Fraser University;

or has conducted the research

(c) as a co-investigator, in a research project approved in advance,

or

(d) as a member of a course approved in advance for minimal risk human research, by the Office of Research Ethics.

A copy of the approval letter has been filed at the Theses Office of the University Library at the time of submission of this thesis or project.

The original application for approval and letter of approval are filed with the relevant offices. Inquiries may be directed to those authorities.

Bennett Library
Simon Fraser University
Burnaby, BC, Canada

Abstract

This qualitative study examined concept formation of Latin prefixes in three students diagnosed with learning disabilities through a theme-based analysis. The study had two purposes. Conceptual processes underlying the learning of Latin prefixes were explored through dynamic assessment and Vygotsky's stages of concept formation were empirically tested. There were five major findings in this study. First, when Vygotsky's model was applied to everyday images, the theoretical underpinnings of his work were called into question. Second, concept formation was a highly individualised process. Third, concept formation used a large body of existing and constructed knowledge. Fourth, the movement between Latin and English meanings necessitated an additional step in forming concepts. Finally, Vygotsky's stage theory failed to provide a reasonable paradigm through which concept formation of Latin prefixes could be explained; script-based and context dependent theories of concept formation offered more viable means of interpreting the data in this study.

Acknowledgements

To Paul, for your enthusiasm, tangents, thoughtful encouragement and honesty.

To Jeff, for lingering quietly with sage advice.

To Maureen, for teaching me to be brave.

To David, for early morning revelations, late-night reassurances and knowing me.

To Purnima, for your support, hilarity and navigating together all that lies beneath the itchy sweater.

To Simon, for float planes, passenger jets, express coaches and freight trains, and for knowing that screwdrivers don't belong in light sockets.

Table of Contents

List of Tables

Introduction

The study of concepts strikes at the heart of learning. When we study individual conceptions of people and things we start to apprehend reasoning, context, value, perception, developmental trajectories and sociocultural forces that shape individual thinking. To capture an individual's conceptual assumptions reveals the genesis and direction of thought.These assumptions are both explanatory and predictive, helping us understand where people start to learn new material, how they incorporate new information and how they draw conclusions based on that information set.

This study constitutes a qualitative analysis of the concept formation process surrounding Latin-based prefixes in dyslexic students. The origins of this study have both practical and theoretical roots, beginning with observations made tutoring dyslexic students using Orton-Gillingham methodology through definitional questions raised over the identification of students with learning disabilities (LDs) and the study of Vygotskian developmental psychology.

Practical Foundations

Although it preceded the official LDs definition by 30 years, Orton-Gillingham (O-G) methodology was designed specifically to help struggling readers. Through its cumulative, multisensory presentation of phoneme-grapheme correspondences, O-G methodology presents reading as an analytical operation that pivots on the systematic blending and segmentation of words. The presentation of phonemes/graphemes begins at the level of short vowel sounds and proceeds up a hierarchy where sound-symbol relationships increase in sophistication and decodability. At the top of the hierarchy is the point at which students must make the transition from phonetic analysis to morphemic analysis where word structures are studied for their meanings. It must be noted that the morphemic level of analysis is a recent addition to the O-G curriculum and is not nearly as well developed as the instruction based on phoneme-grapheme

correspondences; given new research concerning the importance of morphology instruction in addition to phonological awareness in literacy development (Deacon, Parrila & Kirby, 2006), many O-G tutors are attempting to incorporate this instruction for their older students.

After three years of teaching young children who inevitably got older, I was required to devise a curriculum to teach English morphology. Because the suffix morphs *ing, ed,* and *er* are taught simply as word endings and decoded phonetically in O-G methodology (and not as morphs that carry meaning) I decided to focus instead on prefixes and roots. There are teaching materials on the market that roughly address Latin and Greek prefixes and roots, so armed with O-G methodology and an expensive armful of these materials, I created a morphology curriculum and began to implement it.

Out of five students ranging in age from 9 - 14, one student understood the morphology lessons. Specifically, she was able to answer questions, complete worksheets and engage in deductive reasoning concerning the ways that structural changes in words imply meaning changes. She was able to give examples of words containing various Latin/Greek prefixes or roots and could use those examples to generate both real words and nonwords. The students who did not understand the morphology instruction had difficulty even paying attention during the lessons. The sessions which were previously energetic and productive became slow and plodding as the students struggled to grasp the material.

After changing the curriculum and changing the presentation and seeing no further success except with the one student, the obvious question became, "Why can this one student grasp morphology instruction while the other students struggle so profoundly?" This was to be the question that guided the majority of my inquiry into LDs and concepts.

Identifying Learning Disabilities

The literature concerning the appropriate definition of LDs is extensive and incorporates at least

a century's inquiry. In the 1930s American neurologist Samuel Orton acknowledged the body of students who demonstrated significant difficulty with reading and for whom specialised, multisensory reading instruction was required (Geschwind, 1982). In 1962, Samuel Kirk established the first definition of LDs:

> A learning disability refers to a retardation, disorder, or delayed development in one or more of the processes of speech, language, reading, spelling, writing or arithmetic resulting from a possible cerebral dysfunction and/or emotional or behavioral disturbance and not from mental retardation, sensory deprivation, or cultural or instructional factors (Kirk, 1962, p. 263).

Kirk's definition presumed that the learning problems are intrinsic to the child and indeed the majority of research in the field since has been aimed at defining the parameters of the brain and cognitive function of children with LDs. Today's definition of LDs has changed very little and still demonstrates that LDs are thought to be a phenomenon whose genesis lies within individual mental function:

> The term 'specific learning disability' means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in the imperfect ability to listen, think, speak, read, write, spell or do mathematical calculations (Individuals with Disabilities Education Improvement Act, 2004).

Discrepancies in verbal and nonverbal abilities found on tests like the Weschler Preschool and Primary Scale of Intelligence (WPPSI), the Detroit Tests of Learning Abilities and the Illinois Test of Psycholinguistic Abilities were the first means of ascertaining a learning disability at the preschool level (Kirk & Elkins, 1975). At this point, LDs were considered to be a developmental phenomenon so early identification was prudent in order to ensure appropriate remediation.

The discrepancy formula continued to be used as a diagnostic tool to discover any unexpected specific processing deficits. However, comparing ability and achievement proved to be a conceptually thorny issue. First, it was found that measuring potential using traditional intelligence tests provides a poor estimate of general ability (Campione, 1989). Both low-achieving and discrepant students benefited from the same types of instruction (Scruggs & Mastropieri, 2002) and in the case of dyslexic students, 25 per cent of whom meet discrepancy criteria do not meet low-achievement criteria and thus would be excluded from special education services (Shaywitz et. al., 2000). Since discrepancy measures fail to reliably identify students with LDs, research into other explanatory factors has broadened the conceptual maelstrom surrounding the field.

Dyslexia is the most common and widely studied LDs in cognitive, neurobiological and genetic studies. These approaches have helped to specify deficiencies as originating in the language system (i.e., reading, writing and more specifically, deficits in phonological awareness which consistently differentiate dyslexic and non-disabled students) (Shaywitz et. al, 2000). There are consistent differences in dyslexic brains according to functional brain imaging studies of areas of activation. Research suggests the neurobiological correlates that underlie cognitive deficits associated with dyslexia are centred around the left temporal-parietal region and asymmetry of the planum temporale. The differences in brain morphology run in families as evidenced by the fact that 50 per cent of the variance in reading problems is attributable to genetics (Wadsworth et. al., 1992).

Although fruitful, the neurobiological and genetic research is in its infancy in terms of conclusiveness of findings. While both genetic and neurobiological research have centred on central phonological processing deficits, extraphonological processes including speed of processing, visual, auditory and motor problems that both impact on and extend beyond the

literacy domain are important considerations (Catts et. al, 2002). However, once the focus of inquiry moves away from reading processes (e.g., mathematics disability, writing disabilities), the lines between cognitive function and performance become blurry. From an educational standpoint, it is important to understand how LDs reveal themselves in instructional settings; certainly, acknowledgement of etiological foundations is helpful, but it is important to balance academic inquiry with clinical evidence. According to Tzuriel (2000), "Practical experience shows many times that even children who are virtually identical in terms of characteristics such as age, gender and IQ show markedly different behavior -- cognitive or affective -- and require, therefore, different teaching strategies." (p. 387) If we are correct in our theories concerning the reasons for poor performance, our corresponding practice based on that etiological theory can hope to yield some improvement in performance in the course of instruction. To remediate students who struggle with specific aspects of academic instruction it is important to understand conceptual keys such as strategies, memory cues, logic devices and conceptual triggers.

Consider the example of an 11-year-old student I worked with who attempted to write a paragraph about dogs. The student defined a dog as "a large animal with four legs, short white hair and black spots". When informed that she needed to think about dogs in general and not one specific dog, the student attempted another conceptual definition: "a dog is a small animal with short or long hair, that can be brown and likes to chew bones and drink water." Again, the student attempted to broaden the description of dogs, but had difficulty moving away from the images of particular dogs. Given this information it became apparent that the problem was that the student paid attention to specific details of objects but did not form a conceptual group containing those objects. Instead they remained discrete entities that were not necessarily linked. It was helpful to know that the student had ADHD and dyslexia insofar as it indicates that she struggled to pay attention, had trouble inhibiting incoming stimuli and found decoding and text

comprehension difficult. The diagnosis itself gave a rough understanding regarding the localisation of her academic difficulties but failed to suggest specific strategies for remediation; additional research into the intervention literature is necessary to understand how those difficulties manifest, relate to comprehension and the most meaningful decoding/memory strategies. When we understand how a student makes mistakes and how they understand objects and relationships among those objects we may better apprehend thinking. When we understand the processes behind performance and not simply the results of performance we may be able to transcend definitional issues and identify the conceptual keys that suggest a host of additional instructional strategies.

Knowing that the struggle to discriminate between superordinate and subordinate categories was behind my student's difficulty to write paragraphs and see common attributes among words and objects meant that I could provide instruction specifically designed to address the category discrimination problem. Acknowledgement of that specific difficulty meant that both a method of identification and resolution were suggested. Identifying the cognitive hurdle quickly meant that it could be overcome through reconceptualisation and change in strategy use. While standardised testing and disability designations inform the effort to provide additional instruction where needed, they cannot be expected to specify the components of the prescriptive teaching and remedial learning strategies.

Vygotskian Psychology

Vygotsky (1986) believed that mediated learning was the major determinant of human development; all mental processes in humans are mediated by psychological tools such as language, signs and symbols. Through the course of education and interaction, these tools are acquired by children. He emphasised the role of instruction as generating development: "The only good kind of instruction is that which marches ahead of development and leads it; it must be

aimed not so much at the ripe as the ripening functions" (Vygotsky, 1986, p. 188). Ripening functions were the major focus for Vygotsky and consequently much of his work on this subject was devoted to the exploration of the formation of concepts for example, how children develop the capacity to engage in simultaneous abstraction and generalisation in regard to groups of objects.

Knowing the definitional knots that plague the LDs literature and knowing that effective instruction of students with LDs had to appeal on a deeper level than the technical aspects of reading and language instruction, I read Vygotsky with avid interest and was intrigued by the opportunity to understand learning, learning difficulties, assessment and pedagogy using a dramatically different paradigm. Since a significant portion of O-G instruction involves focusing on the learning process and changing that process, Vygotskian developmental psychology was appealing because it pivots on concept formation and change. Vygotskian concept formation offered the chance to study the learning of morphs from the starting point of concepts, where students initially begin to understand that words have structure grounded in meanings; where they learn of the very existence of Latin morphs and proceed to manipulate and extrapolate those meaning structures.

This study had two purposes. First, through a thematic analysis of the outcomes of a dynamic assessment I elucidated the conceptual processes that underlie the learning and understanding of Latin prefixes. Second, this study was an empirical test of Vygotsky's stages of concept formation. By understanding concept formation of Latin prefixes in students with LDs we gain perspective on individual differences that function on the conceptual plane, namely how they perceive relationships, determine category inclusion and see equivalence among phenomena. An exploration of these facets of learning permits an understanding of the fundamental assumptions participants make in constructing meaning as well as the techniques and resources

employed in establishing an understanding of Latin prefixes, which may in turn suggest effective directions for later remediation.

Literature Review

The literature surrounding concepts and concept formation is truly massive. A study of concepts draws together postulates concerning the nature of thinking, language, memory, representation, perception and knowledge. Although the definition of a concept itself has not been settled on, roughly speaking, concepts are stable cognitive wholes that serve to organise our experience of objects and phenomena into groups for the sake of cognitive efficiency. Fundamentally, concepts deal with categorisation; concept formation concerns the ways that we create those categories, discriminate between stimuli and understand relatedness among phenomena. The basic task of all organisms is the segmentation of the environment into classifications by means of which non-identical stimuli are treated as equivalent (Rosch & Lloyd, 1978). Mice learn to distinguish hawk silhouettes from seagull silhouettes to avoid becoming prey, giraffes learn that acacia trees make for delicious dining while grasses are a bit of a reach and sea otters learn that rocks are more useful than logs in cracking open the shells of molluscs. Human babies learn to pick out their parents' voices from a sea of sound, children learn that hitting earns frowns while sharing earns smiles and adults learn the differences between anarchy and democracy. In understanding what a thing is, we also understand what it is not. These everyday conceptual processes that we take for granted are extremely sophisticated and complex.

Consider the question, what is blue? To understand how children assemble a concept of blueness, a multitude of avenues of inquiry can be explored. We must establish the concept of blueness as imbedded in the the evolution of English which, due to its polyglot roots implies a tracing of blue through Latin, High German, French and Anglo-Saxon roots. We can then study blueness from a multitude of perspectives. For instance, we can observe blueness in a developmental context to see how it is constructed in young children and changes with age and experience; through prototypes by understanding ideals of blue; through historical inquiry by

ascertaining how the production and use of indigo and wode helped to define blue. We must consider the entire spectrum of blue (e.g., bluish-green, greenish blue, periwinkle, aqua, turquoise and indigo) to understand individual conceptions of blueness and know how blue differs from green, purple or red. We can observe the interaction of speech and thinking by postulating whether the word blue exists external to thinking about blue or whether thinking about blue generates the concept. Do we answer the question by specifying examples of blue or does blue have different functions that help us construct the concept (e.g., blue food colouring, blue crayon, blue socks, blue jeans)? Does blueness interact with other concepts and if so, which ones? What is the nature of that interaction? Ironically, blue surrounds us, is the favourite colour of many and the inquiry that attempts to answer the seemingly simplest aspect of one of these questions has been the life's work of many scholars dating back even to pre-Socratic philosophers who attempted to ascertain the first answers concerning knowledge and existence.

Prior to the 20th century, work on concepts and concept formation was imbedded in understanding broader thinking, reasoning and sensory processes and was used as the vehicle by which theories concerning the relationship between thought, language and objects could be ascertained. Case (1999) outlines the philosophical foundations that underlie the modern research on concept formation. According to the the British Empiricists (Locke, Berkeley, Hume), knowledge of the world is compiled when the mind detects customary patterns or conjunctions in detected stimuli. Developmentalists who focused on sense experience tended to focus on perceptual learning and the discrimination among stimuli (e.g., Thorndike's laws of learning). The Kantian tradition assumes that knowledge is acquired by a process through which the mind imposes order on sensory data. The ordering of sensory data is concept formation; developmental psychologists following the Kantian tradition tended to examine the foundational concepts of infants and how those concepts changed as the child got older (e.g., Baldwin's

conceptual schemata progression).

Indeed these two veins of inquiry on thinking and sensory data have guided modern concept formation research. The empiricist branch evolved into the cognitive revolution where the fields of computer science, psychology, linguistics and social science intersected to create cognitive science (Gardner, 1985). Cognitive science approaches concept formation in terms of information processing models which focus on the ordering and manipulation of data and presume the solipsistic, analytic nature of concepts. Cognitivism treats the mind as a machine, more precisely as a computer program, more precisely still as the sort of program which functions as a series of computations (that is, rule-governed changes) on symbolic representations. The mind is considered to be a collection of mental representations precisely analogous to the computer's symbolic representations (Rosch, 2005, p. 62).
Cognitivism does not refer to relationships outside the individual mind, preferring instead to examine rules and constraints within a closed system.

The Kantian tradition of pure understanding conversely, has yielded a much broader field of inquiry into concepts which approaches concepts and concept formation as an intersubjective, context-laden process where the genesis of concepts lies in the interaction of individuals, language learning and individual perception of objects and phenomena. Concepts are functional, changeable, contextual things that occur within a web of meaning provided by other concepts and by interrelated life activities (Rosch, 1999). Within the Kantian tradition lies developmental psychology, a category of thinking further specified by its longitudinal approach and consideration of the ways that concepts first emerge in babies and toddlers and develop into the adult mode. The developmental psychology literature places strong emphasis on the relationship between language and concepts; concept formation inevitably coincides with the emergence of new words. Language development and concept formation become recursive processes, each

informing the other to spur further thinking and lexical growth. Acquisition of conceptual taxonomies is a result of the exposure to and experience with the language used to formulate them (Nelson, 1996). The questions for developmental psychologists relate to cognitive skills underlying the formation of conceptual hierarchies and how they relate to both existing and emerging representations.

This section will consist of a review of five major contributors to developmental psychology in the field of concept formation. Jean Piaget created a number of experiments in order to understand the logic and reasoning of children as well as the child's concept of world and causality. Jerome Bruner studied the ways students learned categories that he defined as logical sets designated according to specific attributes and combined by logical rules. Katherine Nelson, in studying concepts from the starting point of language development, contributed some of the most significant findings concerning the emergence of linguistic symbols and their bearing on the conceptual lives of children. Eleanor Rosch has changed the field of concept formation significantly with prototype theory, study of colour concepts and conclusions regarding the participatory nature of concepts. Finally, L.S. Vygotsky whose stage-based theory of concept formation provides the theoretical and empirical underpinning to this study, will be discussed in greatest detail.

Fundamentally, the same thread connects each theorist; they explore the relationship between language, concept, category and representation and how concepts and word meanings evolve into their adult counterparts (Nelson, 1996). Due to their emphasis on interaction and the shaping of development by forces external to the child, they are said to take an experientialist perspective that embraces both biological and socio-cultural perspectives on human development. Children and infants come to understand the world in ways that are specific to the cultural and historical situations within which they exist. The biological aspects have to do with the capacity

to make sense of the specifics and subsequently constructing conceptual abstractions and generalisations that fit the world as it is encountered (Nelson, 1983).

Despite the fact that each theorist falls under the experientialist umbrella, Cocking (1983) highlights a schism among developmentalists in the study of concept formation. Due to his emphasis on cognitive organisation, Piaget is generally termed a Structuralist while Nelson is grouped with Functionalists like Bruner and Vygotsky because she studies continuity of function *within* developmental periods. Essentially, the schism is based on indices of development and the basic research models. Functionalists see the smoothing out of performance as the index of development while structuralists try to determine the underlying knowledge and assumptions behind concepts at various points of development. Nelson adheres to logical empiricism; knowledge is studied for its experiential facets (both sensory and learning) and for the logical thinking that happens after the event in which language plays a central role. Conversely, Piaget understands the child's activity as preparing logical structures; because of these preparatory co-ordinations, logical structures are in evidence, even in the smallest degrees.

Jean Piaget

While he is widely regarded as a developmental psychologist for his stage theory of cognitive development, Piaget was more accurately a genetic epistemologist. He was concerned with the nature of knowledge and the ways it changed from infancy to adulthood. To this end, Piaget conducted a vast number of empirical studies designed to elicit operations that would reveal the patterns of the child's thinking. Piaget presented children with a variety of simple problems and systematically studied the child's reasoning and how he/she arrived at particular conclusions. For instance, in the class inclusion task, children were presented with a set of stimuli that could be classified into a hierarchy of one superordinate set (e.g., trees comprised of two mutually exclusive subordinate sets such as oaks and pines). One of the superordinate sets is

larger than the other and the children are asked which set contains more trees. For a child to understand class inclusion they must have the capacity to know that members of a subclass are all members of a class, but that the reverse is not true as well as understanding the logical and conceptual implications of terms such as *because, some, all* or *and* (e.g., all daisies are flowers but not all flowers are daisies). According to Piaget, children under about 10 years of age have difficulty with these tasks since they tend to read symmetry into the relation between class and subclass (Gruber & Voneche, 1977). However, as Markman (1983) pointed out, this task does not measure knowledge of hierarchical inclusion as incorrect answers do not necessarily mean that children do not understand that daisies are flowers. It is more a measure of their ability to add and subtract classes and to compare parts to whole.

Piaget deliberately included misleading questions so that children had to actively solve problems. Piaget concluded that to overcome misleading schemes, children required a learned repertoire of other relevant schemes, an information-processing capacity of a particular size (typically not developed until 6-10 years of age) and a cognitive style which allowed them to integrate task-specific schemes and reach logical conclusions despite contradictory information (Case, 1999). These types of findings spurred a body of inquiry devoted to the investigation of information-processing capacities and evidence for age-related cognitive capacities.

Piaget's work on concepts and their formation was focused on mathematical and physical concepts such as time, space and volume. Although the topics of Piaget's work are not relevant to this study of concept formation of Latin prefixes per se, his stages of development and work on classification and seriation are important to understand here for two reasons. First, they offer an initial framework which stimulated the modern branch of developmentally-based inquiry into concept formation. Second, Vygotsky aimed criticism towards Piagetian theory and thus it is interesting to understand them juxtaposed with one another and in contrast with the subsequent

research on concept formation.

Piaget's stage theory of development is best known and although his elaboration of the details of each stage was not extensive, his subsequent work on concepts was dependent on his notion of human cognitive development. He insisted that progress through the developmental stages occurs in a constant order as evidenced by the observation that the number of children displaying a certain way of thought or kind of behaviour increases with age. Piaget performed experiments with Swiss, Arab, Indian British and Somali children to show that the sequence is also universal (Gruber & Voneche, 1977).

The *sensorimotor period*, extending from infancy to approximately two years of age (the same point at which spoken language emerges) is characterised by solipsism and egocentrism. True to his scientific roots and consistent with evolutionary theory, Piaget (1927 - 28) believed that the essence of intelligence is the adaptation to things. Babies are in a state of perpetual assimilation of the external world to the self during which they accidentally stumble on new materials, sensations and substances. He gives the example of the baby unsuccessfully finding the breast and instead finding his hand, a pillow, the covers or something else with his mouth; the developing sense of consciousness works on the new element and becomes assimilated into the 'sucking' schema. Babies first classify phenomena according to their elementary reflexes, make new schemas based on those basic cycles of assimilation and subsequently fit the universe into this schematic groundwork. The idea of perceptual knowledge is a critical one for Piaget. It is primary and foundational. All other intelligence is based on extending this knowledge.

Once children become capable of symbolic function (i.e., language, symbolic gestures, mental imagery) around 18 months to two years of age, they move into the *pre-operational period.* Piaget and his colleague Inhelder (1969) thought that intelligence is demonstrated as language matures through the use of symbols, symbolic play and deferred imitation. During this

period, actions within the temporal environment are broadened to include past and future activities and the child begins to divide objects and collections into parts. Because Piaget considered logic as based on operations on objects, children's performance on conservation tasks demonstrated markedly that their logic differed from that of adults. For instance, when a four year old child pours liquid from a bottle of one shape into a bottle of a different shape, he believes that the recipient bottle holds a different amount of liquid simply because the level has changed.

Once children move into the concrete operations period (7 - 11 years), thought activity gains the character of reversibility (being able to return to their original starting point). Intelligence is demonstrated through logical and systematic manipulation of symbols related to concrete objects. Piaget (1969) thought that it was during this time that logical operations result from the actions of combining, dissociating, abstracting, ordering and establishing of correspondences. Children in this age group are able to fully apprehend the logic of classification and group membership. They are finally able to navigate the logical processes behind the statement, 'all daisies are flowers but not all flowers are daisies' and answer class-inclusion questions. Children also acquire the operation system called seriation which allows them to order objects in terms of their increasing length or to list objects from biggest to smallest. The concrete operational child can classify objects according to two characteristics at the same time (e.g., big, red triangles or small, fuzzy bunnies). Piaget pointed out the importance of these logical capacities in understanding concepts of number, time and motion and in constructing different geometrical relations.

The final stage of propositional or formal operations (11 - 15 years to adulthood) saw the ability to logically relate symbols to abstract concepts. Piaget and Inhelder investigated physical inference in children 8 - 12 years of age and 12 - 15 years of age by studying varying the length

and amplitude of oscillations of a pendulum. The younger subjects varied the factors in haphazard ways and then used the results of their experimentation to classify and establish correspondences among aspects of the pendulum and its movement. Conversely, the older subjects formulated hypotheses concerning operative factors and then arranged their experiments as a function of these factors (Piaget, 1969). For the older students, thought began from the theoretical and progressed to verifying those relationships. For the younger students, thought proceeded from the actual to the theoretical. The hypothetico-deductive reasoning that characterised the older students synthesised the possible and necessary since it was concerned not only with the pendulum, but with the propositions surrounding the pendulum.

Piaget's developmental, stage-based trajectory then, was based on a specific notion of knowledge. His developmental orientation was towards formal logic of classes, linear measurement, propositions and general structural features of things independent of content. Logic was derived from the co-ordination of action schemes; the roots of this logical thought and concept formation are not found in language alone but rather in the co-ordination of actions (Cocking, 1983).

Piaget and Inhelder's (1964) work on classification and seriation elaborated the details concerning the means by which children organise thought. They used the formal logic definition of class in their analysis. Definition by *intension* specifies the properties shared by members of the class; the definition by *extension* lists the members of the class. Generally speaking, Piaget and Inhelder's work on concepts was concerned with the use of each classification technique and how it reflects the developmental stage in which the child operates. To return to the previous example, in order for children to understand that all daisies are flowers but not all flowers are daisies, there must be adequate reciprocal adjustment between intension (the predicate of a proposition) and extension (specification of the items to which this predicate applies).

In one study, Piaget and Inhelder asked children to reproduce a row of five blue circles interspersed with three red squares. Since the young children only focused on one colour at a time (e.g., *red* or *circle*) they were unable to produce the sequence. The second feature of the study illustrated the errors of intension that the children made. When the sequence was reproduced and children were asked to state whether all or some of the squares were red, Piaget found that the children conflated the words *all* and *some*. They could conclude that some of the squares were red but they did not seem to understand that indeed *all* the squares in the sequence were red. Only after children acquired logical quantification of the predicate did they become capable of understanding class inclusion. This research demonstrated the idea that for Piaget, concepts are external to the individual. Once children reach the developmental stage where they develop the capacity to negotiate the relationship between intension and extension, they are prepared for the formidable task of logical classification.

In terms of the function of language in concept formation, the Piagetian position is that language serves the function of extraction and internalisation of conceptual matter from environment to individual. Language allows verbal exchange and thus the socialisation of action; it permits the internalisation of words and sign systems and most importantly the internalisation of action which moves from the perceptual and motor domains into a representation by means of pictures and mental experiments (Hyde, 1970). What is peculiar about Piaget is his approach to monologues. Unlike Vygotsky and Nelson (see below) who understood monologues as serving a communicative function aiding in the construction and reinforcement of concepts, Piaget viewed this type of speech as egocentric; the child talks but does not pay attention to the talk of his companions. "He also found that children up to roughly seven years communicate imperfectly because of failure to listen to and comprehend information received" (Hyde, 1970, p. 43).

In the same way that mental growth follows a trajectory from the perceptual mishmash of

infancy to the end state of hypothetico-deductive reasoning, language evolves from an egocentric, purposeless activity to a vehicle by which representations take shape in the mind of the mature adult. In his emphasis on internalisation and stress on logical connections among discrete categories, Piaget presupposes that concepts exist "out there", to be assumed by the individual once s/he has reached the stage where appropriate mental mechanisms have formed with which to learn those concepts. While Piaget's thinking about concepts and mental development did take into account social context, his emphasis was on the nature of thought and adaptation inherent in each individual. As illustrated below, some later approaches treated the social context as a more powerful and pivotal force in language and concept formation.

Jerome Bruner

Bruner's body of work on matters related to concepts, learning and education is expansive. Given the purposes of this study, this section focuses exclusively on Bruner's work regarding concept attainment. Bruner et al. (1956) distinguished between concept attainment and concept formation. Concept attainment "refers to the process of finding predictive defining attributes that distinguish exemplars from nonexemplars of the class one seeks to discriminate" (p. 22). Concept formation is merely the initial sorting into groups that occurs prior to the conceptualisation of each group (e.g., sorting mushrooms into poisonous and non-poisonous piles).

Bruner et al. (1956) emphasised the strategies involved in the approach to conceptual problems, how exemplars can be readily recognised and how the newly formed concept is then used as a tool in subsequent tasks. Bruner believed that categorising serves to reduce environmental complexity, to assist in definitional activities and to help us know in advance about appropriate and inappropriate actions. His purpose in studying concept formation was to understand conceptual processes that underlie everyday human activities. The essential point of

Bruner's work at this time was that learning could occur without any accompanying observable behaviour. He thought that it was possible to do something mentally rather than by pure trial-and-error as in the behaviorist tradition that conceived of the mind as a black box that could only be understood in terms of stimulus-response outcomes.

As a starting point, Bruner took the act of finding equivalence among objects since finding equivalence indicates the preliminary ways in which we sift through stimuli. Bruner (1956) identified three kinds of defining response that capture the fullest range of stimuli that we begin to categorise. Affective categories contain those things that evoke a common affective response (e.g., grey, rainy days, a charismatic politician or the smell of the sea). Bruner pointed out that these categories are not amenable to verbal description due to a lack of correspondence between affective and linguistic categories. Functional categories are those that fulfil a specific, concrete task requirement (e.g., *things that will keep water in a bathtub* or *things that will get me to the airport*). Formal categories are constructed when we specify the intrinsic attribute properties required by class members (e.g., the concept of force in physics stands for a class of events having to do with acceleration in the form of pushing, pulling or lifting). Formal categories develop with the capacity of representing and manipulating them symbolically and in highly elaborated cultures, Bruner noted that the drive to create formal categories even without reference to the events for which they stand is strong and unquestionable. Indeed the categories created are strongly rooted in culture. Our history, language, artifacts, religion and science all shape the way that we experience, represent and express phenomena and perceive relatedness.

The questions of information acquisition, information retention and knowledge transformation Bruner used to guide his inquiry revealed the broad scope of his approach which entertains cultural, structural and pragmatic implications. According to Bruner et al. (1956):

We look about and we see people constantly engaged in picking up and using information

> that enables them to make conceptual distinctions on the basis of appropriate defining attributes, doing it in such a way that they seem neither overwhelmed by the complexity of the task nor much endangered by maladaptive slowness or by reckless speed. People learn to distinguish conceptually between daylight color film and indoor color film, between different cuts of meat, between fresh vegetables and stale ones, between policemen and subway guards, between detergent and soap flakes... (p. 51)

Like Piaget, Bruner turned to the logical analysis of group membership in his study of concept attainment, although unlike Piaget, his goal was to understand the nature of concepts and their impact on learning behaviour rather than establishing links with stages of intellectual development. Since the study of concept formation centers on externalising extremely subtle and sudden thought processes, Bruner took into account the fact that the study of concept attainment must examine the nature of the concept, the nature of the instances presented, consequences of categorisation and the nature of the restrictions. It is insufficient to reflect on one's thought during task performance since our moments of understanding, the material of concept attainment, happen so quickly; recognising that we understand is so shocking that it is nearly impossible to understand what happened in the transition from conceptual wilderness to illumination. Bruner considered the process of externalising thinking alongside his consideration of the nature of the concept on which that thinking is focused. This approach to concept attainment meant that Bruner integrated mind and concept in such a way that the respective dimensions were considered and strategy analysis became the ultimate object of study.

In order to study the mental processes underlying concept attainment, Bruner et al. (1956) used a nonfixed solution procedure. They presented participants with a series of concept identification problems in which stimuli were either predominantly exemplar or non-exemplar. Bruner believed that concept exemplars are central to concept formation since "virtually all

effective strategies for attaining concepts depend on the use of some sort of initial focus" (1956, p. 64). Bruner's research on exemplars which foreshadowed Rosch's (1978) later work on prototype theory and demonstrated that participants had no difficulty in indicating exemplars of a class (e.g., in setting a colour wheel to the colour of a typical eating orange). However, Bruner thought that human minds also order concepts in terms of *generic instances*, a representation of the concept in terms of idealised defining attributes. To use the orange example, when asked to describe an orange, Bruner thought that people hold an image of the ideal orange which for one person is the size of a baseball, deep orange with a green stem; for another person the ideal orange may be the size of a softball, a carroty orange without a stem. Bruner then devised geometric expressions of sufficient information arrays which comprise these exemplars. Psychological informational sufficiency in turn depends on the manner and rate at which the individual is using the information. Thus, the person who envisions a softball-sized, carroty-orange orange, will, on a month-long trip through Mexico purchase a large number of oranges to snack on, revise his ideal orange so that it comes to reflect the more tangerine-like oranges there.

Bruner conceived of the individual as an active experimenter and decision-maker who selects and utilises some attributes over others, tests hypotheses based on attribute choices and revises concepts on the basis of validation. For instance, children at first rely on their elders labelling the small furry animal before them *cat*. Once the child is talking, they are are asked to name the animal and are validated either by commendation or correction. Eventually, the child becomes independent in this experimental mode, and validation by external sources becomes intermittent. The validation variable is critical in concept attainment; positive, negative, immediate, frequent and ambiguous validation stir the individual to recall past exemplars, interpret evidence, define patterns and engage in additive and subtractive assembly of instances.

The question of validation immediately prompts consideration of the consequences of

categorisation. Validation implies that individuals seek verification of their thinking; addressing the ways that individuals value the outcomes of their decision making indicates how individuals continue to move through the maze of decision making as they assemble concepts.

> Let us suppose the individual chooses as his second instance one who differs in all respects save one from the previous positive instance. This is a desperate measure in the sense that, should the instance chosen turn out to be negative, it will provide the individual with little or no information. He will not know which one of ones of the many attributes changed made the instance negative. If, however, the instance chosen turns out to be positive, then in one fell swoop the individual will have learned that only the one attribute left unchanged really mattered as far as influence is concerned - a very big yield indeed. (Bruner, 1956, p. 74)

Although he initially refers to the fruit of concept attainment as a sudden, subtle aha! moment, Bruner characterises the process of concept attainment as a protracted process of decision-making, the results of which are weighed and changed depending on feedback. In this sense, individuals construct experience into personal representation.

Katherine Nelson

Nelson's work has evolved roughly through three periods in which she emphasised in turn the role of function, events, and culture. At all times, her analyses have pivoted on the complex relations between language and cognitive development (Tomasello, 2002). Nelson asked what the child brings to language that enabled him/her to know *that* words mean, *how* words mean and *what* words mean (Nelson, 1991). Nelson believed that the very focus on concept *formation* implies an acceptance of the role of learning and environmental determinism and contrasted this approach with cognitivism's closed-system approach to concepts that emphasised mental structure and interaction of those structures. Unlike Piaget who believed that starting around the age of two children operated on objects to place them into groups, Nelson characterises concept

formation as a phenomenon that starts at birth as babies participate in and observe their surroundings.

In the early 1970s, Nelson's work focused largely on the emergence of language in babies and toddlers. Nelson (1973) conducted a longitudinal study of first word acquisition by 18 children between the ages of 1 and 2 years of age to ascertain the means by which children move from one and two word utterances at age one into short sentence construction that characterises the speech of most two year olds. She analysed the first 50 words spoken by the children according to grammatical form, content and semantic structure. She found that children differed fundamentally along two major lines of communication function. Some children generalise and understand words in terms of their referential function. These children use words to name things. Other children understand words for their expressive function and use words to direct the attention or behaviour of others. These two notions of communication function are not mutually exclusive and indeed some children have equal numbers of words falling in both camps. However, there are children who fall at either end of the expressive/communication spectrum which has fuelled an interesting branch of research into the nature of individual differences in language use (for review, see Nelson, 1981).

One of Nelson's most intriguing lines of inquiry centred on function versus perception in guiding concept formation. She argued (1985) that while perceptual attributes played a role in forming concepts, functional characteristics were central to the conception of objects. The place of objects in significant events in the child's life evokes scripts that yield the conception of objects and construction of higher-level categories. For instance, the child develops a park script with which understanding of balls, slides, and swings become associated. Nelson argued that function can be understood in terms of intrinsic characteristics (what something does) or extrinsic characteristics (how the object relates to something else, primarily the people who interact with

it). In terms of the park script, children learn that balls bounce (intrinsic function) and can be thrown (extrinsic function), swings swing (intrinsic function) and carry people through the air (extrinsic function) and that people whoosh down slides and then jump off (extrinsic function).

She found that intrinsic function can be a perceptual feature as well as in the case of the characteristic yapping of small dogs or the distinctive cawing of crows, for instance, since those functions are only associated with animals with that appearance. "Balls are things that can play a specific functional role in a certain type of event. Something that looks like a ball but cannot fit into a 'ball event' is not a proper member of the paradigmatic set of balls" (Nelson, 1985, p. 182). Nelson confirmed the importance of event representations in the representational systems of young children. When children form scripts of routine events, they can find meaning in the actions of others, in the significance of objects and in their own place in the world. Social event knowledge in the form of scripts connects with concepts which create the foundation for language and higher levels of intelligent behaviour and thought (Nelson, 1983). Unlike Piaget, who would argue that the child abstracts some knowledge about the ball based on the actions performed on the ball, Nelson's relational analysis is constitutional; all elements of the ball event co-ordinate to create knowledge not only about the ball, but about the person operating on the ball, the ground, velocity, gravity and all the innumerable bits of information that present themselves in these types of scenarios. Where Piaget would study what the child learned about the ball, Nelson would study the whole event, how it shapes the child's representation of *ball* and how the representation of *ball* changes with each subsequent ball event.

Attention to functional versus perceptual characteristics is significant in the learning of basic, superordinate and subordinate categories. At the same time as Nelson was postulating this line of research, Rosch (1978) had published her theory on cue validity (see below) of those categories. Basic-level categories are the most inclusive; they include objects such as chair, car,

cat, rose. Superordinate categories are one level more abstract; their members share only a few attributes. The superordinate categories correlated with the previous examples would be furniture (chair), vehicles (car), animals (cat), flowers (rose). Subordinate categories are the specific members of the basic-level category objects. For instance, wingback (chair), Ferrari (car), maine coon (cat), floribunda (rose). According to Nelson, basic-level categories (e.g., chair, cat) have a functional core, correlated with perceptual features that are determined by function. Conversely, superordinate categories (e.g., furniture, animals) are defined almost entirely according to function while subordinate categories (e.g., wingback, maine coone) are distinguishable by their perceptual features. The fact that developmental sequences stipulate that basic-level concepts are learned first bolsters Nelson's theory about the centrality of functional attributes in forming concepts and, in turn, gives credence to the idea that concept formation is indeed a contextually-situated process.

In *Narratives from the Crib* (1989) Nelson undertook a collaborative project that focused on the monologues of 2-year-old Emily spoken when she was alone in her crib either at naptime or at night. With the help of Emily's mother who filled in contextual references, the authors studied the transcripts and reflected on the significance of Emily's talk to herself. Through the examination of references to daily events, Nelson and colleagues were able to study the role of noncommunicative monologues in communicative speech, concept formation, cognitive development and language growth.

> Emily's talk to herself in her crib conveys to most listeners a strong sense that she is giving an account of her life, as she understands it at the time, an account that changes over time as her experience in the world changes and expands. (Nelson, 1989, p. 27)

Nelson found four major themes in the transcripts. The first was "what happened" as evidenced by Emily's episodic memory and mastery of grammatical devices demonstrating that

she could indeed distinguish between past and future. The second theme was "what is going to happen" which revealed itself in the repetition of phrases used by Emily's mother and father and her knowledge of routines. The data were analysed for Emily's use of temporal sequences such as *yesterday, after my nap, tomorrow morning* or *and then* which revealed the third type of temporally organised theme which was "what happens" or "what should happen". These cases were marked by the simple present tense and use of *we* and *you* and were used by Emily to reiterate routines like diaper changing. Nelson found a fourth theme regarding sequential organisation, the reciting of stories based on books read to her which later changed to demonstrate that Emily was constructing stories of her own. Until the age of two-and-a-half, topics of food, sleep and doctor visits predominated but after this point, the monologues turned to topics concerned with nursery school, friends and Daddy, coinciding with Emily's entrance to nursery school at 31 months. In the analysis, Nelson uses the idea of event representations and scripts to demonstrate concept formation and conceptual errors. These monologues are fascinating for the study of language development but in terms of concept formation they reveal startling details that as discussed below, help cut through the speculation over developmental ontology.

In one example, Emily's monologue reflects the development of the concept *cocktail party*; in understanding how Emily comes to understand the concept of a cocktail party, the relation between meaning and social context is illustrated. As Emily's mother puts her down for a nap, she is told that her grandmother will come to take care of her after she wakes up. When alone in her crib, Emily says to herself, "Mormor come afternoon. Read my books. So mommy-daddy to cocktail party" (Nelson, 1985, p. 52) The only experience Emily had previously had of 'cocktail party' was that it had been mentioned the previous week when her mother and father first planned and explained the procedure of the day's events. Later, she elaborates on the concept of cocktail party, learns that it involves drinking and creates a fantasy that includes the

idea of a cocktail party. "Tomorrow morning when my wakes up then Daddy [helps] Emmy [washes the dishes.] Morrow morning when my wake up then Daddy [all clean] then put some juice and cups then Emmy have cock-party, then Emmy drinked the cocktail up" (p. 53). Nelson (1985) observed that Emily was being introduced to new concepts and a new understanding of the world through language. In order to learn these terms through verbal explanation, learners must have the cognitive context in order to appropriately map the explanation onto the relational framework. In another example, Emily's father explained the procedures ("what should happen") surrounding a trip to Child World to buy an intercom that they would use to listen to Emily's baby brother. Emily demanded that the story be repeated three times. In this case, where there was no existing context on which the concept of a baby intercom could be mapped, Emily's notion of the intercom is sketchy. In analysing the subsequent monologue, it was apparent that she understands that the intercom is associated with hearing her baby brother cry, that it plugs in and that it is associated with buying diapers at Child World, but fundamentally the structural and functional aspects of the baby intercom concept elude her. The contrast between these two examples highlights the problem of concepts which depend on demonstration and explanation rather than the direct experience that one would derive from objects such a balls or cats whose conceptual identities present themselves without the need at least for demonstration. According to Nelson (1985) "Their place in the semantic hierarchy is not clear. The child's use of such terms draws our attention to the necessity of defining more precisely the difference between knowledge of a thing and the semantics of a word for a thing" (p. 54).

Nelson's work underscores the importance of understanding concept and word as intricately entwined processes that happen within the socio-cultural context. By addressing issues of representation she urges the evaluation of concepts for their structure, content and

relatedness and not simply as a developmental progression but as situational entities whose change pivots on experience.

Eleanor Rosch

Although not a developmental psychologist, Eleanor Rosch has made some of the most important contributions in the study of concepts; her perspectives on concept formation bear significantly on our understanding of the ways that children understand their environments and classify objects. She challenged notions of concepts and categories that had persisted since the Greeks by observing real-world objects such a pieces of furniture and colours and analysing whether specific objects were accurate representation of their groups. Rosch objected to the artificial world of concept-learning experiments characteristic of Vygotskian and Piagetian research, arguing that the settings for concept learning experiments or the models used to represent the setting (e.g., equivalence categories) are inappropriate for understanding natural category formation (Scholnick, 1983).

Rosch argued that it is not concepts that are universal but rather the structure of categories and how those structures are formed (Rosch, 1999, Categorization section). She demonstrated the continuousness of categories; that the boundaries between real-world objects are fuzzy and difficult to delineate due to the amount of overlap among categories. Take for example the concept of a chair. In order to be included in the category *chair*, an object must fulfil the functions of a chair, have the parts of a chair assembled in correct relation to one another to facilitate those functions, have been constructed by some agent with the intent of making a chair, etc. (Hampton & Dubois, 1993). With the establishment of any conceptual boundaries, the difficulty is that they inevitably exclude objects that, despite some exceptional characteristics, would still belong to that group. Consider a dilapidated old chair, made of wood with a seat but no back and only one leg. Still, it can be recognised as a chair if only for the reason that it was

initially designed to be a chair. In the same vein, consider a very large umbrella stand shaped like a dalmatian that a small child uses over the course of a year to perch on at the dinner table. Indeed, it was designed as an umbrella stand but due to the type and consistency of use imbued by the child, it gains the properties of a chair.

To navigate the quagmire of category inclusion, Rosch et al. (1976) formalised levels of abstraction in terms of cue validity, a probabilistic concept.

> The cue validity of an entire category may be defined as the summation of the cue validities for that category of each of the attributes of the category. A category with high cue validity is, by definition, more differentiated from other categories than one of lower cue validity. (Rosch, 1978, p. 30)

Cue validity was used to establish the paradigm of category types (i.e., basic-level, subordinate and superordinate categories). Basic-level objects are at the most inclusive level at which there are attributes common to all or most members of the category. Categories one level more abstract are superordinate categories whose members have only a few attributes in common; categories with lower total cue validity are subordinate categories because they have fewer common attributes.

Separateness can indeed be created by defining boundaries (that inevitably creates inclusionary dilemmas, as illustrated above). However, grounding her work on cue validity in the tradition of Wittgenstein, Rosch established prototype theory. "Categories can be viewed in terms of their clear cases if the perceiver places emphasis on the correlational structure of perceived attributes such that the categories are represented by their most structured portions" (Rosch, 1978, p. 36). Prototypes represent the clearest case of the category, defined by people's judgements of the appropriateness of that representation. In her previous research, Rosch (1974) found that even when subjects disagreed over the boundaries of a category, they overwhelmingly agreed in their judgements of how clear a single case is in representing the group. For instance,

although a group of people would disagree when defining the boundaries of red and pink when shown colour slides of brick red, cherry red, fuschia, vermillion, cerise, amaranth, carnation and magenta, they would in almost every case agree upon a typical example or prototype of red and pink respectively.

At the time Rosch devised prototype theory, interest in context was in its infancy. Prototype theory presumes that there is some internal mechanism where exemplars of categories lie and does not account for the genesis of the exemplar. In her later work, Rosch (1996, 1999) moved to characterising concepts in terms of their intersubjectivity and participatory nature. Rosch (1999) resolved that fundamentally, concepts function not merely to identify objects in terms of prototypicality, but that they participate in situations in innumerable flexible ways. Akin to the avenue of inquiry followed by Bruner and Nelson in the 1970s, Rosch believed that *situations* are central in understanding concepts and their formation. Instead of asking how concepts represent an external world we must take situations as the unit of study so that we can study the ways that categories and category systems emerge in the first place.

Rosch's work on prototypes and boundaries is critical to the field; it reminds us that very little, if anything, can be tidily categorised and of the fluidity among categories. This is an important consideration because establishing guidelines over what concepts are and what they are not offers the opportunity to understand concept formation for all the detail and nuance that it implies. Given Rosch's work, concept formation changes from the sense of extracting pre-determined networks of knowledge from the external world to being a rather untidy process involving intersubjectivity, context, events, participation and change. Instead of wondering whether people *have* concepts we can move to wonder *how* they have concepts and how that concept changes with experience.

L.S. Vygotsky

In *Thought and Language* (1986) Vygotsky put forth his stage-based theory of concept formation. Like Piaget and Bruner, Vygotsky used an experimental method designed to permit investigation of the inner dynamics of the concept formation process. Vygotsky attempted to move away from the method of studying formed concepts that are reproductions of verbal knowledge and instead focused on intellectual processes. In order to elucidate these intellectual processes, Vygotsky argued that obstacles to thinking must be provided so that the only means of problem solving lies in the formation of new concepts.

Like Piaget, Vygotsky believed that human concept formation moves through fixed stages, each of which feature a specific functional use of the concept. Vygotsky (1986) summarised the results of his investigations of the concept formation process conducted with over 300 children, adolescents and adults, some of whom had pathological disturbances of intellectual and linguistic activities.

> The development of the processes that eventually result in concept formation begins in earliest childhood, but the intellectual functions that in a specific combination form the psychological basis of the process of concept formation ripen, take shape, and develop only at puberty. Before that age, we find certain intellectual formations that perform functions similar to those of the genuine concepts to come. With regard to their composition, structure, and operation, these functional equivalents of concepts stand in the same relation to true concepts as the embryo to the fully formed organism. (p. 106)

Vygotsky believed that it is the functional use of the word or sign as a means of focusing attention, selecting distinctive attributes, and analysing and synthesising those attributes that plays the central role in concept formation. Throughout the concept formation process, the ways that words and signs are used vary and thus mental operations vary. According to Vygotsky, it is

only once humans reach adolescence that mental functions are mediated by word or sign. Problem solving thus is performed through the use of language; words are the means of concept formation. For Vygotsky, "real concepts are impossible without words and thinking in concepts does not exist beyond verbal thinking" (p. 107). Thus, in any study of concept formation, the word must be studied as a tool of thought, the embodiment of mental activity and change. Because words are social and cultural artifacts, concept formation must be viewed as a function of the adolescent's social and cultural growth which affects the content as well as the method of his thinking (Vygotsky, 1986). Vygotsky situated human development culturally and linguistically; development is mediated[1] by linguistic and symbolic tools which are acquired through the course of interpersonal communication with adults and more experienced peers (Karpov, 2003). Where Piaget saw human thought developing from the individual to the social (starting from purposeless egocentric speech), Vygotsky takes society as the starting point and observes development as a cultural apprenticeship.

In order to test his concept formation hypotheses, Vygotsky used the method of double stimulation. Two sets of stimuli are presented to the subject. Vygotsky used 22 wooden blocks varying in colour, shape, height and size. There were five colours, six different shapes, two heights (flat and thick) and two sizes, large and small. On the underside of each object there is a nonsense word written which is the name of the object: *lag, bik, mur, cev.* All the tall, large figures are *lag*, *bik* are the flat large figures, *mur* are the tall, small figures and *cev* are the small, flat figures. The examiner picks up one sample block, reads the name and asks the subject to find all the other figures that belong in the same group (e.g., find the *cev*s). Once the subject has created the group, the examiner turns up one of the wrongly selected blocks, shows that it belongs to a different group and encourages the subject to keep trying. The subject gradually

[1] Mediation refers to the use of other humans or symbols in the process of actively modifying the stimulus situation as part of the process of responding to it (Vygtosky, 1978).

gains a sense of the attributes to which the name refers and then is able to separate the blocks based on what is indicated by the word. Every step of his thinking is reflected in the choice he makes over his grouping of the blocks, how he approaches the problem, his response to correction and his arrival at a solution. The examiner witnesses the very process of concept formation as well as the assumption of the new vocabulary as the subject moves from manipulation of the shapes to manipulation of shapes and words as signifier of those shapes. Thus both language and thought processes are elicited in the effort to solve the shape grouping problem and the functional aspect of the word is laid bare.

> Our experimental study proved that it is a functional use of the word, or any other sign, as a means of focusing one's attention, selecting distinctive features and analyzing and synthesizing them, that plays a central role in concept formation. (Vygotsky, 1986, p. 106)

Vygotsky divided the process of concept formation into three rough stages which are further subdivided: syncretic thought, thinking in complexes and thinking in concepts.

Syncretic Thought

Vygotsky used the term *syncretism* to refer to the initial stage of concept formation when the word refers to nothing more than a vague conglomeration of individual objects. Reflecting their egocentrism[2], very young children bring together thoughts and objects based on the strength of some chance impression (i.e., on the basis of random perceptual factors such as the proximity of some objects to others or because the child happens at the moment to feel they belong together). Vygotsky interprets these randomly formed *syncretic heaps* in terms of the child's effort to compensate for a lack of objective relations with an overabundance of subjective relations that are mistaken for real bonds. The syncretic heap united under one word meaning reflects the coincidence of the child's subjective grouping with the words of adults.

[2] Egocentrism in the Vygotskian scheme is associated with the nature of conceptual thought, specifically, the child's restriction to his/her own sensory impressions. In constrast, Piaget used the term egocentrism to describe the private talk of children which he thought to be autistic and purposeless.

Consequently, very young children of two or three years have (usually concrete) words that share some aspect of meaning with the same adult words which suffices to ensure mutual understanding. For instance, where a child refers to *ball* as having the specific meaning of the purple fuzzy ball that he likes to play with in the garden, the child's parent has a fuller concept of ball which includes all types, sizes, shapes of balls with differing degrees of bounciness. For the purpose of mutual understanding, the word *ball* holds a shared meaning. While both child and parent use *ball*, each have fundamentally different concepts of the object.

Vygotsky identifies three stages in the development of syncretic thought. In trial-and-error groupings, groups are created at random as each object is added or taken away based on a guess or trial and in response to feedback. The next stage is based on the organisation of the child's visual field; the group is formed based on the object's appearance in a particular space or time. The final stage occurs when the child makes judgements based on previously formed groupings. As the child attempts to give meaning to a new word, he reorganises the group based on what he has done in the two previous stages. The operation becomes a more elaborate two-step process, although the groupings are still made using the same subjective assembling of heaps.

Thinking in Complexes

Children reach the second level of conceptual thinking called *thinking in complexes* when they bring objects and phenomena together not only on the basis of subjective impressions "but also by bonds actually existing between those objects" (Vygotsky, 1986, p. 112). At the complex stage, children overcome their egocentrism and personal impressions as criteria for groupings cease to underpin conceptualisation. Instead, the bonds between the components of a complex are concrete, factual and discovered through direct experience. The main difference between a concept and a complex is that the bonds lack logical unity; the bonds can indeed be infinite and differ widely. While the concept groups objects according to one attribute, the bonds relating the

objects within a complex may be as diverse as the objects themselves. Fundamentally, complexes are formed according to rules that differ from the rules of real concept formation; again, understanding between adults and children can be shared based on word representations but on closer inspection these understandings diverge since they are derived in dissimilar fashions. For example, both mother and 4-year-old daughter agree that washing clothes is important. The mother agrees: washing clothes is important because clothes need to get clean. The daughter agrees that washing clothes is important because they need to go in the dryer.

Vygotsky named five basic types of complexes which emerge in succession in the development of conceptual processes. The *associative type* is based on any type of bond the child notices between the sample object and the other blocks. The sample object forms the nucleus of the group and any number of other blocks will be added based on the fact that they share some attribute such as shape, size, colour or thickness. However, Vygotsky found that the bond between the nucleus and other objects may not even be a shared attribute; they may be grouped based on similarity, contrast or spatial proximity.

The second type of complex is called *collections*. In this grouping technique, the child picks out objects that differ from the sample according to one characteristic such as colour, form or size. For example, a group would be made based on the fact that the objects *all have different colours* or *all have different shapes*. Thus, the child associates by contrast rather than similarity. However, since this type of thinking combines with the associative type, Vygotsky found that collections were based on mixed principles. The child fails to adhere throughout the process to one single principle of categorisation so that objects are compiled for their "their participation in the same practical operation - of their functional cooperation" (p. 115).

The *chain complex* is the consecutive joining of individual links into a chain where meaning is carried from link to link, changing with every few links as the child notices additional

objects he would like to add to the chain. For example, the child may start with lining up three yellow triangles; as his attention is grabbed by a blue triangle, he adds it based on 'triangle' as the shared attribute. He may then add a blue circle, switching to 'blue' as the shared attribute. The original sample has no central significance, instead remaining one of a series of equivalent and functionally equal links. Vygotsky believed the chain complex to be the purest form of thinking in complexes due to the total absence of a unifying trait binding the objects together. The child fuses the general and the particular, the complex and its elements into a psychic amalgam.

The *diffuse complex* is a derivative of the chain complex and is marked by "the fluidity of the very attribute that unites its single attributes" (p. 117). The bonds between objects can indeed be endless due to the fact that their shared attributes are indefinite, nebulous, impressionistic and therefore limitless. For example, the child would pick out trapezoids as well as triangles because trapezoids look like triangles with their tops cut off. Trapezoids would lead to squares since they both have four sides and squares would lead to hexagons perhaps because they both have pointy bits. The diffuse complex grows and grows since the inclusionary criteria, based on unreal and unstable attributes continue to expand.

The fifth and final type of complex is called the pseudoconcept and holds an important place in Vygotsky's stages of concept formation since it is the bridge between thinking in complexes and conceptual thought. Pseudoconcepts are complexes disguised as concepts whose causal-dynamic roots reveal their fundamentally different genesis.

> For instance, when the sample is a yellow triangle and the child picks out all the triangles in the experimental material, he could have been guided by the general idea or concept of a triangle. Experimental analysis shows, however, that in reality the child is guided by the concrete, visible likeness and has formed only an associative complex limited to a certain kind of perceptual bond. Although the results are identical, the process by which they are

reached is not at all the same as in conceptual thinking. (Vygotsky, 1986, p. 119)

It is in the realm of the pseudoconcept that Vygotsky revealed the cultural significance of words and their meanings. Complexes corresponding to word meanings are not spontaneously developed by the child. Like Nelson, Vygotsky perceived language and conceptual development as pivoting on the reception of word meanings and their associations with objects and events as they function in the world of adults. The child does not create his own speech; the names, symbols and gestures are 'found' by him in ready-made generalisations through conversation with adults and more-knowledgeable peers. The name given to an object at the moment of interaction between adult and child conceals a cultural and experiential history for the adult to which the child is not privy. For instance, on seeing a cat sitting at his desk on which there are paints and paintbrushes, the mother asks her 2-year-old son "Is the cat going to paint?" The child answers that the cat will not paint because he has no hands. The child answers based on a specific concept of using hands to paint, hands that the cat clearly does not have. The child's concept of the word thus emerges from that setting where word and meaning first intersect; when the child refers back to the word, he is mindful of the particular setting in which he first learned the term but has yet to develop the knowledge and experience which will later yield a fuller and more accurate concept. It is for this reason that Vygotsky referred to pseudoconcepts as carrying the germinating seed of the concept. The child operates with the concept carrying a specific meaning before he is fully aware of the nature of the operations and the implication of the larger concept. It is in this sense that the adult acts as mediator, stimulating the child to higher psychological functions by providing words and initial concepts and engaging in discussion and interpretation to help the child move through the conceptual hierarchy.

Vygotsky addressed the key idea of *participation*, a characteristic of complex thinking. Participation refers to "the relation of partial identity of close interdependence established by

primitive thought between two objects or phenomena that actually have neither contiguity nor any other recognizable connection" (p. 128). Children thinking in pseudoconcepts create bonds that are inconsistent in terms of the logic of adults. Where the adult thinks in concepts, the child's framework is purely situational where words are tied to the concrete. As in the painting cat example above, although the little boy believes cats do not paint for their lack of hands, the mother is aware of the multitude of other reasons that cats do not paint, not least of which that cats are unaware of the activity of painting and see no reason to pick up a paintbrush!

Vygotsky used the example of Levy-Bruhl's experience with the Bororo people who believe themselves to be red parrots as a statement of identity. As primitive people who think in complexes, their word for parrot is a word for a complex that includes both the birds and themselves; the word does not function as signifier of the concept but as a name for a family of objects that factually belong together. Vygotsky did not elaborate on the point which is troublesome because from the standpoint of concept formation, it is critical to know how the Bororo came to name themselves after red parrots which would indicate the finer nuances of language and identification that surround the naming process. As Vygotsky pointed out, thinking in complexes is characterised by the notion that different meanings intersect at shared terminology; the Bororo clearly perceive some shared attributes with red parrots but whether they identify themselves as being the *same* as red parrots or whether this identification is based on linguistic idiosyncrasy is unclear.[3]

Conceptual Thinking

Thinking in complexes is to unify scattered impressions and organise them into groups. Thinking in concepts requires the simultaneous unification (generalisation) and abstraction of

[3] Jonathan Smith (1972) in his study of the role of animal imagery in religion addressed the psychological problem of the Bororo identifying themselves as red parrots. Karl von den Steinen (1887 - 1888) studied the Bororo and found that they refer to becoming red parrots in the afterlife. "They speak of themselves as being red parrots in the present as a caterpillar says he is a butterfly" (p. 393). The Bororo also indicate that the members of other tribes become other species of bird in the afterlife (e.g., white men become white herons). For the Bororo, human shape is transitory, midway between fish and birds.

elements. Vygotsky (1986) determined that the first step towards abstraction was made when children grouped maximally similar objects (e.g., matching objects that were round *and* flat or small *and* round). Since none of the objects had exact matches, it was apparent that the subjects were paying greater attention to some attributes than others. From this point, conceptualisation emerges based on specific attributes while others are disregarded. "An object no longer enters a complex *in toto*, with all its attributes -- some are denied admission; if the object is impoverished thereby, the attributes that caused its inclusion in the complex acquire a sharper relief in the child's thinking" (p. 136).

The second step towards abstraction occurs when subjects move from grouping based on maximum similarity to grouping on the basis of a single attribute. Potential concepts are the result of isolating abstractions and appear very early in childhood. Vygotsky points out that even hens can be trained to distinguish attributes of a series of objects such as colour or shape.

The move to true conceptual thinking relies on the functional use of the word which develops in adolescence, a period of developmental crisis and transition. Adolescents will use concepts correctly in concrete situations but find it difficult to express their thinking in words; Vygotsky pointed to the often narrow definitions given by adolescents as evidence of this transition. Even more difficult is the task of defining a concept when it is rooted in an alternate situation from where it was first learned. Once concepts must be defined on the strictly abstract plane, Vygotsky found that the adolescent subject turned to simply enumerating the objects to which the concept applied. Thus, the adolescent functions with a conceptual name but defines it in terms of a complex. Oscillating between concrete and abstract, between complex and concept, from general to particular is the crisis of adolescent thinking. It is only once individuals reach the end of adolescence that they exist primarily in the realm of abstract, conceptual thought, where they become capable of the simultaneous abstraction and generalisation necessary for concept

formation.

Apart from his studies of concept formation, Vygotsky was concerned with the nature of scientific and spontaneous concepts. Spontaneous concepts are those unsystematic concepts that the child learns through everyday interaction (e.g., chair, car, swing, shopping). Conversely, scientific concepts involve systematic learning for which verbal definitions play a primary role. According to Vygotsky, scientific concepts develop earlier than spontaneous concepts (i.e., can be verbally defined) because they have the benefit of systematic instruction and cooperation between teacher and student. Scientific concepts are excessively abstract and detached from reality, but since they are learned and used with deliberation they enjoy greater ease of development. Vygotsky (1986) gave the following example to illustrate the point:

> When asked to define the concept 'brother', a student turns out to be more confused than when asked to define Archimedean law. The understanding of *brother* is deeply rooted in the child's experience and passes a number of stages before arriving at the definition made in conceptual form. (p. 158)

Interestingly, Vygotsky pointed out that direct teaching of concepts is fruitless, resulting in "parrotlike repetition of words by the child, simulating a knowledge of the corresponding concepts but actually covering up a vacuum" (p. 150). Therefore, it is not words that children have trouble understanding, it is the concept behind the word; when the concept is "ready" the word is almost always at hand.

On this topic, Vygotsky was critical of Piaget who argued that development occurs as a result of the antagonism between spontaneous and nonspontaneous concepts and more specifically between development and learning. Vygotsky thought that spontaneous and scientific concepts, learning and development are closely entwined, constantly influencing one another in a unitary process.

The concept formation literature does not address the formation of linguistic concepts. The concept formation work concerned with words and word meanings focuses on semantic structure and the study of representation (i.e., the ways that words represent objects and phenomena) rather than the ways that children develop explicit understandings and definitions of words or morphs as phenomena unto themselves. This study is a preliminary foray into linguistic concept formation and attempts to incorporate data on how students come to understand word structure and its use. From an educational standpoint, knowing how people learn about prefixes has important ramifications for teaching, especially in later elementary grades when morphology instruction begins. Knowing how context and experience functions in concept formation of Latin prefixes is indeed a unique approach and may offer a significant perspective on theories of concept formation as well as their instructional applications.

Method

An attempt to study concept formation is an attempt to understand thinking; to understand how people make connections among phenomena and how they settle on a definition or even rough idea of the nature of those phenomena. Since concepts are so personal and context-dependent, case-study methodology was used so that a small number of participants could be dynamically assessed. The resulting sessions were transcribed and then analysed thematically to elucidate both the patterns and anomalies present in the participants' performance.

Participants

The students with learning disabilities (LDs) who participated in this study were drawn from a school for children with LDs in the Lower Mainland. The school has stringent admissions criteria that requires the diagnosis of specific academic difficulty and specific professional recommendation of a multisensory, sequential, phonetic intervention approach. The specific admission criteria for the school (drawn from the Admissions page on school website) are listed below:

Admissions Criteria:
Recognizing that there are a variety of learning disabilities, a clear understanding of the student who will best benefit from the Kenneth Gordon Program is essential. All students must meet the following admission guidelines:

* A recent (within the past 2 years) psycho-educational assessment which indicates specific learning disabilities in attaining the skills of reading, writing, spelling and math commensurate with their intellectual abilities and for whom a sequential, multi-sensory phonetic approach is indicated.

* Meets the Ministry guidelines for the determination of learning disabilities reflecting a 2 year academic delay in relation to his/her intellectual potential and that is reflected in their daily work samples.

* The student must have average to superior intelligence.

* The student must have one full year of regular school experience prior to application.

* Student is between 7 and 12 years old.

* Student does not have a primary behavioral, emotional/social, physical or sensorial need.

* All students have English as their first language or are fluent so as not to be confused by phonological expectations of the program.

I initially approached the principal who in turn agreed to send out a form requesting participation of dyslexic students aged 10 - 13 years. Nine parents responded in agreement, providing phone numbers so that I could contact them to introduce myself and answer any questions that they may have had. All nine parents were contacted successfully and we engaged in conversations that lasted anywhere from five minutes to twenty minutes. I assured them that they could contact me at any time if they had further questions and that I would send home with their child informed consent forms that they were to sign and return within the week. All nine parents returned the informed consent forms, signed and dated. Of the nine participants who responded, eight were assessed (one did not participate due to illness).

The performance of three participants is presented in this paper. The students were chosen for maximal contrast in personality and concept formation styles.

At the time of data collection, Adam was twelve years old, in grade 7. Although quiet, Adam was friendly and talkative, enjoyed conversation and humour and demonstrated systematic thinking about the activities. Through the course of my initial phone contact with Adam's mother, she assured me that he would enjoy participating in the study and would probably have a lot of questions to ask me which was indeed the case. He was confident and curious, was at ease when requesting information or clarification and overall had a very relaxed, calm manner. English was his first language, although he also spoke French in the home since his mother's side

of the family were from Quebec.

John was 10 years of age and in grade 5. John was a small, delicate child who was talkative, but scattered, vague at times in his language use and unsystematic in his method of analysis. On the reply form, John's mother noted that he had been designated gifted/learning disabled in his psychoeducational assessment, but commented that they were still trying to figure out what that meant in terms of differentiating him from his peers. John oscillated between quiet contemplation and chatty enthusiasm when he came across interesting images or had flashes of insight. Although he was hard to follow most of the time, John's creative and quirky responses were immensely enjoyable and assessing him was a unique experience.

Cole was 10 years of age and in the same grade 5 class as John. Cole had a twin brother in the same class. I spoke with Cole's mother for about 20 minutes when I phoned as she was intrigued by the study and was curious about the theoretical underpinnings. She informed me that both brothers learned to speak very late, at approximately age four. They had invested a significant sum of money in speech therapy and remediation for the twins' learning disabilities and his mother was extremely eager to read this study so that she might learn something new about her son's academic struggles. At the beginning of the testing, Cole was shy and nervous and spoke very little, but within half an hour we became comfortable with one another and Cole began to smile and laugh. He was a pleasure to assess as he worked diligently but was also candid about his need to take a break or in informing me that he was getting tired.

Dynamic Assessment

Dynamic assessment is based on Vygotsky's theoretical Zone of Proximal Development (ZPD). Vygotsky (1978) believed that two developmental levels must be ascertained to gain a true indication of mental development. The actual developmental level was defined as "the level of development of a child's mental function that has been established as a result of certain already

completed developmental cycles" (p. 84). Actual developmental level was ascertained through standardised tests that attempted to apprehend what the child already knows or has already learned; it characterises mental development in terms of what the child can do independently. However, Vygotsky believed that potential developmental level, that is, understanding what children can do with the help/collaboration with adults or more-knowledgeable peers may be more indicative of the child's cognitive development. The ZPD was an expression of the distance between actual developmental level and potential developmental level; it defines maturing functions, "functions that will mature tomorrow but are currently in an embryonic state" (p. 86). The ZPD permits exploration of mental capacities that are in a state of growth and change; of those mental capacities that are in a state of formation. What the individual is able to do one day with mediation, he or she is able to do tomorrow alone (Poehner & Lantolf, 2005).

Dynamic assessment is an approach to understanding individual differences by imbedding intervention within the assessment procedure and eliciting responses from the learner; the focus of dynamic assessment is on the processes rather than the products of learning (Lidz & Gindis, 2003). Dynamic assessment is an attempt to capture a student's movement through the ZPD; it is dynamic because it aims to stimulate change so that growth (i.e., ripening functions can be observed). As the dynamic assessment moves the child through the ZPD, the child is prompted to examine mistakes and elaborate on or extend current thinking. Due to the focus on process, dynamic assessment enables a qualitative examination of student performance and reveals differences among students that may be undetectable using conventional standardised tests. For this reason, dynamic assessment is a useful tool in understanding concept formation; in fathoming not simply whether a student understands a concept but how they arrive at the understanding and construction of that concept. The dynamic assessment conducted with the three participants in this study is an attempt to understand all the qualitative nuances, patterns and anomalies

present in learning Latin prefixes and is an initial step towards establishing whether a dyslexia diagnosis implies unity in thinking about morphology at the level of concepts.

Materials

The initial design incorporated Latin prefixes, roots and suffixes in a six stage sequence of assessment materials; of the three participants, only Adam completed the entire assessment. John and Cole became extremely tired after the fourth stage and asked to stop. Therefore, this report has been restricted to the data presented in the first four stages and constitutes a study of concept formation of Latin prefixes.

Stage One: Colours

The global concepts of combination and abstraction were taught using six coloured transparencies (red, blue, pink, green, purple, yellow). These two concepts were important to teach first because they capture the idea of morphological manipulation, an important preliminary concept to grasp in order to make sense of Latin prefixes. I first explained to participants that they would be learning two new words useful in understanding Latin prefixes. I asked whether they knew what I meant by Latin and explained that it is an old language that nobody speaks anymore but which a large number of English words are based on.

Once participants understood this aspect of the dynamic assessment I told them that we would first work with the word *combination* and asked if they were familiar with the idea of combination or combining to which each student responded with a definition. Before the participants I arrayed the coloured transparencies in two rows and asked them to name each colour. Then I asked them to combine two transparencies and name the new colour. This was repeated three times and was meant to help participants understand the idea of putting parts together to create a new object with a meaning that differed from that of the components.

I then asked the participants if they knew the word *abstraction*. Regardless of whether

they had or had not heard the word (Note: I avoided giving students explicit definitions in order to adhere to Gal'perin's (2000) idea that provision of definitions is not conducive to conceptually-based generalisation and understanding phenomena for their essential attributes), I presented the coloured transparencies in a fan before them and asked them "to abstract the red". Once participants had drawn the red transparency from the fan, they were asked to place it on the table and again place differently-coloured transparencies on top of the red and name the new colour. Once students had completed both the combination and abstraction portions of the exercise they were asked to define each term and told to remember what we had done in this activity since it would be useful later in the assessment.

Stage Two: Compound Words

I asked participants if they knew what compound words were and explained that we were going to create compound words that reflected objects in pictures I would show them. I placed the array of word/picture cards (Appendix D) in random order on the table: bed, head, cup, cake, cat, fish, ear, ring, lady, bug, bag, pipe. Each word card had the picture of the object as well as the word at the top of the card. Participants were then shown a picture that represented a compound word (but did not have the compound word written on the card): catfish, cupcake, earring, bagpipe, ladybug. Participants had to combine the word/picture cards to correspond with the compound word picture cards. The *bedhead* picture card was left blank and was presented at the end so that by a process of elimination students matched *bed* and *head* and consequently had to summon the idea of *bedhead* in order to describe it.

The compound word pictures were taken away and the word/picture cards put back into a pile. Participants were asked to abstract the word *bed* from the group and were given new pictures to match with *bed*: sheet, water, time, rock, flower, knob, room. Participants had to do two things. First, they had to decide on the correct order of the words (e.g., bedroom vs.

roombed, bedflower vs. flowerbed). Second, they had to provide a definition of the new word.

Stage Three: Number Prefixes - Uni, Bi, Tri

I placed in front of the participants a series of fifteen word cards, each of which showed words with the prefixes *uni-* (unicorn, uniform, unison, unicellular, unicycle), *bi-* (bicolour, bicycle, binoculars, biped, bisect) or *tri-* (tricolour, triangle, triceratops, tripod, tricycle). These words were chosen carefully for a number of reasons. First, I included words that were both familiar and unfamiliar; words that participants were likely to have learned through day-to-day interaction (such a tricycle, bicycle, triangle or unicorn) and words that were likely unfamiliar (such as unicellular, bisect or biped). By including both familiar and unfamiliar words, I could gather data pertaining to deductive reasoning, use of prefix patterns in meaning analysis and theoretically, empirically investigate Vygotsky's construct of spontaneous and scientific concepts (Vygotsky, 1986). Second, these words were chosen for the fact that they had both Latin and non-Latin roots, important again to examine deductive reasoning and morphological analysis. Finally, these words were chosen so that the prefix concept formation process was complicated by common prefixes as well as common roots (bicycle/tricycle/unicycle or tricolour/bicolour). Participants were simply asked to organise them into three groups.

Once the participants had correctly grouped the 15 words according to their prefixes, they were given a stack of pictures (Appendix E) and asked to match the pictures with their corresponding words. Once all the pictures and words had been matched, participants were given a worksheet (See Appendix F) consisting of analogy questions designed to test the means by which students applied their knowledge of prefixes pertaining to number. The worksheet illustrated how participants identified prefix meanings and extrapolated on those meanings using information on the other prefixes in order to answer the question (e.g., If a triceratops has three horns, a uniceratops has _____ horn).

Stage Four: Latin Prefixes

The table below lists the Latin prefixes and their English meanings.

Table 1

Latin Prefixes and Their English Meanings

in-	in, on, into, towards, not
dis-/de-	apart, away, not
ex-	out, forth, from, out of
ac-, ad-, at-, as-, ap-, am-, an- , ar-, ag-, af- (abbreviated as ac-/ad-/at-)	to, towards, at
co-/con-/com-	with, together
super-/supra-	above, down
sub-	below

Participants were shown six prefix groups; each group consisted of three pictures illustrating a Latin prefix. For example, the ex- group contained a picture of an orca jumping out of a pool, a lady taking a cookie out of a jar and a caterpillar emerging from a cocoon. Participants were then given a stack of six picture cards and asked simply to match the picture cards with the group of pictures that had the same meaning. For the ex- picture group, participants had to match an image of a geyser. The prefix groups and their corresponding pictures are listed in Appendix G; the highlighted pictures are the ones participants were asked to match to their corresponding groups.

Once participants had correctly matched the picture cards to their groups, they were asked to match the prefixes to their appropriate group. Then they were given cue cards on which each Latin prefix was written and asked to write a definition of each prefix. Definition-writing was included for two reasons: so that participants had the opportunity to create definitions and

thus demonstrate their understanding of the prefix concepts given a worksheet based on the Latin prefixes presented in the exercise and so they had a tool to aid them in the subsequent stages of the assessment, should they have chosen to continue.

Participants were then given the Stage Four worksheet (see Appendix H) which was comprised of two parts. In the first part, participants had to use their knowledge of Latin prefixes to create nonwords that reflected characteristics specified in the questions (e.g., I spilled cranberry juice all over my shirt! I need to _____ my shirt).

In the second half of the worksheet, participants had to circle the correct prefix-based answer (answer choices are in bold print) (e.g., Working in a group and **co-operating / disoperating** can make the work go faster).

Procedure

Dynamic assessment is a theory-driven approach and as such implies its own set of procedural guidelines. Vygotsky (1986) believed that individuals must be prompted to overcome mental obstacles; it is only in solving a problem that necessitates the formation of a new concept that true concept formation can be observed. Due to this stipulation and because concepts are born of action rather than through theoretical process (Zaporozhets, 2003), each activity was designed with mental hurdles so that students had to actively engage in problem solving in order to derive a concept of Latin prefixes. These hurdles were either inherently a part of the activity or I supplied them at critical junctures so that participants had to pause to answer questions, explain their rationale (and in doing so stumble upon any errors), suggest alternatives and consider new information. In the tradition of Gal-perin's Systemic-Theoretical Instruction (Arievitch & Stetsenko, 2000), the essential direction of dynamic assessment for this project was to help participants discover the means to engage in conceptually-based generalisation of essential relationships between words with Latin prefixes and the concrete objects/phenomena to

which they referred. My purpose was not simply to get the participants to know prefix facts. The goal was to help them develop an analytical technique whereby they could learn Latin prefix concepts and understand their practical derivations and consequent applications. In the Vygotskian tradition, the aim was to affect development; not simply to take on more knowledge, akin to filling a bathtub with water, but to change perceptions, methods of analysis and conceptualisations of words and word structures.

> In systemic-theoretical instruction, immediate judgement by visual characteristic was replaced by the analytical procedure in which children learned to discriminate among different properties of objects and transform a given property into multitudes by using certain measures. (Arievitch & Stetsenko, 2000, p. 81)

Participants were compelled to move beyond observation of discrete perceptual elements towards abstraction and ultimately into the realm of the concept.

Dynamic assessment is largely dependent on the skill of the assessor to understand the theoretical underpinnings and practical applications of the methodology. There were no pre-existing questions or probes because that would defeat the purpose of the dynamic assessment which primarily is to assess individual concept formation whilst stimulating change (i.e., movement through the ZPD). Having conducted standardised tests as well as informal reading assessments that function along the lines of a dynamic assessment, I equipped myself for the testing by sketching out rough conceptual guidelines for myself. These conceptual guidelines were made clearer due to the fact that I myself had been dynamically assessed on two prior occasions so I was able to understand the process from both perspectives. These guidelines were meant to remind me of the feel of the assessment and aid in the decision-making process during the assessment when participants gave surprising or confusing answers. They are listed below:

a) Above all, elicit as much conversation as possible

b) Ask open-ended questions such as "What made you think of that?" or "Why is that answer correct?" or "Can you explain further?"

c) Provide hints in the the form of supplemental pieces of information that do not give clues to the answer, but clues to means of solving the problem.

d) Allow for lengthy pauses.

e) Be mindful of the fact that you are examining process, not outcome. The right answer does not matter; understanding the process is most important

f) Help participants get in touch with the conceptual mechanism behind prefixes.

g) When instruction is made into a game where remembering is not specially required, he or she was able to remember it very well (Zaporozhets, 2003).

h) Remember *bo* (from the first dynamic assessment session I experienced where I formed shape concepts, one of which was called 'bo').

Participants were informed that the testing would take up to two hours but would likely be finished after an hour and a half. I assured participants that that they could stop at any time if they were uncomfortable or felt tired.

Each session was recorded by digital video. At the end of each session, I made preliminary notes with my feelings, impressions and questions that immediately struck me as the participant left the room. These preliminary notes offered details that would later remind me of specific scenarios and interactions that made me pause for thought initially.

Once data collection at the school was completed, I downloaded the tape data onto a hard drive so it could be opened in iMovie and I could scan the assessment sessions with ease. I watched all eight of the sessions in their entirety and made rough notes of interest to return to on later analysis of each session. On the second watching, I began transcribing specific excerpts of conversation that comprised significant indicators of concept formation processes. It was at this

point that I consulted with Dr. Neufeld and decided to analyse three of the students who were maximally different to gain perspective on how varied the concept formation process may indeed be. I then transcribed the full sessions for Adam, John and Cole for both conversational and gesticulatory features which resulted in watching each session approximately three subsequent times.

Once transcription was complete, I met with Dr. Neufeld once again and through our discussion, approximately ten themes emerged that from the data which captured the concept formation process. Upon further private examination, I found that the ten themes coalesced into five themes that effectively captured all the patterns and idiosyncrasies that characterised concept formation of Latin prefixes for the three participants.

Each theme was identified and described in terms of features, examples and feelings emoted. Each theme was then designated a colour code (e.g., red for Language Use) using coloured felt-tip pens and the transcript of each session was read over until the majority of the conversation was divided into excerpts and identified with the colour denoting the particular theme for which it provided evidence. In cases where one excerpt supported two or more themes, they were circled with two colours and analysed accordingly.

Results

Language Use

Since language is the primary vehicle by which we understand thinking and thus concepts, patterns of language use are a critical starting point in an analysis of the formation of those concepts. Changes in terminology, hesitations, fillers (such as kind of, sort of, ummmm) repeated phrases or words, gestures, supplemental information and anecdotes are all useful sources of information in understanding the processes behind concept formation. Data were analysed for features of language use such as production and manipulation of vocabulary, word patterns, error correction, specificity of vocabulary, requests for help and response to the help provided. In short, the study of language use permits us not only to see whether students got the right answer but more importantly, how they are using language as a means of capturing and expressing their thought processes in forming a concept of Latin prefixes.

The three participants varied significantly in the ways that they used language to provide descriptions, express confusion, connect thoughts, recall information and most importantly form concepts. Vygotsky thought that language use and concept formation were contiguous processes. "Thought is not merely expressed in words; it comes into existence through them. Every thought tends to connect something with something else, to establish a relation between things" (Vygotsky, 1986, p. 218). The first two participants, Adam and John were both talkative, yet used language in strikingly different ways to conceptualise Latin prefixes. The third participant Cole, spoke relatively little during the testing and as a result, yielded negligible data on the topic of language use. Overall, each participant had a unique way of using language to construct and revise concepts; in the end, each participant was successful at all the activities but the amount and type of assistance they required, the language they used to express relationships and the way they used words as a means of forming and expressing linguistic concepts varied dramatically.

Of the three participants, Adam demonstrated the greatest verbosity. He easily described his thought processes, requested clarification, rephrased questions, volunteered anecdotes and supplemental information and revised conceptual categories in response to new information. Adam abstracted the greatest number of attributes from the picture groups in Stage Four and used word repetition as a means of forming and expressing the concept. Adam initially matched the picture of the pool diver with sub- and declared that "they all have water in them". When I prompted him to analyse the picture differently, he manipulated the idea of water in relation to the cave.

> ST: So you've analysed this according to the fact that all of them have water in them. So again, let's look at a different aspect of this.
> Adam: OH! There's water in the cave.
> ST: But you're still using *water* right?
> Adam: Yeah...

When I advised Adam to disregard the water idea he immediately directed his reasoning towards the concept of a cave to observe how each picture reflected the cave concept.

> ST: So let's look at it a bit differently. Forget the water idea, which is valid, which is true.
> Adam: So this is kind of like a cave (points to the rock formation in the scuba diver picture) and this is like a cave for the lemons.
> ST: So you're saying that this belongs in this group? (cave = sub-)
> Adam: Yep.
> ST: So now we have to figure out why
> Adam: because he's swimming by - it kind of looks like a cave right there, like the entrance to the cave and this looks like a part you can get from the cave (iceberg) and like, this glass of water, it's surrounding the lemons so it's kind of like a cave.

In an effort to help Adam to understand the sub- group as a relational concept wherein objects are related to their surroundings in terms of under-ness, I further prompted Adam to examine the relationship of the objects.

> ST: So where is the diver in relation to the water?

Adam: Ummm, under it.
ST: Right (point to iceberg)
Adam: It's under it
ST: What's under what?
Adam: It looks like a rock with water that's under, like, snow.
ST: Ok, another way to look at it is that part of the iceberg is under the water.
Adam: Oh! That's an iceberg?
ST: So what about the cave? So if you're using this idea of *under*, how does it work for the cave, then?
Adam: The cave is like, underground
ST: Right, perfect.

In another example, Adam talks through whether the chain picture (correctly) matches the group he chose:

Adam: (says to himself, "chain")
Adam: Is this like, a chain breaking? I think this would go here... because breaking this apart (velcro) and the egg breaking open.
ST: how does sweeping the dirt fit into that?
Adam: 'Cause it could have been like something that broke
ST: What might have broken?
Adam: A dusty old pot?

Adam uses *breaking* as representation of the dis-/de- group. Although there is no pot evident in the picture and only the dust, the concept of breaking has been abstracted from the picture series and is used as the analytical pivot with which to inductively reason the meaning of the final picture.

The interesting point in both of the above examples is that Adam used one word to represent the abstracted concept. Using the word as signifier, Adam not only interpreted the subsequent pictures in terms of that concept, but actually structures the concept in terms of that word to demonstrate group membership -- as though the explanation containing the word as placeholder for the concept is sufficient grounds for group membership. As long as Adam could create an explanation that contained some variant of the word *break* or the word *cave* he was able

to justify the reasoning behind his decision to match the pool diver with sub- or breaking chain with dis-/de-.

A second example reveals how the word becomes the point on which meaning and conceptualisation converge. Adam attempted to uncover the concept of in-, a prefix that incorporates two meaning categories (in- can mean in, on, on, into or toward as well as not, to indicate opposition). Both meanings for the picture grouping of in- were included so that participants had to negotiate the contradictory meanings inherent in this prefix.

> Adam: (matches cave with in-) This would go here because the mouth is like a cave and he looks into the mouth which is kind of like a cave so he's basically exploring (gestures with air quotes) and this boy could be like, looking for bugs and those bugs could be hiding in a little cave.

In order for Adam to know the concept presented in the pictures, he had to do three things. First, he had to examine each picture and abstract from it the pertinent attribute. Second, he had to assemble the meaning conveyed by each picture to judge whether the attribute is indeed common to all pictures. Third, he had to summarise the abstracted meaning of the picture groups in order to label it. Where the concept is not revealed without knowledge of the prefix, meaning is oblique and can only be discovered once the participant is taught that one prefix can connote two meanings. In the first example using sub- and dis-/de-, where the meaning was consistent, Adam was able to move through these stages quickly and label the concept accordingly (e.g., break or cave). Again, Adam established the word *cave* to represent the concept but in this case, created a narrative in which he included the representational word each time he described a picture and integrated it into the concept. When the concept became even more difficult to ascertain, it is easy to see this process breaking down.

> Adam: (matches stair climber with ac-/ad-/at-) This building looks like a museum and this girl's in a museum and um, she could be seeing this guy so he could give her a box with some rope on it or she could be um, walking up here so that she doesn't have to cross traffic or something to go and see her son (points to the picture-taker).

ST: right... (laughs)
Adam: (starts laughing, shrugs shoulders)

Adam began by connecting two pictures with the representation *museum* but then reverted back to the narrative, only this time, failed to use *museum* to connect the other pictures. Instead they coalesced into a story in which the subsequent picture relates only to the last picture described. Vygotsky referred to this type of thinking as chain complex and used it to characterise the beginning stages of thinking in complexes. He described the chain complex as:

> "a dynamic, consecutive joining of individual links into a single chain, with meaning carried over from one link to the next... The single trait is not abstracted by the child from the rest and is not given a special role, as in a concept... the structural centre of the formation may be absent altogether" (Vygotsky, 1986, p.116).

The fact that Adam was talkative throughout the exercises meant that he was able to engage in an exchange of thought. Superficially, one might be tempted to take this for granted but in terms of concept formation, this ability is critical. Since Adam was able and willing to discuss his ideas, together we were able to generate a knowledge base and method for interpreting the images. This allowed Adam to modify and specify his representations so that his knowledge base was increasingly accurate and he was therefore able to create alternate representations that would in turn signal the appropriate concept.

The second participant, John was also talkative, although the form and function of his language use differed significantly. There are a number of interesting aspects to John's use of language that are important to consider in an appraisal of the nature of John's formation of linguistic concepts. Most striking was the seemingly idiosyncratic nature of his conversation and the ways that his verbal expression provided an effective means of experimentation with the ideas presented. He was extremely thoughtful about each problem presented and talked through his thought process at great length yet was often scattered in his descriptions and included details or exclaimed flashes of insight that seemed incongruent and unexpected. The following examples

illustrate the point:

> ST: So let's talk about this one, why is this a biped?
> John: Because... (long pause)
> ST: You're a biped as well and so am I..
> John: Oh, one thing which has other stuff connected to it. Like just one ummm, um...like...uh Barney, like triceratops this and this has all the legs, it's all connected.

John later explained the concept of the ex- group, once he has matched the picture with its group:

> John: Everything is going up. Like, the cookie's going up, the caterpillar's (pronounces it kellerpitter) going up, the... (stumbles on the word for whale/orca) sea killer?
> ST: Orca?
> John: Orca, yeah
> ST: Or killer whale?
> John: Killer whale, I thought killer whale. I um, was, (garbled) say dolphin. It's hot springs like where... (bell rings) It's fifth period.

After a long pause, John talked about the definition of a flowerbed:

> John: It kind of reminds me when there was like, a bunch of crows outside during this time and I said maybe it looks like um, from Star Wars... 'cause my imagination kinda sometimes drifts off.
> ST: Does it?
> John: And it, I think it... but it's just like a bunch of crows.
> ST: It sounds like you have a lot of really interesting things to think about.
> John: And I have a pirate picture that I took from a movie and it's in the movie The Fog.
> ST: Ok, "The Fog?"
> John: Yeah, The Fog - have you heard of it?
> ST: No, I haven't...
> John: It's a horror movie...
> ST: Oh, ok...
> John: 'Cause when I was in grade 3 a cloud, it wasn't at this school but my first school, they took it and everyone in the class made one for the movie The Fog. Okaaaay? (ready for the next activity, watches as I lay out the next cards).

John's conversation seemed scattered and hesitant at first, with many pauses and non-sequiturs. For instance, John's comment about the dolphin and hotsprings (the hotsprings were likely a reference to the picture of the geyser in the group, but how it fit into the conversation about whales or dolphins was unclear) or how crows and subsequently the elaboration about The

Fog related to flowerbeds was at first confusing. However, on deeper examination, it became apparent that John's language was paradoxical and belied a deeper and more sophisticated thought process. In order to understand how these scattered descriptions function in the larger relationship between language and concept formation, it is important to understand the role of what might be described as linguistic *triggers*.

As John discussed the pictures, described the appearance and function of particular objects, abstracted meanings and observed relationships, he stumbled on words or images that ignited meaning for him and helped illuminate additional paths of thought. As he followed the new paths of thought, additional triggers were activated.

ST: Ok, tell me what binoculars are
John: Binoculars are, um, things that uhhh...
ST: What do you use them for?
John: Like seeing far or looking, like if you see an animal and you're trying to hunt it then you could use binoculars (gestures with fingers around eyes)
ST: So which part of your body do you use with binoculars?
John: ummmm, your eyes? (does the binocular gesture again)
ST: So tell me, do the words binoculars and bicycle, do they have anything in common?
John: *They both have b's... oh! they both have (makes the binoculars gesture again and moves hands up and down) two... bicycles have two wheels and binoculars have two (gestures again) seeing...*
ST: So what do you think bi- might mean?
John: Means, multi. It has two (gestures two with fingers).

The italicised section highlights one event during which John experienced a language trigger. He discussed one concrete aspect of the commonality between *binoculars* and *bicycle* but then made a sudden shift to understand that each object had two of something (i.e., binoculars have two lenses and bicycles have two wheels). Although it is apparent that John had trouble naming the lenses, his gestures conveyed that he understood the structure of binoculars and that they share a structural attribute with a bicycle. As above, this moment of insight seems surprising and its genesis is mystifying. Yet, these linguistic trigger moments happened constantly throughout the

session with John. In another example, John responded to the task in which he had to match the word *bisect* with its picture.

> John: Hmmm, what could this be, someone cutting money...ummm...
> ST: *What if I told you that sect means to cut?*
> John: *(whispers "bisect") Oh! Isn't that like dissecting something?*
> ST: Right, ok, except we have *bi*sect.
> John: (thinks and mutters) bisect ...two...
> ST: So if that means cut then bisect means to cut into...?
> John: Two, but there's like two...scissor...blades. So it might work.

The dissecting idea was triggered when I instructed John in the meaning of *sect*. Once the mistake was corrected, John was able to focus on the prefix since that had been the source of distinction and then he was able to continue the stream of thought along the lines of bi- and then onto the correct matching of the word and picture.

This is not to say that John reached the correct answers through this pathway of triggered thought. Even when John had had a revelation of sorts, he sometimes still remained mired in confusion. In completing the worksheet following Stage Three, John attempted to create a word that captures the idea of *a three legged pod creature running towards you*.

> ST: Which prefix are we going to use to mean three?
> John: Tri.
> ST: Tri, and which prefix means 'towards'?
> John: Triceratops

In this case, it appeared that the linguistic trigger for tri- became *triceratops*. This is particularly likely for two reasons. First, we had discussed triceratops at relatively great length during the exercise: in creating the concept of tri-, in confirming why tri- started the word triceratops (see example that includes Barney above) as well as distinguishing a biped as an animal with two legs. The fact that the triceratops was studied for its characteristics and used as a contrasting example meant that the sheer repetitiveness of the material and contextualisation may have meant that John simply remembered the word triceratops easily. Second, John also provided anecdotal

knowledge in his definition of triceratops in addition to making the connection with Barney the dinosaur.

> ST: So why is he a triceratops?
> John: Because it has that and two horns and the other horn and... when I was a kid I remembered that triceratops has two horns and I forgot what the other one was called because it was such a long time ago, it only had one horn right there..."
> ST: So the word triceratops, what does it have at the beginning?
> John: Oh, three! Three horns!

The memory of triceratops distracted John and instead of following the thread of thought in which he must create a word that structurally reflects the fictitious pod creature, he was reminded of the triceratops thread that he had to override while retaining the concept of tri- for the creation of the appropriate word.

Conversely, there were times when there were no linguistic triggers and John correctly identified concepts and matched pictures with their corresponding groups. Unexpectedly, John was the fastest at conceptualising the prefix groups in Stage Four and was exceptional in the fact that he correctly named the concept immediately in two of the picture groups (ex- and super-/supra-) and immediately matched the correct pictures for two of the picture groups (ex- and ac-/ad-/at-). For example,

> (sifts through cards in his hands)
> John: WHOA!
> ST: What's whoa?
> John: I know, this one would go there! (matches geyser to ex-)

When John correctly identified the match for (ac-/ad-/at-),

> John: That would definitely go there
> ST: Why would that definitely go there? You seem pretty certain...
> John: All of them have uh, people, like, the action, like someone holding something or like doing something or seeing something.

The presence of language triggers was the most significant difference between the

performance of John and the other two participants. In all cases, John's formation of linguistic concepts pivoted on the presence, absence, frequency and contextual support of linguistic triggers. Neither of the other participants reacted by responding with new information, vivid imagery or new veins of thought to particular phrases or words with the same vigour, certainty or frequency that John did.

The third participant, Cole was the least talkative. He spoke very little, preferring instead to gesture or use short (often only single-word) answers. Cole was extremely hesitant in his answers and frequently said "maybe" and "sort of", suggesting that he was unsure of his answers or was only able to approximate the meanings and answers he was asked to give. As a result, the assessment was heavily dependent on my ability to prompt, question and create a conceptual path for Cole to follow in order to match words to the correct pictures in Stage Three and match pictures to their groups in Stage Four. The following example is typical and reflects the effort to establish a definition for *flowerbed.*

Cole: Umm, I don't know what this one is.
ST: Ok, so what's the object?
Cole: A flower
ST: Ok, so the flower... it can either be bedflower or flowerbed (demonstrate with word placement). Right? The same way as it was with waterbed?
Cole: (nods)
ST: Ok, so let's think about it together. So what do you think it is, flowerbed or bedflower?
Cole: Flowerbed
ST: Ok, so what do you think a flowerbed is? Where would you find a flowerbed?
Cole: Ummm...
ST: Would you find it inside or outside?
Cole: Outside
ST: So if you found a flowerbed outside, what do you think, where do you think it would be?
Cole: On the ground?
ST: Ok, why do you think it would be on the ground?

Cole: Because that's where flowers grow?
ST: Ok, so I think you have a clue as to what a flowerbed is right there.
Cole: (pause) A group of flowers, sort of?
ST: Good!

There were a number of occasions, particularly during Stage Three when I had to prompt Cole to remind himself what each of the number prefixes were in order to answer a question or progress further down his avenue of thought.

(bicolour and biped are the last words to be matched)
Cole: (matches *bicolour* with men in choir) Because they are wearing two colours.
ST: And this is biped because...?
Cole: It was the last one.
(looking at zebra = bisect)
ST: So bi means what again?
Cole: Two colours?
ST: Not necessarily two colours...
Cole: I don't know
ST: Let's look at bicycle - why is it *bi*cycle?
Cole: Two wheels
ST: And why are these *bi*noculars
Cole: Because there are two things that you look through.
ST: So what does bi mean?
Cole: Two
ST: So let's look at bisect. So if bi means two... and now I'll tell you that 'sect' means to cut in Latin. (gets the match)

When he was not able to remember the meaning of the prefix at hand, I provided cues not simply to remind him of the answer, but to see relationships among objects in the prefix group in order to provide context. By prompting Cole to create that context, my goal was to help him gain an intuitive sense of the prefix meaning that would in turn help him remember its meaning and understand the relationship between word structure and meaning. By seeing that *bicycle* and *binoculars* both start with bi-, Cole was at once able to witness the commonality among words that share a prefix, attend to the structural relationship in both word and object and understand one principle of group membership concerning Latin prefixes namely, that words can be grouped

according to their morphemic structure.

When Cole offered longer answers, they were hesitant, stilted and imprecise. There was no consistent word usage reflecting that Cole was tying attributes together in order to create a concept. In this example, Cole looks at the chain break picture.

ST: What do you see in that picture?
Cole: A person holding a chain?
ST: Ok, are they just holding the chain or pulling the chain?
Cole: Pulling it
ST: And what happens because they're pulling it?
Cole: It's breaking
(matches immediately with dis-/de-)
ST: Right! So explain how this works along with these pictures...
Cole: Uuuuuh, like the egg is breaking and they're pulling that away (velcro) and they're moving it sort of?
ST: Right, they're moving the dirt away from the floor.

Cole attended to the person holding the chain but neglected to include the fact that the chain is being pulled apart, as evidenced by the tension in the hands and the middle link breaking apart. Once he was encouraged to express the chain image portrayed in its entirety then he was able to move onto describing the dis-/de- concept presented in the picture group. Unlike Adam and John, Cole did not use any recurring words to reflect the conceptual consistency among the pictures. For example, where Adam reiterated some form of the word *break* to describe each picture, Cole used "breaking" or "pulling away" or "moving it" in turn. This is significant because it conveys that Cole described each picture severally and used language to convey particular dimensions of each image rather than abstracting the conceptual attributes of all the pictures that would otherwise be evidenced by language used to express a unitary concept. It is intriguing that although Cole did not use language to express the concept, he did correctly match *chain break* to the dis-/de- group, a phenomenon that will be further explored in the following sections. While the study of Cole's language use yields relatively little, further examination of the way in which

he drew relationships and used the concepts he had learned elucidates the very interesting manner by which Cole forms the concept of Latin prefixes.

Anecdotal Knowledge

Rosch (1999) has suggested that concepts occur as part of a web of meaning; they are participatory in the sense that they are formed through and play a role in situations in innumerable flexible ways. Concepts are born through experience, where we witness structure, function and relationships of things, animals and people. Nelson refers to contexted relevance in explaining how children come to understand new words.

> "The idea is that children's understanding of novel pieces of language depends crucially on their understanding of how that piece of language fits in with is relevant to the ongoing social-communicative interaction in its particular social-cultural context" (Tomasello, 2002 p. 13).

Vygotsky (1986) likened concepts to living cells that must be viewed with their offshoots penetrating into surrounding tissue. It is important to understand the ways students connect words and morphs to personal experience in order to create and extrapolate meaning. The very nature of an object changes when it is connected to a personal experience and when that experience is conveyed to someone else. For example, looking at Stonehenge and understanding that it is Stonehenge rather than simply a quirky formation of standard rocks suggests a broader and more detailed concept. How we name the rocks defines how they become integrated into the concept. If we can call the rocks *Stonehenge* we recall a structure that is created with deliberation, that has a specific use of historical value and significance. We connect our own vivid experience in seeing Stonehenge, whether in person or through historical study. Certainly, rocks can be meaningful if, for instance, one fell on one's toe or got lodged in one's shoe. However, rocks are more often than not anonymous and without the particular structure or significance of

Stonehenge. This particular meaning structure means that students make specific reference to that object and conceptualise it in specific ways. Thus, the ways in which students use specific, anecdote-based names and analyses bear an important statement regarding concept formation, especially when they are attempting to understand some unfamiliar words such as the ones presented in the activities on Latin prefixes.

Adam connected prefixes and words to specific experiences or specific words. When deciding whether he could make *bedrock* or *rockbed* in Stage Two, Adam referred to the television program *The Flintstones* to confirm that he was correct in forming *bedrock* with the two compound word components.

> Adam: If you switch it around it's bedrock - it's where the Flintstones live!
> ST: (laughs) Ok, very good. Do you know why they call where the Flintstones live bedrock?
> Adam: Because it's full of rock and in prehistoric times.
> ST: Ok, great. Wow - I didn't know anyone still watched The Flintstones!
> Adam: Well, I was just remembering it because I went to my grandma's house once and I was watching t.v. and I saw it.

In Stage Four, Adam picked out Stonehenge immediately as I laid out the picture groups and told me a fact about Stonehenge.

> Adam: Stonehenge used to be used as a calendar
> ST: Right, how did you know that?
> Adam: from National Geographic

When Adam was asked to match prefixes to the picture groups as the last task in Stage Four, he gave examples of words that began with the same prefix in order to deduce the prefix meanings.

> (co-, con-, com-)
> Adam: Like *com*bination because it's like people combining to like, do one thing.
>
> (ex-)
> Adam: Like *ex*plode.

(in-)
Adam: Like *in*trude 'cause it's like *in*truding into the mouth

(ac-/ad-/at-)
Adam: Oh, this is like *ac*quiring information.
ST: Exactly, like acquire... or attend.
Adam: Or *as*sign. Or *ap*pear and *ar*range.

Adam stressed the prefix in each word that demonstrated his awareness that the prefix was the part of the word structure to be manipulated in changing meaning or seeking commonality. It is interesting to examine Adam's means of grappling with the prefix group dis-/de- because the process behind his observation of word structure is more transparent.

Adam: (pauses at length to consider dis-/de-)
ST: Do what you did before; try to think of words that begin with 'dis' or 'de' and that might help give you an idea of which one it might be.
Adam: Dis... there's disposable cameras but that's not one.
ST: Ok, well think of the word 'dispose'
Adam: Oh! this one
ST: Why?
Adam: Because he's disposing of the yolk in the egg.
ST: So what do you do when you dispose of something?
Adam: You like, throw it away.
(matches correctly)

Although Adam did not get the full technical definition of dis-/de- (from, away or apart), he used *disposable camera* to deduce dispose meaning to throw away which was then used to make a literal translation of dis-/de-. This, in turn, allowed him to interpret the concept and abstract the idea of throwing away that he imposed on the entire group. This example is an excellent demonstration of the recursive nature of speech and language and how specific anecdotes can form and impose meaning on a concept. Since *disposable cameras* is the image that signifies dis-/de-, it became the vehicle for fuller understanding of the concept and as we will see later, associating a prefix with a specific, vivid image can actually create meaning loops from which it can be difficult to move away to develop fuller or even correct prefix meanings.

Of unique and particular interest to Adam was the means he used to match biped with the correct picture in Stage Three. Adam first matched biped with the picture of scissors cutting a bank note, the reasoning being that scissors have two blades, that captures the meaning of the bi- prefix. I then drew Adam's attention to the root of the word.

ST: *ped* is a latin word...
Adam: legs
ST: right, how did you know that!?
Adam: 'cause... I'm French. So it kind of looks like *pied* which is *foot* in French.

Adam's bilingualism (especially in French due to the fact that it shares with English Latin as a linguistic root) meant that he had an additional linguistic structure on which to draw relationships. Not only did Adam's knowledge of *pied* mean that he could compare and contrast units of meaning, but he could correlate those meanings with the structural aspects of words, thus solidifying his understanding of the networks of meaning and structure inherent in English words derived from Latin. Generally speaking, the knowledge that Adam acquired through the exercises remained stable and solid, meaning that he very rarely had to be reminded of words and meanings and his understanding of the material was logical, step-by-step and cumulative. Because he had a wealth of experience and a second language to draw on, he was able to quickly see relationships among words and meanings and use his knowledge of those relationships to form prefix concepts.

Like Adam, John offered anecdotal comments such as learning about triceratops "when he was a kid" and told the story about the movie The Fog (see Language Use section for the full conversation). These stories were often triggered by the material we were studying at the time but in some cases the anecdotes became disconnected from the material at hand. Still, in other cases, the anecdotes served to enhance John's effort at understanding prefix meanings. In this example used in the last section it is clear that John connected the root *sect* to both *dissect* and *bisect.*

John: Hmmm, what could this be, someone cutting money... ummm...
ST: What if I told you that sect means to cut?
John: (whispers *bisect*) oh, isn't that like dissecting something?
ST: Right, ok, except we have *bi*sect.
(he's thinking and muttering bisect... two...)
ST: So if that means cut then bisect means to cut into...?
John: Two, but there's like two... scissor... blades. So it might work.

By drawing a comparison between *bisect* and *dissect* John reinforced the commonality among words with the same roots and saw that contrasting prefixes imply a contrast in meaning. When John constructed the meaning for *triathlon*, the results were dubious.

John: What's a b... I've never heard of...
ST: So what's a triathlon? Have you ever heard...?
John: No...
ST: So a triathlon is an athletic event
John: Is it like the Olympics?
ST: Right. With a triathlon you normally have swimming, running, and
John: Skating?
ST: And cycling.
John: So just three (gestures)
ST: Yeah, just three - that's why it's called a *tri*athlon, right?

Here, John used his knowledge of the Olympics to contextualise the concept of a triathlon that is, to verify that it is an athletic competition. Although he had never heard of a triathlon, he could understand where, how and why it would take place. However, because he did not fully understand the triathlon concept and know that it consists of running, swimming and cycling, he fell short of understanding the bearing that the three triathlon events have on the structure of the word (i.e., that tri- means three).

ST: OK, but in *this* triathlon, in this question, instead of swimming, running and cycling we've got skipping, tricycle riding and hoop jumping. So, if you were to make it into a biathlon, which events would you keep out of these ones (repeat and show on paper).
John: So, I'm supposed to... tri- is three, bi- is two...
John: (holds his head, thinking, thinking, reading it over, whispering to himself)... mmm - just circle it? Tricycle riding and hoop jumping.... skipping would kind of be... what kind of skipping? Like, just any skipping?

ST: I guess, I haven't thought that far, actually! I don't know what kind of skipping! (laugh)
John: Ok.

When John had to apply his knowledge of a conventional triathlon, understand a new type of triathlon and then transfer knowledge to understand how you would create a biathlon with different events, he began wondering about the type of skipping the question might mean and followed that logic. Thus, John's anecdotal knowledge was a double-edged sword of sorts; while it served to supplement the connections he found between words and concepts (e.g., identifying what a triathlon might be through knowledge of the Olympics), it also served as a distraction, taking him down paths of inquiry that did or did not bear on his work in understanding prefix concepts (e.g., trying to identify the type of skipping in question).

In another example from Stage Four, John immediately noticed the photo of the woman taking a cookie out of a cookie jar.

John: The mother's taking a cookie from the cookie jar?! (laughs) That's kind of weird!
ST: Maybe she's on a diet. She doesn't want anyone to know she's stealing a cookie.
John: Or maybe she's sick, or she's supposed to be getting groceries and she steals a cookie. (laugh)

This example demonstrates the richness of interpretation that can be derived from a simple picture and how powerful initial impressions can be in shaping conceptualisation. John formed the ex- grouping the easiest and labelled the concept quickly. In the following worksheet exercise, he was most readily able to identify the prefix meaning (i.e., out, from, forth). It was likely that the vividness of his first correct interpretation followed by a narrative and the humour attached to the perceived ridiculousness of the picture created a concrete image on which the concept could be formed and remembered.

Cole offered no anecdotal comments at all. In studying the words in Stage Three he commented that he had never heard a lot of them. He experienced significant difficulty in

grouping the words either by meaning or by structural attributes and did not volunteer any remarks that would suggest that he was connecting word meanings or structures with other objects or experiences.

Although anecdotal knowledge was a minor theme in the data, it was useful to examine as it offers specific insight into how experience contextualises new information and helps to structure new concepts in terms of related concepts. Perhaps most importantly, studying anecdotal information permitted a fuller apprehension of the students' thought processes and mistaken interpretations. For instance, it was extremely valuable to know that John wondered what type of skipping to which the worksheet question in Stage Four referred. While we did not pursue this line of thought fully, it informed me that John was attending to particular aspects of the events within the triathlon and interpreted that this had some bearing on the choice he made in selecting events when changing the triathlon to a biathlon. Knowing to which aspects of a phenomenon a student is attending has a direct correlation with the manner in which they are forming a concept and knowing how the student contextualises information using anecdotal knowledge is a key in fathoming the depths of their interpretation.

Forming Concepts Based On Concrete Attributes vs. Relational Attributes

According to Vygotsky (1986) the complex stage of concept formation is characterised by the uniting of individual objects based not only on subjective impressions but also by bonds actually existing between the objects. These concrete, factual (as opposed to abstract and logical) bonds are discovered through direct experience. "Any factually present connection may lead to the inclusion of a given element into a complex. That is the main difference between a complex and a concept" (p. 113).

Since the cornerstone of Vygotskian concept formation was the distinction between complex and concept, it is interesting to explore the ways that the three participants interpreted

both the concrete and relational attributes present in the pictures in Stage Four. This section will be concerned with performance in Stage Four as they were the only series of pictures that depicted action where students had to observe the situatedness of the objects as they related to other people or objects. All three participants demonstrated the capacity to observe and form concepts based on concrete and relational attributes. Concrete attributes are physical features (e.g., water or cave) studied in isolation from the rest of the picture. Those same attributes can become relational when they are situated in relation to other people or objects (e.g., *the whale jumps out of the water* or *the cave is underground*). For this analysis, a relational attribute is any attribute where something bears a relationship to another thing. The Latin prefixes selected for this project all reflect relational attributes; understanding the performance of participants in Stage Four lends important clues to how students understand relational attributes and how that understanding impacts on their ability to learn prefixes. By understanding which dimensions participants used in forming prefix concepts and understanding how they moved from working with concrete characteristics to working with relational characteristics we can know whether the number of relationships among objects can indeed be infinite, as Vygotsky believed and whether students do indeed ascend from the realm of the concrete to the realm of the abstract (Vygotsky, 1986).

Although it was not planned in the research design, Stage Four roughly took place across two phases. First, participants preliminarily matched the pictures to the groups based on first impressions. On making preliminary matches, participants encountered contradictory information when they matched one picture and then decided that another match was more accurate or matched most of the pictures and realised that the leftover pictures had no reasonable match. These outcomes compelled them to reconsider previous matches and move into a second phase of analysis where participants reorganised the picture matches as I guided them through

the appropriate attributes to which they must attend in order to match the pictures correctly and thus form the correct prefix concepts. Stage Four was interesting because it permitted the observation of concept formation for the fluidity of mental change and manipulation.

In the first phase of Stage Four, Adam's attention oscillated between concrete and relational aspects of the pictures. Adam began by leaning over the picture groups arrayed before him and studying each group silently, in their turn. Suddenly he picked up the planes picture and matched it with super-/supra-:

> Adam: ...the hot air balloon is flying and the satellite's in the air too and if you look behind Stonehenge there's the sun in the air too. So... things that have to be in the air.

Adam then examined the chain break image:

> Adam: Is this like, a chain breaking? I think this would go here...
> (matches chain with dis-/de-)
> Adam:...Because breaking this apart (velcro) and the egg breaking open
> ST: How does the sweeping this dirt fit into that?
> Adam: 'Cause it could have been like something that broke
> ST: What might have broken?
> Adam: A dusty old pot?

The planes and chain break images were the first pictures that Adam matched and they were indeed matched based on their relational characteristics that is, relating objects to the air in which they are suspended and breaking apart (i.e., the detachment of two parts of the same object). Adam then observed concrete attributes of the following picture set.

Adam then selected the pool diver from the cards in his hands and began to describe it:

> Adam: ...Guy diving into water. 'Cause there's water, here, here and glass of water.

Adam attended strictly to the presence of water in each picture, when the concept sub- implies underness, an expression of a relationship between two things. For the following two groups, Adam returned to analysing objects in terms of their relationship to one another.

> Adam: (comes to the geyser picture) Geysers (matches geysers with ex-). It would go here 'cause the water's shooting out and the whale's jumping out, coming out of like, a cocoon or something, and she's taking out a cookie.

Adam continued to predominantly observe relational attributes for the rest of the first phase of Stage Four. Out of seven attempts at matching, two were based on concrete attributes. This is not to say that he correctly matched all the pictures, it is only to say that he was predominantly attending to the relational attributes in the pictures. In his first matching attempt, Adam correctly matched three pictures with their prefix groups.

During the error correction in the second phase, Adam continued to attend to both concrete and relational attributes and on four occasions a significant part of the instruction centred on helping Adam understand how to attend to the relatedness among objects presented in the pictures. However, in some cases, the task was to help Adam see the relationships in different ways. For instance, Adam first matched the planes with super-/supra-, forming the concept on the basis of *things that are in the air*. When Adam analysed the group again, he reiterated that the concept had to do with the sky.

> ST: Look at how the planes are together and not just that they are in the sky, see how they're related.
> Adam: Oh, like a team! So this would go here (matches planes with co-/con-/com-)
> ST: So, where would that one go? (cablecar)
> Adam: Right here (matches with super-/supra-) for now.
> ST: Or, you can just hold it in your hand for now if you're not sure of where it goes.
> Adam: (holds in his hand)

When I explained that Adam had to observe the relationship between the planes themselves rather than the relationship between the planes and the sky he immediately corrected himself and correctly matched the planes with the group that illustrated the prefix meaning teamwork (co-/con-/com-).

Adam was by no means the only participant to experience difficulty with Stage Four and

in fact, Adam had the most success in perceiving and manipulating concepts based on the relational attributes of objects. One example is particularly poignant in demonstrating the difficulty with which participants shifted attention between concrete and relational attributes. At this point, Adam grappled with matching ac-/ad-/at-, sub- and super-/supra- with the pool diver, cablecar and cave. He offered a number of concrete attributes in conceptualising the prefix groups and struggled to observe the relational attributes.

ST: Soooo, the cablecar fits here? (cablecar = ac-/ad-/at-)
Adam: Oh! (switches pool diver to ac-/ad-/at- and cablecar to super-/supra-) Humans! They're people...
ST: And the cablecar fits there?
Adam: Yeah, because everything is like, going up. 'cause this is like when the sun's coming up and the satellite's going up and the hot air balloon is going up.
ST: Let's look at this again. So again, let's change it once more. So what if I told you I want you to look at the relation of the rocks to the other rocks? So forget the sun, let's look at the top rock.
Adam: Oh, it's like this (places one flat hand on top of the other)...parallel or something.
ST: Ok...
Adam: It's like, the same way as the ground is. (points to cablecar) and this is like the same too (parallel)
ST: And how about the balloon? does that look the same?
Adam: The balloon? umm...oh, I think I know what it means! So it's like high in the air 'cause it's the top rock and and this is high in the air because it's on the cable and this is high in the air because the hot air is pushing it up and this is high in the air because it's in space.
ST: Very good, ok, so that's exactly the right idea, I just want you to take it one step further. So look at where the balloon is in relation to the group.
Adam: High off the ground.
ST: What's another way of saying it's high off the ground (gesturing)
Adam: Uhhhh...
ST: So here, what was the idea here (look at sub-)...
Adam: Below. Oh, so above.

There were a number of interesting phenomena occurring within this exchange. First, Adam began with *humans* as the conceptual tie for the ac-/ad-/at- group and matched the cablecar with super-/supra- as the alternative, characterising the group as reflecting *going up*. Not only were both concepts based on the concrete, but Adam began a deeper analysis by observing the Stonehenge

picture for the sun rather than looking at the rocks -- interesting since he initially exclaimed that it was Stonehenge, that would indicate that he is attending to the rock formation rather than the sun. When I asked him to forget the sun and observe the top rock he easily moved into a relational understanding of the rocks, reflected in his use of the word *parallel* which by definition implies relatedness. He then struggled to capture the relationship between the rocks; he attached "or something" to the end of his statement implying that he was unsure of his explanation and used his hands to demonstrate the rocks in relation to the ground to further show that they are parallel. Although *parallel* did not explain how the rocks related to each other (they were perpendicular), the word *did* capture how the top rock looked compared with the ground beneath it. I moved onto the hot air balloon picture so that Adam could fill out the developing concept of the super-/supra- group but interestingly, he reverted back to the *high in the air* idea that he used at the beginning to explain why the planes matched with super-/supra-. Incidentally, this is another example of the conceptual loops to which I referred in the section on anecdotal knowledge where a strong preliminary impression of a concept carries over in the subsequent conceptual manipulation and acts as a consistent point of analysis, whether explicitly or implicitly. Focusing on the hot air balloon picture, we again returned to a relational analysis in order to capture the concept with the appropriate word. By drawing an analogy with the sub- group, Adam was able to perceive the antonymical relationship between the two pictures and state that where the sub- group means *below,* the super-/supra- group means *above.*

What was paradoxical about Adam's formation of prefix concepts based on concrete vs. relational attributes was that from the beginning he was able to apprehend the notion of grounding a concept in the nature of a relationship, yet with further analysis he struggled significantly to move beyond the concrete. One might expect that since he demonstrated the capacity to understand relational attributes, in all cases he would at least see relational attributes

quickly with instruction, if not independently at first glance. It is apparent that this was not the case; ability to accurately understand some concepts in terms of their relational elements does not ensure that the participant will move beyond the concrete in other cases. Whether they do move beyond the concrete certainly may have to do with their developmental trajectory, but equally, it may be a function of the nature of the concept and objects they are attempting to locate in the first place.

John also oscillated between observing concrete and relational characteristics, but again, demonstrated idiosyncratic interpretations that were not systematic yet surprisingly accurate. John began the activity by taking notice of the pictures right away and commented enthusiastically on the cookie out of jar picture, laughing at how weird it was. John then confirmed what he was required to do saying, "I'm supposed to pick which one matches?" to which I replied that he needed to look at the pictures to "kind of get a feeling." Immediately John began describing the groups.

> John: Yeah, I can tell what that is... (looks at ex-)...straight up, straight up (gestures) oh! coming up... (looks at super-) rising up in the air (looks at in-) this one, this one I don't know (I tell him it's a tricky one), (looks at co-) this one is like more than one, probably (looks at dis-/de-) I don't really know that one..."
>
> John: (matches planes with super-/supra-)
> ST: So why do those match?
> John: Because they're all like, in the air
> ST: Ok.
> John: Yeah. (confirms)
> ST: Great...

John matched the picture based on a relational characteristic, that is, that everything is *in the air*. In fact, John abstracted the relational attributes from nearly every group in forming the concept.

> (matches stair climber with ac-/ad-/at-)
> John: That would definitely go there
> ST: Why would that definitely go there? You seem pretty certain...
> John: All of them have uh, people, like, the action, like someone holding something or like

doing something or seeing something.

(matches dis-/de- with cablecar)
John: And this one would probably go there because there (points to velcro) you see something go up, you see here something in the air, the dust is in the air and the egg yolk is in the air and the velcro is in the air.
ST: And then the cablecar is in the air?
John: Mmm hm.

In the first example, John conceptualised the group based on the fact that the picture showed people engaging in action towards an object, capturing the concept of ac-/ad-/at- nearly perfectly. It is interesting in the second example that John perceived the velcro piece being torn apart as being in the air. It was an extremely literal interpretation of the picture, but more bewildering is that he called it velcro, suggesting that he would understand its function apart from being in the air. Yet John still said that it was in the air in the same way that a cablecar or satellite is in the air (i.e., with no connection to the ground or, unlike the velcro piece in the picture which *does* remain attached to the rest of the velcro strip).

Again, it is important to stress that John abstracted relational attributes but those were not necessarily the attributes necessary for creating the correct prefix concept. As with Adam, we worked further through the second phase of Stage Four to correct the mistakes made during the preliminary matching. When we examined the photos further, it was interesting to note that John fixated on the concrete aspects of the pictures more rigorously than in the first phase when he made initial connections. For example, when we returned to the match between planes and super-/supra- John repeated "in the air", the phrase he had previously used to label the concept of dis-/de-. When I further prompted him to look at the picture differently, he then focused on the colour of the jetstream and named the colour of each jetstream that the plane emitted (blue, white, blackish white, pinkish purple). Although the colours coalesced roughly into red, white and blue, John started giving them colour names that would suggest he is examining the jetstream

and further specifying colour detail. Rather than examining the picture for its breadth of meaning, John focused with even greater depth on the concrete elements. I then reminded him to observe the relational characteristics of the planes.

ST: Have a look at the configuration of planes so look at the way they are organised.
John: Making colour
ST: Ok, so don't look at the colours, just look at planes. So *abstract* the planes.
John: It's a v-shape
ST: If you had to pick another category... where would that go? So have a look at all of them again, Here hold onto that (plane picture) and have a close look. See what that would go with.
John: (matches with co-/con-/com-) Maybe here?
ST: That's right, so why does it go there?
John: (examines pictures serially) That's in, together, that's together, that's together...
ST: So when you say together, tell me a little bit more.
John: They're like, all working together, they're shaking hands with each other and they're walking with each other.
ST: So that's like co-operation, right?
John: Yeah.
ST: Great.

John seemed to struggle in switching his attention from concrete to abstract attributes yet when he made the preliminary attempt at matching the planes with the co-/con-/com- group he was able to form the concept based on the idea of togetherness with relative ease. This example supports the idea of triggered thought discussed in the section on Language Use; once John actually places the picture in the picture group he can suddenly move to understanding the group for its relative qualities and form the concept of co-/con-/com- accurately.

In another example, I asked John to explain his reasoning behind matching cablecar with super-/supra-. In this case, he struggles to find the correct means of explaining the relative nature of the prefix group. As in the previous example, John became hyperfocused on the best way of ordering pictures, although the reasons for this focus are unclear.

ST: So why does the cablecar go there?

John: The ca.. blecar
ST: That's right, now I need you to tell me why it's right.
John: Because it's up in the air and...
ST: Is this up in the air? (points to the rock)
John: Oh, it's being raised. (hesitant)
ST: If you look at it slightly differently, look at where the satellite is in relation to the earth and where the balloon is in relation to the ground.
John: (starts trying to order the pics, muttering) Start from here (cablecar) and then there (not air balloon), no, here (rock) then there (cablecar), then there (balloon), then there (satellite).
ST: Are they below, beside, above...?
John: Above. Is it correct?

John was able to match the picture with the correct group yet he found it difficult to specifically describe the nature of the relationship between the cablecar and the super-/supra- group and instead became absorbed with how the pictures seem to relate to one another in a sort of hierarchy. In the end, although John was able to identify the correct preposition of place, he was still unsure of his choice.

When John tried to analyse the sub- prefix group, he had similar difficulty. Again, he rigorously examined the pictures for their concrete features and fell into a conceptual loop during which he recalled groupings from episodes of analysis previously completed. Prior to the analysis of sub-, John had formed the concept of in-; John initially included the pool diver picture in the sub- group since they all showed water (a concrete attribute) and even once the in- group had been discussed and put in the correct group, John still returned to it to wonder if it was incorrect.

ST: Look at the objects in relation to the other objects in the picture
John: They're all in water. And... is that water?" (looking at cave pic)
ST: Yep.
John: So that's water?
ST: Yep.
John: Oh.
ST: There's more to it though - they're not just *in* water.
John: It's a cave

ST: It's a cave...
John: Something's in*side* something, they're all inside something and in this one the water is inside that (the cave).
ST: So do we say that the diver is *inside* the water?
John: Yeah
ST: Do we?!
John: Um, no.
ST: We say that he's under the water, don't we.
John: Yeah
ST: Ok, so the diver here is under the water, the iceberg is under the water.
John: OH! The water's under the guy! (pool diver)
ST: Ok, but that's a different one right? That's where he's diving into the pool. So how does the cave relate here?
John: Because rocks are inside the water.
ST: So when you go into a cave, what are you under? Are you under something?
John: Rocks.
ST: You're under the ground. So that's how it all works.
John: So is this wrong? (points to in-)
ST: No, that's absolutely right.

John attended selectively to the concrete aspects of the pictures such as the water, and the cave. The issue in gaining a true approximation of the sub- prefix is partly one of semantics where John used *inside* to describe how the scuba diver is situated in the water when *under* is a more commonly used word in English. However, in the case of the other pictures in the group such as lemon/limes or iceberg, it would be reasonable to describe them using *inside*, depending on the attributes to which one attends. For instance, were you to orient yourself towards the relationship between the glass and the lemon/lime slices it would be semantically agreeable to say, "the lemon and lime slices are *inside* the glass". Conversely, if you were to orient yourself towards the relationship between the water and the lemon/lime slices it would be more appropriate to say, "the lemon and lime slices are *in* the water". John essentially had two tasks before him. First, he had to form a concept based on the shared attributes or functions of the pictures. Second, he had to capture that concept in words, and the word he used to capture the concept was *inside* since presumably, it is the word that would most readily reflect consistency

across the group. As discussed previously, language use and concept formation are recursive processes; the manner by which the concept of sub- is formed will depend on the word used to embody the meaning and likewise, the semantic choices are made to adequately and accurately convey conceptual integrity. When I attempted to shift John's semantic usage to reflect that the scuba diver is *under* the water, he maintained the image of the water and drew a parallel with the pool diver, even though that picture had already (correctly) been assigned to the in- picture group. John's confusion over the appropriate means of semantically summarising the concept resulted in difficulty gaining a solid understanding of sub- and also called into question the previous conceptualisation of in-.

Like Adam and John, Cole was also able to observe the pictures for both concrete and relative attributes but he differed in how he used those attributes to form concepts. Since the dynamic assessment of Cole was largely reliant on my ability to supply questions, direct conversation and elicit commentary, analysis of Cole's attention to concrete and relational attributes is based on his short responses.

Unlike the other two participants, Cole struggled to understand the task from the beginning so Stage Four was not split into two phases. I began Stage Four by laying out the picture groups and handing Cole the cards. I instructed him to match the pictures to the groups based on their meaning.

Cole: What do you sort of mean?
ST: What do you mean, what do I mean?
Cole: Like...
ST: What's confusing right now?
Cole: I don't know...how...to mix them. Just...put them down...like?
ST: Yep, so what you'll do is... let's start with one card. So let's look at the cablecar (was in his hand already). So I want you to match that with the group of pictures that it's most consistent with, that has the same meaning.
(long pause, sorts though pics)
Cole: I don't really get any of them

ST: Let's pick one. It's always good to pick one and start with it. Let's look at the geyser, the picture of the geyser. So I want you to look at the picture really carefully and tell me what you see. Just describe the picture to me.

Due to the fact that Cole had trouble understanding what I was asking him to draw from the picture groups in order to abstract a concept I scaffolded the task for him so that we could study and describe each picture, match the pictures with the group and then elucidate the reasoning behind the decision. Each stage of this process was painstaking as I struggled to question Cole in such a way that he fully conveyed meanings and relationships. An excellent example characterising the nature of our analysis is the following excerpt of conversation that immediately followed the one above.

ST: Let's pick one. It's always good to pick *one* and start with it. Let's look at the geyser, the picture of the geyser. So I want you to look at the picture really carefully and tell me what you see. Just describe the picture to me.
Cole: Water?
ST: So where is the water? What's it doing?
Cole: Coming out of, like a hole.
ST: And how is it coming out of the hole? is it just trickling out, is it bubbling?
Cole: Sort of like...?
ST: You can even act it out for me.
Cole: Exploding sort of (gestures with his hands)...
ST: So it's exploding out of the hole. And that's what a geyser is - it's the water under the earth that heats up, right? Until there's so much pressure that it shoots up (gestures with hands). That's what a geyser is.

ST: So do you see anything these pics have in common (with co-) anything to do with water or the ground or water shooting out of the ground? Anything there?
Cole: This river thing (points to iceberg picture)?
ST: Ok, so what does this one (point to the iceberg picture) have in common with the geyser (I press my hand to the whole group).
Cole: They all have water?
ST: Ok, good. They all have water. So that's one way we can look at the picture. Remember before when I said there were lots of different ways of grouping words and ideas? So that's one way of grouping this. What we could do instead is look at the fact that, look at the idea that the water is coming out of the ground (gesture with hand). And if you look at the idea that it's coming out, that idea of exiting or coming out, then it would match these

pictures (matched the geyser with the ex- group).

Cole's performance in this dynamic assessment was misleading because he did not necessarily have difficulty identifying both concrete and relational attributes. However, the fact that he supplied so little spontaneous commentary or conversation made it extremely difficult to understand the dynamics of his thinking and to know how his thought patterns changed. Indeed, from the data it appears likely that he did not form concepts spontaneously, that he was almost exclusively reliant on my cues as examiner to create broader descriptions and categories. Ironically, whether Cole responded by identifying a concrete or relational attribute is not the critical point; whichever attributes he chose never seemed to fully capture the phenomenon he was trying to describe due to the lack of specificity and hesitance in his language use. A great deal of effort had to be expended to enable Cole to make meaningful, accurate conceptual descriptions. It is difficult to identify any overall trends for Cole's performance apart from the fact that he relied heavily on my prompting. Any responses having to do with the concrete or relational attributes resulted from my prompting directing him to abstract those attributes.

(examine the cablecar)
ST: Look at the cablecar in relation to the trees. Where does it hang?
Cole: On wires?
ST: And it hangs above things, right? (demonstrate with sounds and gestures)
(matches with super-)
ST: So why does it go there?
Cole: Because there is stuff on the bottom, like that's above the earth and that's above the ground.
ST: And how about the rocks?
Cole: The sun is above it?
ST: Ok, so forget the sun. It's funny, everyone picks out the sun in that picture. Have a look at how the rocks are.
Cole: That rock is above the others.

The fact that Cole drew both concrete and relational attributes from the pictures is evident in this example. He identified the wires from which the cablecar hangs and was able to give a rationale

for his matching decision that is grounded in the relational features. It was also evident that Cole was unspecific in his language use as he used words like "stuff" and "that" instead of naming objects as satellites or trees.

(examines the planes)
(long pause)
ST: So what are you thinking?
Cole: I don't know.
ST: So look at the planes and how they're flying.
(pause)
ST: So you can see there are a whole bunch of planes. Are they flying alone or in a group?
Cole: In a group
ST: Right...
(matches with co-/con-/com)
ST: Right - so why do they belong there?
Cole: Because all those other pictures are like a group sort of?
ST: Great. They're showing teamwork, working together.

In this example, Cole struggled to describe anything about the picture of the planes. Recalling John's description of the planes that was almost excessive in its detail, Cole was the opposite, having had difficulty knowing where to begin the conversation. The point here that will prove interesting in the following sections is that Cole *did* identify that the planes are in a group formation and on that basis, correctly matched the picture with the co-/con-/com- group. Cole also used the word *group* to reiterate the concept of the picture group.

Although this example was given previously, it is interesting to understand it for the types of attributes abstracted by Cole.

(examines the chain)
ST: What do you see in that picture?
Cole: A person holding a chain?
ST: Ok, are they just holding the chain or pulling the chain?
Cole: Pulling it
ST: And what happens because they're pulling it?
Cole: It's breaking
(matches immediately with dis/de-)

ST: Right! So explain how this works along with these pictures...
Cole: Uuuuuh, like the egg is breaking and they're pulling that away (velcro) and they're moving it sort of?
ST: Right, they're moving the dirt away from the floor.

Cole only saw the chain in the picture first and with prompting, partially elaborated to include the image of a person and then to complete the image fully by saying that the hands in the picture were pulling a chain and then finally breaking it. In the same way as John used thought triggers to move between avenues of thought, the very act of Cole speaking the words "it's breaking" helped him conceptualise dis-/de-. Of even greater interest is that although that trigger (which results in the correct identification of the prefix group concept) seemed so strong, it still did not result in any greater language specificity in Cole's explanation of the concept (i.e., repeating words to create conceptual pivots, using specific object descriptions such as velcro or dustpan). It would seem that Cole would be able to easily explain the concept behind dis-/de- using specific vocabulary words to convey his thought. As further analysis will reveal, Cole's method of concept formation contained some interesting surprises.

Drawing Relationships

Keil (1989) explained that because concepts provide explanations about things in the world and are related to the frequency and correlation of features, concepts are construed as intrinsically relational sorts of things. Thus, any qualitative analysis of concept formation must address the means by which relationships are drawn. Of course, because concepts are linked with other concepts and experiences (as opposed to isolated theoretical propositions) there are many ways that people can perceive, interpret and understand the nature of these relationships. The preceding sections addressed major themes in concept formation having to do with constructing and relating meaning. In this section, focus is drawn to the finer nuances in the process of understanding relatedness among objects and phenomena. Participants not only made use of

broader experiences in forming concepts, they followed different routines and patterns in assembling perceptual information as a precursor to forming the concept. Simply put, this section addresses all of the preliminary mental work that participants did during concept formation.

From what I observed through my analysis of the data, there are five subthemes that elucidate the means by which students draw relationships in forming Latin prefix concepts: serial, perception/function, familiar to unfamiliar, visual organisation and morphological analysis.

Participants worked *serially;* they studied each picture discretely and then linked the images one-by-one. Participants attended to *perceptual or functional* features of objects in the pictures; they either understood subjects in terms of what they did or what they looked like. According to Nelson (1991) while structural characteristics are certainly observed, function is central to the formation of object concepts and in the construction of higher order categories. In other cases, participants moved from *familiar to unfamiliar* in forming concepts. That is, they began with the items they knew and extrapolated on that information to understand the concept. This is not to be confused with Vygotsky's (1986) differentiation between spontaneous concepts and scientific concepts; the study of scientific concepts concerns the interaction between teacher and pupil, not merely the process of inference used to make assumptions about unfamiliar objects or structures that is the focus in this section. Through *visual organisation* participants arranged words and pictures so they reflect shared attributes. Finally, participants drew relationships among concepts through *morphological analysis*; by analysing the structure of words they were able to deductively reason through prefix concepts.

Serial Observation

Observing phenomena and objects as members of groups and abstracting the bond that unites them (or differentiates them) is what defines concept formation. In operating through serial

observation, participants gave lists of attributes or sequences of observations and then tied them together in a conceptual framework based on repeated images or words. The idea of repeated words as concept placeholders was established in the section on Language Use; there, Adam used one word or phrase to represent the concept and related all other objects back to the concept through that representation. While Adam's performance was predominantly a function of language use and manipulation, the idea that he examined picture groups holistically to abstract conceptual elements is pertinent here as well.

One excerpt from John illustrated how discrete elements of serial observation can be. In this example, John attempted to explain the relationship between the words unicycle, tricycle and bicycle that he had organised into the first category in Stage Three.

> ST: so these, you've made this group because...?
> Cole: they all have *cle*
> ST: cle?
> Cole: ycle... no, cy, icl... no, icycle. They all have icycle.

John compared the words by following spelling patterns that are revealed letter by letter. This point is significant because when reading words, we usually chunk words into syllables or at least into common spelling patterns. The fact that John read letter by letter may be indicative of two things. First, this means of word analysis may be a feature of dyslexia; it has been suggested that dyslexic students have superior visual-orthographic skills at the level of words and letters (Siegel, Share & Geva, 1995) meaning that John may have relied on his strength for identifying letters in identifying common attributes among the words with number prefixes. Second, this letter-by-letter analysis could reveal something about the way that John perceived relationships, namely that he may integrate conceptual material serially rather than holistically. However, it is important to consider that *cle* is addressed in Orton-Gillingham methodology as part of the consonant-le spelling/syllable rule. It could very well be that examining relationships serially is

limited to the realm of word analysis or this could be an artifact of instruction since John works weekly with an Orton-Gillingham tutor.

John thus designated his first grouping the *icycle* group. When he attempted to create the second category given the remaining words arrayed before him, he only attended to single letters in each word.

> ST: The next group...
> John: (makes short vowel sound i)...like, biscuit... at the beginning maybe, but this would also be in there...'cause it has...
> ST: So that's it for that group. You said this also belongs in this group?
> John: They might share a group. (see below). This might go in both groups.
> ST: Ok, we'll look at that again after and we'll make a decision, ok? How about the ones that are left?
> John: Some start with b..u and t

Given the fact that John analysed the relationships among words serially only in these scenarios and that in subsequent activities he was able to form concepts quickly and accurately, it is plausible that this strategy is limited to activities involving word attack and that it is a function of dyslexia rather than a perceptual disposition associated with concept formation.

The technique of analysing conceptual elements serially is perhaps most dramatically illustrated through Cole's performance. As Cole held the picture of the pool diver he was confronted by a mass of pictures containing even more objects and relationships. Once Cole pinned down the task expectations, he was confronted with the seemingly ominous task of how to actually match the picture with a group that had the same meaning. Not only did Cole work picture by picture, he only abstracted one element relevant to that picture at a time. This example represents quintessentially serial relationship perception.

> Cole: (trying to find the match for pool diver picture)
> ST: (place it on top of in-)
> Cole: Yes, because that shows people.
> ST: That shows people? OK, and shows people doing what? We're trying to get that idea of *in* (demo with hands).

Cole: Okaaaaaaaay...? Uhhhh...
ST: 'Cause this shows people too, or parts of people (co, con, com), right? But we want that idea of going *in*.
Cole: Uuuuh...(long pause) I don't know.
ST: Where else do you see a picture of someone going into something or looking into something?
Cole: That one! (ac, ad, at)
ST: So what are they looking into there?
Cole: A camera (starts sorting through pics again)
ST: How about this one? (point to in- group)
Cole: No. (shakes head vigorously)
ST: No? definitely not?
Cole: Yep.
ST: Ok, why is that definitely not?
Cole: Because it doesn't look like it's going into something.
ST: Ok... what about this? Going *into* someone's mouth?
Cole: (pause) Yeah, but then that one doesn't show that one (man with mask)...
ST: So that's the problem? The man with the mask?
Cole: Yeah.
ST: OK, and what about the little boy? Is he...?
Cole: Yes, that would work.
ST: Right. So if we took the mask guy out that would work? (I physically cover up the mask guy).
Cole: Yes.
ST: OK, this actually does belong here and let me tell you why, what the problem is. The issue is, and I'm glad you came across it...
Cole: (interrupts) Oh! The guy's looking *into* glasses!
ST: Well actually, the prefix that belongs here has two meanings - it can mean 'in' or it can mean *not*, so let me give you the prefix that belongs here and see if that helps (I give him the prefix card in-). Now in- can mean like (gesture like I am looking through a magnifying glass) investigate, to look into something or to discover something, *or* in- can mean opposite, like visible... invisible.

Over the whole exchange, Cole was able to understand the pool diver picture in terms of the presence of water, diving, that it reflected movement and the presence of people. Although I shaped the activity so that Cole proceeded picture by picture, the goal was to tie the pictures together in order to find common conceptual ground. However, the object of the exercise did not evolve into concept formation as it did with the other participants -- it remained an activity

centred on listing features that were not tied to a conceptual core. As the example above finally shows, even when Cole was given the conceptual tie (i.e., in-), he still observed each picture singly, across groups and made membership judgements that way, as though each picture stood on its own. In other words, forming the concept eluded him. Most interestingly, when I helped him conclude that the masked man belonged to the group for different reasons, Cole persisted in tying the picture to the concept of in- despite the fact that he had such difficulty in understanding the centrality of the *in-* attribute previously. This suggests that he remained fixated on drawing attributes from the pictures rather than creating a concept.

Perception/Function

When conceptualising objects, students can either describe and categorise objects based on what they look like or what they do (or what can be done to them). For instance, a carrot could be categorised according to the following attributes: long, thin, orange, green-topped, ridgy. It could also be categorised based on the fact that it tastes sweet, can be made into soup or makes a nice side dish for fish. Since there is evidence (Kemler Nelson, Russell, Duke & Jones, 2000) that the earliest stages of concept development are based on the functions of objects, it is interesting to observe to what extent participants in the present study used perceptual and functional attributes in forming concepts of Latin prefixes.

In naming the concept that subsumed *bicycle*, *tricycle* and *unicycle*, Adam titled it *ways to get around* which is a clear example of categorising according to function. When John was asked to describe a bicycle, he too began with the functional attributes:

> ST: So let's start with bicycle, tell me about a bicycle.
> John: A bicycle is like a bike is ummm, you can ride them, do tricks with them, umm
> ST: What do they look like?
> John: Ummm, well they have two, they look like, well they have two wheels, they look like a stick piece, a long piece of metal which you bend up and tear apart and then you make the bike.

When asked to describe the physical attributes of a bicycle, John described the specific attributes serially as though he were physically constructing a bicycle and was asked to describe each piece as he assembled it. The language with which he could describe function was much clearer and more concise than that used to describe the structure in the detail he clearly wanted to provide. Interestingly, Cole took the opposite tack and started by describing structural features first. In creating the compound word *bedknob* in Stage Two, Cole set about creating a definition.

> Cole: On some beds there are those sort of like, like, circle things, sort of?
> ST: Ok, so on this picture of the bed, this picture of a bed, even though it's teeny-weeny, show me where the bedknobs would be.
> Cole: Maybe right there...
> ST: OK, so on the bottom?
> Cole: Top.
> ST: Top. OK, and what purpose to they serve? What are bedknobs for?
> Cole: No purpose?
> ST: Why do you think they're there then?
> Cole: Decoration?

Although the description was rough and imprecise, the point is that Cole chose to define a bedknob according to its structure, and then easily moved on to define their function as decorative. In Stage Three, Cole created the same initial category containing bicycle, tricycle and unicycle as Adam but instead grouped them according to their common structural element.

> Cole: (creates the first category: bicycle, tricycle unicycle).
> ST: So why are those grouped together?
> Cole: They all have wheels.

An important caveat to consider here is how the nature of the tasks interacted with the participants' observation of structure vs. function. Stage Two was the only stage that lent itself to open definitional choices (i.e., students were essentially answering 'what is this?' and could thus answer using anything that came to mind). Conversely, Stages Three and Four lent themselves to particular types of descriptions. For Stage Three, number prefixes constrained the choices made since the structure of the prefix was directly related to the structure of the object

represented by the word (e.g., tricycle is so named because *tri* refers to the fact that a tricycle has three wheels, the three wheels being a structural attribute). For Stage Four, the pictures showed action so that participants could observe attributes related to either structure or function (i.e., concrete or relational attributes, as discussed in the previous section).

This distinction introduces another aspect of this analysis that must be addressed. Superficially, the contrast between concrete/relational and structure/function dichotomies may seem to be hair-splitting. However, it is important hair-splitting because the nuances in meaning differences bear critically on the conclusions derived from these data. The concrete/relational distinction implies that the participant is gathering information from the stability (or lack thereof) of objects within a scene. By studying this facet of concept formation we can understand whether a child is seeing a picture for the relatedness of meaning or whether they are simply attending to specific elements as though they did not bear any relationship to other objects or people in the picture. Attending to the structural elements *is* for all intents and purposes the same as attending to the concrete elements since the physical structure of objects are not fluid and changeable (at least not within the timeframe that conceptualisation occurs, and in such cases we would be prudent to study those objects for their changeability rather than their structure).

The crucial point lies in the distinction between relationality and structure; studying the means by which participants interpret pictures on these bases yields critical information concerning concept formation of Latin prefixes. Where relational attributes, by definition, implicate two or more objects/bodies, we can observe structural attributes for their implication of other bodies or as multi-faceted things in themselves. For instance, a bicycle spoke can be described as being an element of a wheel or it can be described as a thing in itself that is, long, thin and rodlike. When the participants conflated structural and relational attributes, the result was a peculiar conceptual construction where they appeared to have an understanding of the concept,

but on further investigation I found that they had the right answer but for the wrong reasons. There are three examples in the data from which we can glean the importance of this claim. In all cases, students gave the correct answers but with a significant error: the Latin prefix correlated to the wrong structural attribute (that would otherwise be conveyed through knowledge of Latin roots).

> Adam: (matches bisect with lady picture) Because she's wearing jeans and a tank top. Boys wear jeans and girls wear tank tops and girls wear *both*, so yeah.

Adam was correct in labelling the lady with *biped* because the word refers to the fact that she has two legs, however, the reasons behind the match are quite different. Adam correctly abstracted and used the bi- prefix meaning *two*, but linked the prefix to wardrobe options rather than number of legs. The mistake in understanding the structural characteristics to which bi- applies reflects gender-based assignations of clothing options; the girl has two options for clothing and stands in contrast to the boy for whom clothing choices are far more limited.

In another example, Adam made a similar error that was extremely interesting. Adam was asked to answer a worksheet question from Stage Three where he had to choose two events to create a biathlon from a triathlon having the events skipping, tricycle riding and hoop jumping.

> Adam: (reads question) A new type of triathlon has three events: skipping, tricycle riding and hoop jumping. Which events would you keep if you were running a biathlon. (pause) Tricycle riding... (long pause) Because a tricycle's like a bike.
> ST: OK.
> Adam: (pause as he looks to the next question)
> ST: Hang on one sec, let's go back to this. Tell me what the question's asking you...
> Adam: (rereads the question)
> ST: So you're going to change this from a *tri*athlon to a *bi*athlon...
> Adam: Oh, so skipping and hoop jumping? So out of these three?
> ST: Yep. So you've said you'd keep tricycle riding...
> Adam: But would a tricycle count as a bike?
> ST: Why are you wondering if it counts as a bike?
> Adam: 'Cause like, tricycle is like the same thing as a bicycle except three. I'm just wondering if I put tricycle riding would it count as a bike or still as a tricycle?

ST: It would count as a tricycle.
(pause)
ST: I'm wondering why you feel you need to choose between bicycle and tricycle...
Adam: Oh, 'cause like, tricycle has three and bicycle only has two and in a biathlon I thought you'd ride, like, two stuff.
ST: Ok, so you're saying in a triathlon you ride things that have three? Like three wheels or three blades or something like that?
Adam: Oh, I know the answer now.
ST: OK, what's the answer?
Adam: Skipping, 'cause bi- means two, so skipping and hoop jumping because you're on like, two legs (writes the answer down).
ST: OK, so let's stick with that question for a minute longer, because I just want to ask a couple more things. So you're saying that with a triathlon, the events involved there has to be three of something like three people or three wheels or three skipping ropes, right?
Cole: Yeah...
ST: Whereas with a *bi*athlon the events would have to have two. So you could have... you chose skipping and hoop jumping so there would be say, two skipping ropes.
Adam: Yeah, or two legs, like two legs for jumping.
ST: OK, so what if I told you that - because your answer is right, but it's right for different reasons. So, what if I told you that the tri- in triathlon and the bi- in biathlon refer to the number of events?
Adam: Oh, so there would be two events.
ST: Right. So it doesn't really matter what the two events are.
Adam: Oh...
ST: Right. So it could be *hop on one leg jumping.*
Adam: Oh, so I didn't really get this - which *events* would you keep.
ST: Right. So that's the... when you're talking about meanings, when you're combining two separate meanings of the word, you have to be sensitive to the prefix, right, the bi- meaning two, the tri- meaning three, and also the last part of it, the *athlon* part which is referring to the event rather than what you actually have to have to participate in the event.

When Adam asked whether a tricycle counts as a bicycle, that was the first clue that he was struggling with a decision regarding group membership (i.e., whether tricycles and bicycles can belong to the same group). It was clear that he discriminated between *triathlon* and *biathlon* and decided that tricycle riding could belong in the biathlon, on the condition that it could belong in the bicycle category. He confirmed that he had to ascertain whether a tricycle could count as a bike because the biathlon clearly must only include activities that require two of something to do.

Again, Adam correlated the bi- prefix with the types of structural attributes that participants or equipment of the participants must have in order to participate. Indeed, he made his thinking clear when he commented that skipping and hoop jumping must belong in the biathlon because they require two legs to compete. The critical importance of understanding the assumptions behind concept formation is illustrated here; in many cases children will get the right answer but for completely different reasons, largely due to the various methods of deduction available in perceiving relationships among structural, relational, functional and concrete attributes.

Another example illustrates the broad reaches of thinking in forming concepts. John struggled to correctly match biped and unison with two remaining pictures. He knew from a process of elimination that they needed to be swapped, but struggled to figure out why they fit the pictures with which they belonged.

ST: Why is that unison?
John: Mmmm, I don't know. Because ummm...
ST: Let me give you another hint. What if I told you that 'son' means sound, so one sound.
John: (Whispers) one sound... (scanning the table)
ST: The problem is here, with these two (lady/unison - men in choir/biped)
John: That they need to be switched?
ST: Ok, why do they need to be switched? So let's switch them and then let's talk about why we're switching them. K, so let's talk about unison. What is this a picture of?
John: Ummm, people who look at the same place but who have different jackets?
ST: Ok
John: Maybe it's uniform
ST: Why are their mouths open?
John: What? Oh, they're singing!

John succeeded in forming a rather sophisticated concept of unison namely, people who look at the same place but who have different jackets. Not only was the concept based on both structural and functional attributes but John's knowledge that uni- means one is reflected in the fact that he notices that the choir singers are all looking at the same place (presumably the conductor). It is cases like this one that concept formation is most fascinating; John focused on the jackets

(preceding this segment of conversation was a moment where John grappled with what colour the jackets actually were in the effort to assign biped to the group based on the fact that there were two colours of jacket depicted) and the fact that the choir singers were all looking in the same direction while the fact that they have their mouths open (one of the more noticeable attributes) eluded him.

Familiar to Unfamiliar

When reasoning through unfamiliar material or when having to make preliminary "stab in the dark" guesses at the meaning behind words and pictures, John was the only participant who deliberated over the relationship that his familiar body of existing knowledge bore on the unfamiliar concept. In moving from familiar to unfamiliar, John simply applied what he already knew to theorise and make predictions about words and prefixes. The triggered thought that John demonstrated also incorporates the idea of moving from familiar to unfamiliar; when a concept or question struck a familiar chord, John was able to follow the new stream of thought to produce different possibilities. This tendency is most evident in the exercises in Stage Two where John had to provide simple definitions for compound words.

ST: So what's a flowerbed?
John: I think I've heard of it. Oh, is it like a bunch of flowers in a field? (gestures to show 'sweeping', as in sweeping across a landscape).
ST: Where else would you find a flowerbed?
John: Mmm, I don't know.
ST: Ok, great.
John: Maybe a forest?
ST: Ok... Would you ever find a flowerbed in a garden?
John: Yeah.
(long pauses - I gather he's finished)

When John commented that he thought he had heard of a flowerbed, he was likely engaging in semantic recall, where the word sounds familiar but he could not summon the matching concept. He suddenly became animated, likening a flowerbed to a field of flowers, and swept dramatically

across the desk as though he were gesturing towards a magnificent landscape. It is interesting that he made another guess, attempted again to recall the familiar word, but then located a flowerbed in a forest, quite the opposite of a field of flowers. John essentially worked with a flower theory that incorporated the ideas of where flowers might be found, where he has seen them before and subsequently extrapolated on his knowledge of flower habitat to theorise what a flowerbed might be. Curiously, when I suggested that a flowerbed might be found in a garden, he only mumbled "yeah" and waited for the next question. This may be a clear indication that John has a different idea of a flowerbed than those existing in a garden.

In the next example, John attempted to define a bedknob; his difficulty with verbal description is evident.

> (looks at the bedknob picture)
> ST: So what's a bedknob?
> John: Is... I think it's like a thing (pause, looks at pic again). I know it has to be this, I think it's like on your bed you have, you might have a knob thing on that, like, up there that may be a bed knob.
> ST: And what does a bedknob do, what's it's purpose?
> John: (shrugs) Just to be fancy, maybe...

It seemed as though John was veritably sifting through information, as one would sort through socks in a drawer to find the right pair to match an outfit. In several of the examples from John's data there is evidence of this sifting where he talks to himself and verifies that he has the correct answers, almost as though he is literally matching word to object. Compounding the problem is that John had difficulty explaining relationships between objects which means that he can succinctly state that a bedknob's function is to be fancy but cannot describe the bedknob's structural attributes. While describing the bed, John gestured a great deal to demonstrate the shape of the bed, the head and the foot and pointed to the bed picture to show possible positions for the bedknob; these were the parts of the bed he was familiar with. Once he had gestured through the bed parts he deduced that the bedknobs were on the headboard, thus incorporating

the unfamiliar with the familiar.

John correctly matched uniform and used the correctly completed matches as the familiar jumping-off point to deduce the meaning of the prefix uni-.

> ST: Why is that uniform? What's uniform?
> John: That, because... it... mmmm, I don't really know - oh, only one colour maybe?
> ST: Ok...
> John: No, but uniform is... well, unicorn (matches)...unicycle (matches). It means only one!
> ST: What means one?
> John: Uni-
> ST: Well done!

There were several instances of deductive process where students labelled pictures but could not explain why. Participants would make (often) correct matches but when prompted to explain the reasoning behind their choices, they said that they had no idea, that they just guessed or they simply had a feeling about the right answer. An interesting avenue for future study would be to investigate how these initial impressions shape and are shaped by word associations and relationships. For example, Cole correctly matched unicellular:

> ST: What makes that unicellular?
> Cole: I dunno! (laughs) I just guessed!

Although it was incorrect, Adam matched unison with the picture of the man in uniform:

> Adam: I thought unison was an older man or something.
> ST: Ok, what made you think that unison meant an older man?
> Adam: Umm, I dunno, I just thought it was. Something in my head just said that's an older man.

To return to the example of John, once this initial impression prompted the correct match of *uniform*, it is evident that even before he defines uni- he uses the uni- concept to deduce that uniform must mean *one* colour. Once he returned to the familiar material (i.e., correct matches that he had already completed), he verified the definition of uni-. There is another critical point in this example that will be expanded in the Discussion section of this paper; the fact that John

verbalised his analysis of uni- proved important in creating depth and sophistication in concept formation.

Visual Organisation

Visual organisation concerns the ways in which students organise the physical space to reflect group membership and shared attributes between groups. Visual organisation occurred in Stage Three where students were asked to physically arrange words in groups; therefore, all three participants moved the words around and placed them into groups. However, there was a significant difference between Adam's use of visual organisation and that of John and Cole. Where Adam limited visual organisation to creating the three groups and discussed the constraints of group membership verbally, John and Cole created patterns with the words as a means of demonstrating group membership. Cole was unique in the fact that he almost exclusively relied on visual organisation to create groups and demonstrate relationships, speaking very little and opting instead to shuffle groups and create patterns to illustrate group inclusion/exclusion and words that were leftover or reserved for later analysis.

John set up the first column for words containing *icycle* and then set up a second column for words with bi-. He placed the word bicycle between the two columns to demonstrate that it shared attributes with both groups. He then examined the words that were left over from this preliminary structural analysis and concluded that they either started with b, u or t. Once he noticed that r followed some of the t's, he quickly saw the tri-, bi- and uni- patterns and then organised them into their respective columns. It is important to note that John read the words aloud during categorisation; by reading words aloud, he became aurally attuned to the morphological similarity among word groups that helped him organise based on morphs rather than serial analysis of letter repetition.

Cole did not demonstrate this conversion from serial letter analysis to morphological

analysis as quickly and indeed that may be due in part to the fact that he spoke so little and did not read any of the words aloud. Cole began the grouping by placing bicycle, tricycle and unicycle in a horizontal line across the top of the desk. He then moved on to create the second category and then at my prompting, recognised that unicycle shares the group and created an L shape with unicycle at the intersection of the two lines (groups). Thus, the horizontal line group was composed of the bicycle, unicycle and tricycle while the line down group was composed of words with u in them (unicycle was common to both groups because it shared the attributes u and cycle).

ST: So are those going in a group?
Cole: Yep.
(piles most of the words together)
Cole: All of these have u's in them.
ST: Ok, so let's have a look. We've got unicellular, bicolour, unison, binoculars, unicorn, bicolour, ok. How about these - are there any here that would belong in this group?
Cole: Yep (chooses unicycle)
ST: Ok, so unicycle. great. So where are the u's? I want you to look at this group.
(organises L shape - u's down, tri's across. Tricolour shares the groups)
(unicycle, bicycle still in their own groups on the side)
ST: OK, so this is neat, how you've done this. So what does this mean, that you've organised this into an L shape?
Cole: Uhhh, I don't know.
ST: So you've grouped these this way and then you've put these across the bottom.
Cole: That's in two groups.
ST: OK, so this is one group here and this is one group here?
Cole: Yep.

Cole then made the tri- group by adding on another horizontal line, thus creating a Z pattern where the word tricolour lay at the intersection, reflecting that it shared characteristics with both the u category and the tri- category.

ST: This is great - I love seeing when people do stuff like this, that's why I'm smiling. So what is the group here?
Cole: At the beginning it says like, tri-?
ST: OK, and then, this word, tricolour also belongs in this groups because it's got a *u* in it?

Cole: Yep.
ST: So let's leave that for a minute and let's look at these - is there any other way we could group these? And before we get to that what about these (the cards left on the side)? Are they staying in that group or do they belong in a different group?
Cole: They stay in that group.
ST: So my question is (point to top) how does unicycle fit into this then? Does it belong to two groups?
Cole: Mm hm (makes Z shape with cycles on top)
(cards leftover on left side of table)

Despite a comprehensive visual analysis of the number prefix words, Cole had not accounted for several words that remained outside of the conceptual structure that lay before us. I drew Cole's attention to the tri- group in order to help him understand the concept of the prefix and direct him towards a prefix-based strategy for grouping the words.

ST: So what I want you to do now is I want you to look at the words differently again... So the way you've categorised these is *very* interesting, now I want you to look at the words differently, as I said. So think of how you did this. You said these all start with tri-. Tri- is actually a prefix. Can you find any other words with another type of prefix here?
(long pause)
Cole: (shakes head)
ST: So let's look at unicorn. I'm going to tell you that there *is* a prefix in unicorn. I'm wondering if you can think what it might be.
(long pause)
Cole: (shakes head)
ST: Take a wild stab - what do you think it could be?
Cole: Un?
ST: Ok, good. Now let me give you one more bit of information. The prefix in unicorn has something in common with these prefixes - with tri-.
Cole: The i? Maybe?
ST: So that would be the prefix - the uni-.
Cole: Okaaay?
ST: So we've got tri-, that's one group and here's uni-. Which other words would fit into this group? (uni)
Cole: Ummm...
ST: So let's rearrange these groups here a little bit and we'll put these back in the pot (the two cards left on the side of the table). Let's rearrange the groups.
(long pause)
Cole: (puts all cards in one pile)
(laugh)

Once Cole had established the tri- and uni- groups it became apparent that the next task was to reconceptualise the organisation of the groups so that at least two thirds of the words belonged under either prefix. However, Cole recalled the part of the conversation where we discussed the fact that all the words have i's and decided to organise the groups based on the i's, even though the initial direction stipulated that he must place the words into three categories.

> ST: So now what? (laugh) Now you've put them all back together again!
> Cole: Yep, they all have i's.
> ST: Ok, good (laugh), so they all have i's. Now, I said at the beginning that they have to go in three groups. You're right, this is exactly what I'm trying to see. Because when you look at words, just so I can help you through the muck a little bit here... When you look at words, there are *lots* and lots of different ways of categorising words right? Because a lot of them have the same letters. So what we're looking at here with prefixes, is we're looking at groupings that come at the beginning of words. OK? So the way you noticed this with the tri's... So we have triangle, triceratops, tripod, tricycle, right? And then tricolour. So that's one group. So tell me again, what is the chunk of letters that comes at the beginning of these words? What is the prefix at the beginning of these words?
> C: (long pause) Tri-?
> ST: Then we looked at unicorn and said uni- was another prefix. So look at all the words again and find the ones with uni- at the beginning.
> C: (makes the uni- group)
> ST: So what do we have left, then? What are these words?
> Cole: Uuuuuh...
> ST: What prefix do they have?
> Cole: Bi-?

At this stage of the conversation we had begun to move away from focusing so heavily on visual organisation of the groups since evidently, grouping according to the serial analysis of letter repetition between words could go on indefinitely and put us no closer to morphological analysis. Once we returned to the morphological analysis that we had previously incorporated into the assignation of groups, Cole was able to see that once uni- and tri- were restored as conceptual centres of two groups, bi- revealed itself as the third prefix group and we were then able to complete the activity.

Morphological Analysis

Since participants were forming concepts of Latin prefixes, it is unsurprising that they engaged in morphological analysis to relate words, objects and people with those prefix meanings. Although morphological analysis was not the predominant means by which participants drew relationships, it is important to consider as it was the goal of the dynamic assessment.

The majority of instruction on morphological analysis concerned the shift between understanding a word for its semantic attributes and understanding the word for its structural (i.e., morphological) attributes. Morphological analysis permits the understanding of words in qualitatively different ways than semantic analysis. Semantically, we either have or have not heard of the word; we can either define or locate its meaning or we cannot. Apart from recontextualising the word, there are no strategies to achieve a correct interpretation. Morphological analysis implies an analysis that is directed towards the segmentation of words, the understanding of each morph as an abstracted entity and the subsequent reconstitution of the word whereby meaning parts must be integrated. Of course, there are words that cannot be analysed morphologically (e.g., Anglo-Saxon words such as *dog* or *wife*), but for words that are Latin derivatives, there are indeed these two levels of analysis available. Observation of the shift between them reveals not only how concepts of Latin prefixes are formed but how knowledge of the entire word changes.

All three participants shifted between semantic and morphological analysis. Without exception, all of them began the activities with semantically based analysis. A consistent theme across participants was my instruction to examine words differently, to look at the parts of the word rather than the meaning of the words. When Adam had to reorganise the word groups he had initially created in Stage Three, I explicitly instructed Adam on observing word structure in order to create the three categories, inclusive of all the words.

ST: So maybe try looking at the words a little bit differently. Maybe there is a different way of categorising them. Well, there has to be a different way, right?
(long pause)
ST: Ok, let me give you a bit of a hint. So here, why did you put these together (colour)?
Adam: Because it has colour in it.
ST: For these you actually looked at the word and what the word is composed of.
Adam: Yep
ST: And you saw that both words were composed of *colour*?
Adam: Bi- and tri-.
ST: Right, and the same here too. You looked here, with unicycle, bicycle and tricycle and you saw that all three words have which word in them?
Adam: Cycle (pronounced sickle).
ST: So, maybe, what if you try looking at different parts of all the words. Do they have anything in common in that sense?
Adam: Oh! (organises into tri-, bi- and uni-) Triceratops (whispers). What's a tripod?
ST: (points) That's a tripod.
(finishes arranging)
ST: Great, and now you've got your three categories. What would you call this category?
Adam: The uni- category...
ST: And this would be?
Adam: Tri-.
ST: And this is?
Adam: Bi-.
ST: Soooooo, do uni-, tri- and bi- have any sort of meaning?
Adam: Bi- is like two.
ST: Great, so if bi- is two, what do you think tri- would be?
Adam: Three.
ST: And what is uni-?
Adam: One.

By pointing out the structures that were common across the three groups, Adam was able to deduce that it was through analysis of the number prefixes that he could group words and formed the concept of each group based on the prefix. The most interesting point is that Adam assigned each prefix its correct meaning; one would think that if the meaning came to him so easily, it must have pre-existed the exercise in some form. However, by organising each word, acknowledging meaning at the semantic level and attending to meaning derived at the morphological level (i.e., prefixes), Adam was able not only to perceive the morphological similarities but structural

similarities among the objects themselves. In this manner, prefix meanings emerged and formed the concept of the group. This example serves to illustrate the shift between semantic and morphological levels of analysis; that concept formation of Latin prefixes is not a linear, one-dimensional process of structural analysis.

The point is further illustrated in the next example where Adam attends to the meanings of each morph in order to deduce the meaning of the word and match it with the correct picture.

(trying to match the word unison with its picture)
ST: Translates literally to *one sound.*
Adam: One sound (looks around)...
ST: So where is the pic that shows one sound?
Adam: (points to the amoeba)
ST: Why would that show one sound?
Adam: Because it's like one little...
ST: But does it make a sound?
Adam: Noooo... something that makes a sound. (pause) A flag makes a sound 'cause when it blows in the wind... (looks around) These guys look like they're singing (men in choir) but there would be more, there's only like, 15.
ST: What if they're singing together, like in a choir?
Adam: Oooooh.
(matches unison with the choir singers)

Adam began with *one* and pointed out the amoeba. When I prompted him to connect *one* and *sound* he acknowledged that the amoeba did not make a sound; his analysis only satisfied the initial structural criterion. He then moved on to survey the pictures according to the sound attribute, picking out the flag and the choir singers, but thinks that there would be more than 15 that suggests that he is tying singing and sound to a larger number of people; perhaps his concept of 'choir' involves more than 15 people. However, when I labelled the picture with the word choir Adam was able to make the correct match.

John assembled a concept of bi- by starting with the functional definitions of bicycle and binoculars.

ST: Ok, tell me what binoculars are

John: Binoculars are, um, things that uhhh
ST: What do you use them for?
John: Like seeing far or looking, like if you see an animal and you're trying to hunt it then you could use binoculars (gestures with fingers around eyes)
ST: So which part of your body do you use with binoculars?
John: Ummmm, your eyes? (does the binocular gesture again)
ST: So tell me, do the words binoculars and bicycle, do they have anything in common?
John: They both have b's... oh! they both have (makes the binoculars gesture again and moves hands up and down) two... bicycles have two wheels and binoculars have two (gesture again) seeing...
ST: So what do you think bi- might mean?
John: Means, multi. It has two (gestures two with fingers)
ST: Two? ok, so let me give you the pictures.

By discussing the functional attributes of *bicycle* and *binoculars*, John explored the context surrounding the semantic level of interpretation. Because he used gestures to point out two wheels and two lenses, he could easily connect not only that the two words started with b but that they had *two* in common that resulted in an easy transition into an observation of the bi- prefix and its meaning.

Cole used morphological analysis in the same fashion, although he formed Latin prefix concepts mainly in response to my prompting (as discussed previously). Consequently, information on the means by which Cole formed prefix concepts could be observed as an outcome rather than a process. It was only once he made the matches that he was able to give reasons why as opposed to the other two participants who talked through the activities.

(matches unicorn)
ST: So what makes that a unicorn?
Cole: It has a horn, sort of.
ST: How many horns does it have?
Cole: One
ST: And what makes this a tripod?
Cole: It has three sort of stands sort of?
(matches triceratops)
ST: What makes that a triceratops?
Cole: Three horns.

Cole: (sifts through pictures, matches to words - looking for familiar pictures first). (matches tricycle)
ST: What makes that a tricycle?
Cole: Three wheels
ST: So are you getting an idea of what tri might mean?
Cole: Yeah, three.
ST: So if tri- means three what might uni- mean?
Cole: One
ST: And bi- means...?
Cole: Two.

Of note is the fact that Cole had no difficulty matching the words *unicorn* and *tricycle*; he sifted through the pictures and selected the ones with which he was most familiar. Having Cole define each match without exception meant that he was able to hear the prefix patterns as he read the words. This strategy was particularly important given the fact that Cole had difficulty visually identifying structural attributes of the words at the beginning of Stage Three. By having him say the words aloud that he was attempting to conceptualise we achieved a verbal structural analysis which, as we would observe in the final worksheet exercises, was extremely fruitful.

Defining the Concept vs. Using the Concept

According to Vygotsky (1986), if a child has fully formed a concept, they should be able to give an accurate verbal definition. In order to tease out the interaction between concept definition and concept usage, each stage was followed by a worksheet with questions that necessitated the manipulation of the Latin prefix concepts. Thus, this section outlines the performance of the three participants on the worksheets that followed Stage Three and Stage Four.

The worksheets, however, presented additional constraints on the participants because they had to co-ordinate prefix concepts with additional semantic and syntactic challenges. Because students not only had to be cognisant of Latin prefixes but also tricky syntax, creation

of nonwords (e.g., excat, substend), sifting through pertinent information for prefix referents in order to choose or create the correct answers became that much more difficult. Consequently, in examining the final worksheets to understand how participants defined and used Latin prefix concepts, it is important to consider the greater sophistication of linguistic expectations and how their knowledge of prefixes functioned against this background.

Adam and John both performed similarly on the final worksheet tasks; they both continued to verbalise their thought processes, make guesses and revise their answers based on feedback to prior questions. They both used the definition cards to remind themselves of the correct prefix meanings and both struggled predominantly with the syntactic aspects of the questions. The examples below illustrate the syntactic difficulty both participants experienced on the question about Pluto on the Stage Four worksheet (Appendix H).

Adam: (reads question) I have read ten books about Pluto and I can only include or conclude that it's not a planet. Hmmm, this was made recently.
ST: Oh, you heard about the whole Pluto debate, did you?
Adam: Yeah.
ST: I think I watched a news program just the night before I wrote this so...
Adam: Oh, so you wrote this.
ST: Yes.
Adam: Ooooooooh... (laughs) Reads the question again. This one's like, it ISN'T a planet, so er, conclude (looks at cards) or include... So include because it could be invisible. It can't be part of the planets, it's too small.
ST: OK, but in- doesn't mean invisible - we put that down as a reminder that it can be opposite. So there are ten books. So I read all the information and put it together (hold hands apart and clap to gesture the coming together), ok, so the information is working as a team...
Adam: Oh, conclude, because it's together.

John: Include that it's not a planet - because it isn't a planet.
ST: Right, let's look at that. Let's try the other word.
John: Include means that it is a.. conclude...
ST: So let's look at our prefix in-.
John: In means *not*... but, oh. *Con*clude... that it is not a planet
ST: Right? Con- means bring together, so we bring together all the bits of information
John: Because it is *not* a planet.

Adam and John both struggled to figure out what con- and in- referred to. Adam wondered if in- referred to the fact that Pluto is virtually invisible while John thought that in- referred to the syntactic element *not*, making a literal translation between in- meaning *not* and *not* referring to Pluto's new classification of not being a planet. They both switched to *conclude* as the correct answer but again, for different reasons. Where Adam attached the con- meaning to the prefix definition, John made a semantic/syntactic justification (i.e., according to the meaning conveyed by the sentence, *conclude* fit appropriately). Where Adam was able to use morphological analysis of the prefix concept to deduce the correct answer, John moved away from morphological analysis to instead think through the logic of the sentence by trying out the correct word. For the last question in Exercise C, Adam reverted back to analysis of the semantic/syntactic aspects of the sentence in order to choose the correct word.

> Adam: Include is... (studies cards) can mean allowed or inallowed.
> ST: Right...?
> Adam: And ex- can mean out. So it would be exclude.
> ST: (points) My mother *refused* to...
> Adam: Oh, to *in*clude him, to let him come.

Adam first ascertained the meaning of *include* and implied that he was examining the prefix by stating that in- can have two meanings. He then defined ex- correctly, demonstrating that he was making an accurate appraisal of the function of the Latin prefixes in the word choices (i.e., include/exclude). He chose *exclude*, drawing a relationship between the literal meaning of Josh being left out of the trip and the definition of ex- being *out*. When I drew Adam's attention to the syntactic feature *refused* and imbedded it in a sentence fragment, Adam understood the meaning and thus chose the correct word. Essentially, this phenomenon demonstrates that Adam and John both attended to the prefix definition as a concrete sentence attribute, thus perceiving a relationship that moves between sentence structure and prefix meaning structure. When this

relational analysis failed to reveal the correct answer, both Adam and John relied instead on semantic/syntactic cues to answer the question, an interesting linguistic problem-solving strategy.

Adam and John also had difficulty in understanding the use of a referent in creating definitional nonwords.

ST: So what are you going to call that mouse?
Adam: Dismouse
ST: So remember you have to actually refer to what it came out of.
Adam: Decat mouse?
(laugh)

ST: So the mouse came out of the cat
John: Exmouse?
ST: remember though, you have to include this word, what it's come out of
John: De...? Like threw...
ST: It's come out of the cat, right? So it's an excat mouse.
John: Excat.

Both Adam and John were able to use the correct prefix in response to the question; Adam was able to suggest de- as an alternative to dis- and John was able to define the meaning of de-. Once again, the difficulty for both these participants was providing the full definition for each question, including all of the necessary syntactic components.

Perhaps the most unexpected result of this section and indeed of the entire study was the performance of Cole who had demonstrated difficulty in understanding expectations, who relied so heavily on my cues for concept formation, who struggled to see beyond discrete attributes of pictures and volunteered little to no supplemental discussion throughout the testing. Cole was extremely tired towards the end of Stage Four and indeed requested that we stop the assessment soon. He agreed to start one part of the worksheet on the condition that we could stop at the end of that section. Thus, Cole completed Exercise C on the Stage Four worksheet that concluded his assessment.

Cole's performance on Section C was effortless and he answered every question

correctly on the first attempt. As he was extremely fatigued, I did not press him to reason through each of his answers. However, Cole paused on the distended/substended question to ask me if he was correct.

> Cole: (circles distended) Is that right, I think?
> ST: Yep, why do you think it's right?
> Cole: Because... (pause)
> ST: What would it mean, show me how your belly would look if it were substended.
> Cole: (thinks) Like sort of like... (long pause)
> ST: You can show me with your hands if you can't describe it.
> Cole: I don't know. I really don't.
> ST: So dis/de means apart or away, right? So it's like your belly is sticking out, like this (gestures). So if it were substended it would be... (Cole: yeah) hanging down. Right? Because it's below?
> Cole: (nods head)
> ST: So that's why that is right.

What was remarkable about Cole's performance is that although he asked if he was right, his difficulty lay in finding the means to explicate his thought process as opposed to making the correct choice. It was as though he was absolutely sure of himself yet could not explain why or gesture how distended vs. substended bellies would look.

The fact that Cole completed this final worksheet section with so little difficulty might suggest one of two things. First, Cole may have relied solely on syntactic/semantic cues in reading the questions; he may have known which word fit because it sounded better or made more sense. Second, Cole may have assembled a conceptual base of Latin prefixes that was stable enough to accommodate the tasks before him so that morphological analysis occurred effortlessly. Because he read the questions to himself and quietly circled the answers, there is not enough information from which to glean any useful data in regard to these conjectures. Given the fact that Cole's previous work on Latin prefixes had been scattered and unfixed, it would be surprising if he was indeed engaging in a so-described morphological analysis. Still, as in the case of John's triggered thought, perhaps it is the recontextualisation of the Latin-based words that

helped Cole gather a newer and more practical sense of word usage that moved him away from abstract analysis and into semantic analysis where he could experience a different dimension of understanding. Whichever the case may be, we must consider the fact that performance in concept formation tasks need not bear resolutely on the ability to use those concepts.

These results have shown the varied and idiosyncratic ways that the three participants formed concepts of Latin prefixes. Studying the ways students used language, flexibility of expression, language triggers and concept placeholders helped illustrate representational approaches to learning concepts while anecdotal knowledge helped students provide context and support for those representations. Participants' observation of the attributes themselves indicated specifically which aspects of the images and words they were abstracting in forming concepts, an important consideration since the attributes the participants chose bore significantly upon the relationships they perceived among the objects and phenomena presented in the images. The relationships themselves were rich and varied and reflected strategy use, anecdotal knowledge and the vast number of ways that participants interpreted those relationships. Finally, whether the participants could define the concept and/or use the concept revealed the assumptions upon which the Latin prefix concepts were formed and whether they were used correctly.

These results indicated significant findings regarding Vygotsky's notion of concepts and concept formation as well as the pecualiarity of learning concepts that translate from Latin to English. Clearly, concept formation of Latin prefixes is a sophisticated process requiring consideration of individual similarities and differences, all of which are discussed in the following section.

Conclusions and Discussion

This study has elucidated the finely nuanced process of concept formation of Latin prefixes through the examination of language and strategy use of three pre-adolescent participants. The study was designed based on the Vygotskian (1986) theory of concept formation which stipulates that individuals must be prompted to actively overcome mental obstacles so that concept formation can be observed.

There are five major findings in this study. First, Vygotsky's experimental design was narrow, artificial and grounded in the existence of objective knowledge; once concept formation was focused on everyday objects and phenomena the subjective nature of concept formation became evident which in turn called into question the theoretical underpinnings of the Vygotskian construct. Second, for the participants in this study, the formation of Latin prefix concepts was a highly individualised process with no common pathway. Third, the concept formation tasks necessitated a large body of existing and constructed knowledge, drawn both from the participants' experiences and through interaction with the examiner. Fourth, the movement between Latin and English meanings meant that in addition to constructing English concepts, participants struggled with literal Latin translations that did not have English equivalents; the concept had to be constructed twice in some cases, first for Latin words and then for their English counterparts. Finally, while Vygotsky's stage theory may be used to interpret limited aspects of the data from this study, it failed to provide a reasonable paradigm by which concept formation of Latin prefixes may be captured; script-based and context-dependent theories of concept formation are more appropriate theoretical constructs to this end.

Theoretical Underpinnings

It is important to consider the nature of the tasks Vygotsky used to establish his theory of concept formation and their inherent assumptions. In the tradition of developmentalists

interested in concept formation who had gone before him, Vygotsky's tasks were based on wooden shapes whose colour and thickness attributes had clearly defined boundaries. According to Garner (1974) some dimensions of category structure seem to be easily isolated as separable units such as shape, colour (in terms of colour, Garner indicates that hue and saturation dimensions are not easily separable and cannot be used independently to classify colour) and size, precisely the dimensions along which Vygotsky created his testing materials. Even apart from Garner's proposal that children may treat shape and colour as integral to the categories and thus not achieve separability of characteristics, the very fact that the attributes are clearly bound means that group inclusion is far more clearcut. For instance, the block design Vygotsky used contained blocks that were prototypically blue, red, black or yellow. That is, each colour was distinct from one another so that colour attributes were clearly delineated; a block could either be yellow or not yellow. Conversely, the activities used for this study contained objects and showed phenomena found in everyday life since these images conveyed the Latin prefix meanings. When there are no obvious boundaries or reference points in the continuum of a dimension, it becomes far more difficult to determine whether two objects do indeed share attributes (Keil, 1989).

This is a significant consideration since Vygotsky's theory, particularly in his discussion of thinking in complexes, pivots on the type and number of connections individuals make among objects. Complex thinking is partly characterised by the identification of an infinite number of connections among objects. Since the children at the complex thinking stage were attempting to create concepts of shapes with bound attributes their tendency to create groupings based on partial identity stand in stark contrast to the "correct answer". Vygotsky assumes an objective reality; there are concepts that exist outside the child's language use capabilities that would otherwise permit the appropriate use of the word in sharing an objective meaning. As the child

moves through the developmental pyramid of concept formation they become increasingly able to use words to signify historically and culturally situated concepts.

When we consider the continuousness of object categories (Rosch, 1999) and the fuzzy boundaries distinguishing the vast majority of objects, concept formation of everyday phenomena must be understood in terms of the subjective meanings drawn from the multitude of connections that can be made among them. When grouping and conceptualising everyday objects in everyday situations as the participants were asked to do in this study, it is evident that there are indeed a large number of valid connections that can be made among objects. For instance, in Stage Four, John was able to establish four possible attributes in the planes picture: that they were in the air, colour of the jetstream, their *V* configuration and finally that they were flying "together". Participants in the present study had a great deal of choice in terms of the image features they would link together to express a prefix concept. Broadly, participants could group according to either structure or function. Since most of the images presented in this study contained animals or people in natural situations, students could attend to their actions, clothing, gestures, hair or skin colour, peculiar markings or any combination of these attributes. The participants in this study had to select common attributes, justify their choices and then explain the underlying concept that bound objects into their groupings. Vygotsky defined concept formation as the ability to group on a single attribute; this finding was largely a function of the block design testing tool. This study demonstrates that once the testing tool is located in everyday scenarios, Vygotsky's very notion of conceptual thinking can no longer be validated. This study underscores the personal, subjective and shared nature of concepts and refutes Vygotsky's notion of concept formation as growth towards an end state of simultaneous abstraction and generalisation of a single attribute.

The finding that Vygotsky's block formation task implies a completely different set of

assumptions than this study based on everyday objects and situations is corroborated by Fodor (1972) who argued that Vygotsky's block task is not really a study of concept formation at all. "Arbitrary conjuncts of features in short-term learning situations in which children are attempting to discover the experimenter's rule for labeling hardly constitute a naturalistic measure of conceptual development" (as cited in Keil, p. 17). Indeed, the conceptual constructs that children hold are not simply impoverished versions of fully developed adult concepts. By assuming heterogeneity of concepts and subjective understandings of phenomena, it becomes possible to understand concept formation not necessarily as a developmental trajectory but rather as a series of linguistic, experiential and interactional changes.

Concept Formation is Highly Individualised

The second finding of this study is that concept formation in the participants in this study was highly individualised with no common pathway. Differences ran along the lines of how participants began the tasks, completed the tasks, used language and worked with feedback.

For Stage Three (number prefixes) Adam chose to begin by looking at the first letters of each word in order to group them while John verified what I meant by *categories* by predicting the first group based on the final spelling pattern *cle*. Unlike Adam and John, Cole didn't respond verbally to the task instructions, choosing instead to form the first group (bicycle, tricycle, unicycle) according to the structural attribute of *having wheels*. Due to the fact that each participant started by attending to different features of the word, the direction in which they elaborated the initial theory also differed. Adam formed the prefix categories based on observation of structural and functional elements of the objects represented by the words but moved easily to a structural analysis of the words when I drew his attention to the fact that morphs represent the structural and functional aspects of the objects themselves (e.g., tricolour means three colours). John remained glued to the print and focused predominantly on spelling

patterns as a means of categorising. Unlike Adam, John required explicit instruction on the idea of prefixes to move him away from spelling pattern analysis into morphological analysis; I gave the specific examples of *bicycle* and *binoculars* to help him draw the conclusion that word chunks called prefixes represent a concrete aspect of the objects to which they refer, in this example, that *bi* refers to the fact that both bicycles and binoculars have two of something. Different still was Cole, who had difficulty continuing the activity after his initial grouping because the words were all unfamiliar to him, indicating that he was grouping according to the objects represented by the words themselves rather than tapping into the morphological features of the words. Using the initial grouping (bicycle, tricycle, unicycle) I directed Cole's attention towards the structural aspects of the word. He continued to have difficulty understanding that prefixes or word chunks had to consist of more than one letter. We worked through an extensive visual elaboration of his conceptual scheme that involved reminding him of the conditions of categorisation for the task, namely that he was placing the word equally into three groups and that he must engage in structural analysis. As stated previously, Cole did very little talking and his concept formation strategy functioned solely on my verbal feedback in the form of questions and prompting.

At the end of the matching task in Stage Three, each participant had correctly matched each word with the corresponding picture, since a goal of dynamic assessment is to have the student complete the task, regardless of the amount of scaffolding required. An interesting similarity was that all three participants ended the matching task with matches they did not understand. As the activity drew to a close, participants matched based on a process of elimination and guessing rather than analysing word structure and matching the picture that reflected that structural feature. Each participant "tried out" a final theory to link word and picture but lost interest and waited for me to fill in the missing information. This demonstrated that task completion (i.e., matching all the pictures to their correct words) was as much, if not

more, a priority as understanding the link between the words and pictures and illustrated the idea that participants used getting the correct answer as a measure of success, even if that meant they did not carry away a full understanding for the reasons behind the final matches. For instance, John had been talkative, attentive and excited throughout the activity but became distractedly cavalier on discussing the relationship between *unison* and the choir singers. This may indicate his fatigue, although given the fact that he recouped his energy for the worksheet segment shortly afterwards, it is more likely that he simply considered his work done once the final match had been made.

The ways participants used and manipulated language in response to the dynamic assessment also illustrates the highly individualised nature of concept formation. As stated in the section on Language Use, where Cole responded with one word utterances for the majority of the testing, Adam and John were both talkative, using linguistic devices in different ways to form concepts. Adam either devised terms or used words to represent concepts, tying subsequent image interpretations back to a single word and then used that word as the placeholder for the concept. This process was evident in his representation of the dis-/de- group (Stage Four) as grammatical equivalents of *break* (i.e., breaking apart, breaking open, sweeping up the dirt from something that broke). Adam's efforts were focused on establishing a model of representation based on the word and fitting any subsequent interpretations around the use of that word. This method of establishing the word as conceptual signifier, once established partway through interpretation then was used to direct attention to specific attributes. In the above example, attempting to shoehorn the final picture of the dirt being swept by a brush into a *break* concept, Adam attended not to the action of the brush sweeping but the material that was being swept. This example revealed the recursive nature of concepts and language, each shaping the other in turn as representations are established and new information is integrated into the conceptual

model.

Through his conversation and verbal experimentation, John used words and phrases as triggers to explore attributes and create hypotheses. He would voice his thoughts and in doing so would provide himself with another avenue of thought to pursue. By the same token, ideas and answers would come to him like a sudden flash of insight so that the assessment was a process of talking through seemingly unproductive lulls until the next trigger point or key words were activated to stimulate cognitive movement. Unlike Adam who plodded logically and persistently through tasks, operating with words as representations, John's thought process and conversation was often difficult to follow. As the examiner, I would only understand the direction at the subsequent trigger point when John hit on another word or phrase that reminded him of a different object or event that he would then talk through and move beyond. Where I felt I was working in tandem with Adam, I very much had the sense that I was trailing slightly behind John, waiting until I had enough (coherent) information to stimulate change in his thinking. Still, John worked in relative privacy, his flashes of excited insight being some of my only clues to his thought process.

Cole was unique in the sense that unlike Adam and John who used their own language as a means of constructing concepts, he relied on my questions and feedback to guide his formation of Latin prefix concepts. Concept formation in Cole's case was a process of abstracting attributes and postulating relationships and then modifying those theories based on the feedback he received. In Cole's case, a dynamic assessment approach was particularly effective because it generated the language base from which Cole could form a conceptual structure. In adhering to the principle of dynamic assessment which stipulates that students are to be taught tools for detecting underlying conceptual structures rather than being told answers, the circuitous exploration of Latin prefixes meant that together, Cole and I could create a network of

understanding that included both fruitful and unfruitful avenues of thought. For instance, in attempting to begin Stage Four (matching pictures to their prefix meaning groups), Cole had significant difficulty in understanding what I meant when I asked him to match the stack of pictures with their meaning groups. Instead of reiterating the instructions, I asked him if he could clarify his confusion. When he could not explain what was difficult to understand, I worked through the example of a cablecar with him, asking him specific questions regarding the attributes of the cablecar picture and the meaning conveyed. When he still did not understand the task, I turned to another example I thought would be more transparent. I chose the geyser picture and asked Cole again to attend to increasingly specific attributes of the picture. When I asked him to describe the picture he pointed out that there was water in the picture. My subsequent questions concerning the location of the water, what it was doing, how it was coming out of the hole and so forth were all designed to narrow the focus of his attention to specify particular aspects of the image. This questioning method was used throughout the dynamic assessment and served the purpose of creating a language base that increased and decreased in its specificity, depending on the task. This format permitted the appraisal of both specific and general functional and structural attributes so that Cole could understand the images as a whole while learning to select specific qualities. It was this scope and choice and the consequent selections that served to shape his concept of Latin prefixes. Indeed because there was a peculiarly extensive discussion of these images, a linguistic base was devised through the interaction that later served to help Cole navigate the worksheet which tested the qualitative aspects of the concepts he had formed to that point. Simply put, where Adam and John generated concepts largely from their own language use, Cole predominantly formed his concepts of Latin prefixes through our interaction.

These individualised approaches to concept formation are important to consider because they point to the dramatically different ways that students use language and interact with others

to create a knowledge base.

Concept Formation Implicated a Large Body of Knowledge

The third finding of this study is that participants used a large body of both existing and constructed knowledge to form Latin prefix concepts. Since the task instructions for both Stage Three and Four did not specify strategy use and instead directed participants to simply categorise or match, their means of doing so revealed important information about task conceptualisation and execution.

Since Cole volunteered so little commentary and his process of concept formation relied heavily on my ability to elicit information, he followed a significantly different pathway than Adam and John who *did* supply theories and anecdotes, asked questions and verbally formed hypotheses. It is true for Cole that he required a large body of knowledge to complete the tasks but the onus was on me to supply the appropriate questions, draw attention to salient characteristics and assist him in moving from vague terminology to supplying specific descriptions. As in the geyser example above, Cole was able to say that there was water in the picture, but I had to pose four additional questions and finally supply specific details that would define a geyser and differentiate it from any other setting where water played a part (e.g., swimming in a pool, mixing juice, washing a dog or surfing). To reiterate, it was true that Cole depended on knowledge to form the prefix concepts but it in terms of fully generating the specificity required to differentiate one image from another, Cole relied on my cues as assessor.

Conversely, Adam and John employed a number of strategies, recalled experiences and experimented with interpretations in order to work through the conceptual hurdles and establish relationships among words and images. Use of anecdotal knowledge and storytelling was one of the more striking aspects of their efforts to find connections among objects and phenomena. For instance, John relied on anecdotal knowledge to work through the relationship between bicycle

and binoculars. He started by describing the function of a bicycle (that you can ride them and do tricks with them) and then moved onto a detailed description of the appearance of a bicycle, peculiar because he described a bike as though he were giving instructions on how to assemble the parts of a bike. When he moved on to draw a relationship between a bike and binoculars, he again started by describing the function (that you use them to see far away or when hunting). John gestured the shape of binoculars by making circles with his thumb and forefinger and held them to his eyes. The gesture moved him away from analysing the words bicycle and binoculars for their letter patterns and suddenly he understood that they have *two* in common (i.e., two wheels and two *seeing*).

In another example, Adam attempted to match dis-/de- with the correct picture group at the end of Stage Four. Up to that point, he had made matches by identifying words that had the same prefixes and thus the same meaning. This in itself is remarkable as it demonstrates that Adam understood the concept of morphology (i.e., that prefixes represent meaningful structures in terms of object identity). Adam came up with the word *dispose* as an example of the dis-/de- prefix and analysed it in terms of a disposable camera, more specifically, what it means to dispose of something. He drew a relationship between disposable cameras and literally disposing of the yolk from the egg to conclude that they both had to do with throwing away. This conclusion allowed him to correctly match dis-/de- with its image group.

These examples epitomise the role of anecdotal knowledge in concept formation and underscores the importance of having a significant knowledge based from which to draw postulates and conclusions regarding relationships among things.

Generally speaking, the more knowledge the participants had, the more connections they were able to make and thus the more relationships they were able to establish. Even when the participants were not able to explicitly define the objects or phenomena, they were able to use

existing knowledge to support the concept formation process through inductive reasoning (i.e., coordinating specific details of both the task and existing knowledge). For instance, Adam used the following series of ideas to understand the task and form prefix concepts: The Flintstones (watched at his Grandma's house), prehistoric times,the French translation of foot (pied), Stonehenge/National Geographic, gravity and the series of words with prefixes used to match prefixed words with their groups (combination, explode, intrude, disposable, acquiring, assign, appear, arrange). In Adam's case, the sophistication of his knowledge lent specificity to the images he attempted to group. Specificity in identification and hence in forming concepts is important because it was that specificity that allowed the participant to understand the number of planes on which objects could bear relationships to one another. When the individual just sees a stack of rocks with no particular configuration, they are limited to relating the object to others in the sense of rockness, in other words, in terms of its size, shape, colour, weight, situation in the picture. When the individual sees Stonehenge, they understand as Adam did, that the rocks were deliberately placed in that configuration because ancient people used them as a calendar. The rocks are understood to have a relationship due to their design. *Rocks* suddenly gain a social, cultural and historical identity relative to their location in England, a research base that states their use as a calendar as an ontological hypothesis as well as all the event components surrounding the time when Adam actually learned about Stonehenge such as a family holiday, classroom setting, particular readings, postcards etc.

To contrast this example with Cole who only saw water in the geyser image, this superficial analysis means that for concept formation, Cole may not perceive the number of class differences among objects simply because he does not perceive (or at least acknowledge verbally) the number of attributes and identifying characteristics. Thus, anything that has to do with water or shows water would belong in the same category. It is true that *water* can be one attribute along

which objects and phenomena are grouped, and indeed we followed this method of analysis so that Cole could identify two other pictures that "all have water" (iceberg and pool diver picture). However, when Cole had to identify how the water looked in relation to the other objects in the images (i.e., coming *out of* the hole in the ground, the iceberg floating *in* the water, the man diving *into* the water), he found it extremely difficult and a great deal of instructional effort was made helping Cole to understand that there were numerous attributes in the pictures, each of which could be abstracted to conceptualise objects differently. It may be the case that this difficulty Cole experienced in observing multiple attributes, particularly abstract attributes, may not necessarily be related to the amount of knowledge that he possessed. What it *does* confirm is that knowledge had to be constructed and that this method of perceiving had to be explicitly taught through repeated comparison and examples using the exercise materials. Through analogy, explanation, exemplars, deductive and inductive reasoning efforts, Cole was finally able to match all the words and prefixes with their images in both stages. The fact that Cole was so readily able to answer the questions in the final worksheet seems surprising; surely after having such difficulty with the concept formation activities, the worksheets through which he had to summarise and use his knowledge of prefixes would be at the very least challenging. My contention is that the knowledge Cole needed to answer the questions was developed through our interaction. Certainly, Adam and John developed knowledge through our interaction but insofar as they came to the activity with far greater knowledge, the work was focused on analysing relationships. Conversely, the work with Cole was focused on constructing knowledge of each image and acknowledging the number and nature of connections among attributes. Once Cole had gathered all the information he required and perceived the images for all their complexity, the conceptualisation tasks followed with relative ease.

The Peculiarity of Forming Concepts of Latin Morphs

The fourth finding is not a major one but is important to consider in terms of its implication for instruction. In using Latin prefixes as the means to study concept formation, forming the prefix concept involved an additional stage in which participants had to translate meanings between Latin and English. Part of the difficulty in teaching Latin prefixes is that the meanings are often extremely literal and lack English equivalents. As is the case with many translations between words that lack equivalents in either language, it becomes the case where one language holds approximations of the meaning of the word in the other language, but fails to strike at the heart of the meaning. For example, the word *perezhivanie* is a Russian word used in Vygotskian literature to imply a unit of analysis between individual and environment; there is no English equivalent because for a number of cultural and historical reasons, this space between the two never arose. They remain distinct for English speakers. However, to study Vygotskian psychology in English, a translation must be found. The following example taken from an online debate regarding issues in educational psychology demonstrates the point.

> I am a Russian speaker, but it doesn't make the task of translation of "perezhivanie" easier... I do not have an English translation, but in his Pedology of Adolescent, Vygotsky names "perezhivanie" to be a unit that helps to avoid the dualism of individual and environment. According to Bozhovich, for a short period of time Vygotsky considered "perezhivanie" as the unit of psychological development in the study of the social situation of development. Moreover, I do not know whether it was included in the English translation, but in the last three pages of Pedology of Adolescent, he discusses perezhivanie as a dynamic unit of consciousness that allows to explore the attributes of consciousness in their connection, while he considered memory, thinking, etc., to be the elements. "Perezhivanie " is often discussed in relation to emotion, but it seems that for Vygotsky it is much more than

> emotional experience. The word itself for a Russian speaker, does not sound as a term, it can be easily used in poetry. I do not mind experience in Dewean sense, but *perezhivanie* is rather a reflection of the experience, the internal both emotional and cognitive process in child's consciousness that is a transformational for future development. (Lampert-Shepel, 2007, second paragraph)

There is a struggle to find as many ways as possible of capturing the essence of the definition with the hope that through compiling each mode of expression that a feel for the term can be conveyed.

Precisely the same process occurred with the morphs presented in this study. Latin prefixes occur in common English words so we assume them through a process of language acquisition and develop an intuitive sense for them. However, when individuals must reflect on formal meanings and learn explicit definitions of the prefixes as they did in this study, the difficulty of translation arises. Sometimes during the assessment I felt as though I was teaching a second language, explaining how literal translation of Latin morphs related to English words and meanings. Take for example the Latin prefixes in- (meaning in, on, on, into, towards, not) and dis- (meaning apart, away, not, from). Both prefixes can mean *not* but with slight nuances in meaning. Particularly for the prefix in-, it is difficult to distinguish to which of the two meanings in- refers. In fact, merely the idea that in- had two meanings was difficult to understand for the participants. Without exception, each participant in Stage Four understood in- in the sense of going into and readily identified the picture series that showed in- but each participant stumbled over the idea that in- could mean *not*. I had to explain that in- could also mean not and asked the participant how the doctor picture (representing the *not*) aspect of the definition reflected the second meaning. Each participant persisted with their interpretation of in- meaning *into* and had difficulty moving away from that specific definition. Cole explained the picture by observing that

the "guy's looking *into* glasses!" and then became unresponsive; John observed that the doctor would use glasses to look into someone's mouth, connecting the masked doctor picture with the open mouth boy picture; Adam had a similar response to John, stating that the masked doctor is the person who looks into the mouth, again, connecting the masked doctor picture with the open mouth boy picture. It may be the case that the masked doctor picture is an ineffective means of demonstrating the *not* aspect of the in- definition; it was difficult to find a still photo of images portraying *not.* A point of interest still is that even despite receiving instructions and examples on the dual meaning behind in-, the participants remained wedded to the definition of *into* for the in- prefix and did not engage in any interpretative behaviour by which they could hypothesize possible links between the image and its representation of the *not* definition.

This translation breakdown always occurred at the end of each exercise segment, when the maximum number of matches had been made and students were left with remaining matches but no way to work through the definitions. For example, Adam reached the point in Stage Three where he had correctly matched all images with their pictures and could interpret each picture in terms of its its corresponding word structure save for one: unison/choir singers. Adam knew that unison referred to *one* but how the choir singers reflected *one* he could not work out. He hypothesised that sonus might refer to something little and thought that unison belonged with the amoeba (to which he had already correctly matched unicellular). After I prompted him to consider whether it made a sound he guessed the flag (makes a sound blowing in the wind) and then the choir, citing that "these guys look like they're singing". He hesitated though, thinking that there would "have to be more" when there were only about "15" in the picture. At this point I stated that they might be singing in a choir and like Cole, he just lost interest and the activity came to an abrupt end without further interpreting *son* as derived from the root *sonus* and how it is reflected in the choir singer image.

As stated above, we got to this point at the end of activities where it was inevitable that the participant had to be given the definition or that they lost interest when they could not arrive at the answer through deductive or inductive reasoning. In John's case, I was able to explain the literal meaning of unison (one sound) but he still had difficulty linking the word with the correct image, theorising that the *one* referred to the fact that the choir singers were looking at the same place but with different jackets. As we moved through the explanation, like Adam, John lost interest. Both students gave the impression that they were waiting for the definitional instruction to be finished so they could move on. This finding is consistent with Vygotsky's belief that "memorizing words and connecting them with objects does not itself lead to concept formation..." (Vygotsky, 1986, p. 100). Explicit definitions were meaningless and uninteresting; it was only when the participants were actively engaged in problem solving and strategy-making that they formed concepts.

Several tentative conclusions can be drawn from these scenarios. First, in Latin to English translations, sometimes explicit definitions must be given. Second, this need for explicit definitions involved rote memorisation in addition to concept formation. However, unless the student forms the concept to accompany the memorised definition, it will not be meaningful, as demonstrated in the above examples. Third, learning that involves linguistic translation may imply a different type of concept formation process; participants were able to form concepts of rough prefix meaning groups by attaching specific meanings to each prefix that did or did not capture the entire essence of the prefix group. In terms of explicitly defining prefix concepts such as in- which had multiple, contradictory meanings or literal translations from specific Latin definitions to broader English meanings (e.g., unison -- one sound -- choir singing is literally the emission of one sound), explicit instruction is necessary.

A Critique of Vygotsky's Stage Theory and Alternative Explanations

This section will provide a critique of Vygotsky's theory and offer other possible interpretations of the data gathered from this study. As discussed above, a great deal of the critique of Vygotsky's theory surrounds the narrow and artificial tasks he used to gather data regarding concept formation and his notion of conceptual thought as an end-state of his stage theory.

Vygotsky's theory of concept formation overall, was not a useful tool for interpreting the data from this study. The performance of the participants did not reflect a stage-based theory of concept formation, it did not reflect concept formation as a process of simultaneous abstraction and generalisation of a single attribute, nor did it demonstrate the evolution of the functional uses of words. Participants did not consistently start with creating syncretic heaps and the pinnacle of the process was not a fully-formed concept, nor did they all exhibit characteristics associated with one particular stage of concept formation. This study emphasised that we must consider the outcome of tasks designed to observe concept formation processes. Can we legitimately refer to an individual as *having* a concept? What does it mean when someone has mastered a concept? How does it intersect with language? Vygotsky theorised from the standpoint that concepts are either present or developing and studies the groupings of objects and then functional uses of words as theoretical vehicles.

Alternative theories of concept formation predominantly take into consideration the idea that the object towards which the concept formation process is focused is as much a part of concept formation as the mental activities engaged in the process. *What* you conceptualise is at least equally important as *how* you conceptualise. Since the performance of the participants is heterogeneous, it is impossible to identify one theory or even a combination of theories that sufficiently encapsulate the nature of their thinking. According to Keil (1989) the assumption

that there is heterogeneity both within and across concepts permits us to postulate that a child may successfully communicate with an adult in some domains and not others. What is clear in a theoretical analysis of the results of this study is that the theories of Rosch, Nelson and Bruner all offer plausible interpretations of the differing aspects of concept formation activity and that conceptual thinking is not an end point but rather a set of causal and categorical beliefs dependent on language and experience. When compared with the Vygotskian interpretation, it becomes apparent that concepts and their formation must be studied not only in terms of mental process but also for linguistic development, representation and for their event participation and situatedness. The evidence from this study strongly supports the idea that concept formation does not occur in a vacuum; it is a process imbedded in the everyday that is situation-dependent and accomplished through interaction with people, animals, events and objects. As Rosch commented (1999), we should ask not how categories can be universal or how concepts represent an external world but how categories and concepts come to be in the first place. This section will revisit one intriguing scenario from each of the participants' transcripts to demonstrate this conclusion.

The first scenario is Adam's attempt to answer the triathlon/biathlon question on the worksheet for Stage Three (see Appendix I, Transcription Excerpts, and preliminary analysis in Results). Adam answered the question with "skipping" and "hoop jumping", leaving out tricycle riding. This was in fact a correct answer, superficially. He chose two events to keep for the biathlon. However, when he commented "Because a tricycle's like a bike", it indicated that he had the right answer but possibly for the wrong reasons. Adam wondered whether a tricycle and bicycle "count" as the same thing to judge whether he should switch the tricycle riding event from the triathlon category into the new biathlon category. Adam believed that biathlons require two of something (e.g., two

legs, two skipping ropes, two wheels). According to Vygotsky, this example demonstrates thinking in complexes, more specifically an example of a pseudoconcept because Adam has made an error concerning the functional use of the terms *triathlon* and *biathlon*. Adam appropriately abstracts the pertinent concepts from the question and attends to the structural aspects of each word (i.e., that tri and bi convey some quality about the athletic event) but instead of associating the prefixes with the number of events, he sees the prefixes relating to physical attributes an object or person must posses to be part of the competition.

Vygotsky would argue that this is a pseudoconcept based on the fact that Adam's answer resulted in mutual agreement and understanding. "The child thinks the same thing in a different way, by means of different mental operations" (Vygotsky, 1986, p. 126). When we began to explore Adam's means of understanding the question and the reason he chose skipping and hoop jumping (because you need two legs to do them), the fundamental divergence between thinking in concepts versus thinking in complexes was revealed. As the more knowledgeable adult, I have formed the concept of biathlons and triathlons because I can simultaneously abstract and generalise the attribute *event* to refer to the meaning of the prefixes. Adam, conversely, had qualitatively different mental operations that yielded this mistake.

This analysis pointed to one of the fundamental problems with Vygotsky's stages of concept formation and moves us to ask the question stated above that is, what does it mean to *have* a concept? Adam did in fact engage in a process of simultaneous abstraction and generalisation and attributed the correct meaning to each of the prefixes (i.e., bi means two and tri means three). The point is that Adam required fuller knowledge of triathlons and biathlons to understand that the prefixes pertained to the number of events that supports the idea that concepts are relational and contextual. It also pointed to the idea that a child can have a prefix

concept and still make mistakes regarding situations related to that concept. So although learning about the triathlon concept and biathlon concept is not specifically relevant to the study at hand, it is necessary to have that understanding in order to use the prefix concepts to answer the questions. In instructional settings, this is an important consideration since it is clear that students must learn not only the meanings of the prefixes but also the words in which they appear so students can understand to which attribute the prefix refers.

This web of understanding in which concepts are imbedded is emphasised by Rosch in her article *Reclaiming Concepts* (1999) where she stresses that real situations are information-rich complete events. "One does not stand in thin air gaping at a tree as one does in philosophical examples; there is always a rich context... situations/contexts are mind-world bonded parts of entire forms of life" (p. 72). This ties back to the artifice of Vygotsky's block design which he used to examine concept formation. Vygotsky (1986) argued that even adults who have reached the level of conceptual thinking revert back to the level of pseudoconcepts in solving daily problems and functioning with everyday objects in everyday tasks. I would argue, as would Fodor (1972), Rosch (1978, 1999) and Nelson (1991, 1999) that conceptual thinking must be concerned with the everyday if we are to understand human development and learning. Since concepts are formed in everyday settings they must be studied in everyday settings.

Latin prefixes are not prototypes to be examined as entities unto themselves. One might argue that the object of the study was to examine prefix concepts, not the vocabulary in which prefixes appear. I would argue that prefix concepts cannot be studied in isolation, in the same fashion as Vygotsky used blocks with discrete attributes. They exist as part of everyday language and have changed through linguistic evolution where meanings, spellings and words are constituted and reconstituted across time. Morphology is tied to the making of new words; as new words are made, prefixes are used in different ways to devise words that reflect novel

situations or objects at the time (Bauer, 1988). It is necessary to understand words and their morphs simultaneously, both for their structural and semantic features since they are recursive and thus cannot be fully understood taken separately.

In this example, Adam was using Latin prefixes pertaining to number that are the most transparent, transparency referring to the extent to which there is a clear match between meaning and form (Bauer, 1988) and take a one-to-one relationship between form and meaning. In cases where the relationship between meaning and form is opaque as in the Stage Four prefixes, prefix concepts become almost exclusively dependent on knowledge of the broader linguistic context (i.e., literal Latin meaning versus translated English meaning). The important relationship between structure and semantic features, word and prefix is at its most complex where one prefix has two different meanings and, as illustrated above, a surfeit of English words is used to cobble together an approximation of the Latin meaning. I would postulate that this is at least part of the reason that morphology is so difficult to teach; students require linguistic, situational and morphological knowledge in order to understand word parts to effectively manipulate structure and meaning.

This example also draws on Nelson's theory of events and their scripts in concept formation in the sense that experience of phenomena conveys specific conceptual details. In this scenario, Rosch and Nelson would agree on the importance of situational understanding. Had Adam seen a triathlon or had been part of a triathlon, his knowledge of the phenomenon, obviously, would have been much more accurate. Recall the example of Emily who, in learning the concept of a cocktail party, attached to particular elements of the event (i.e., drinking liquid, being at a party). Nelson's work is interesting to consider here, especially along with Rosch's prototype theory because it prompts us back to the question of what it means to have a concept. It is clear that Emily has a concept of cocktail parties; she has abstracted two of the most critical definitional attributes, that they have to do with drinking liquid and being in a roomful of people.

A prototypical cocktail party concept would require that the beverages drunk be cocktails that by definition, are made with alcohol. Still, the blurriness of categories plays its role here: would the designated driver who is drinking pop for the night still not be considered to be part of the cocktail party? What if only two people out of twenty at the party feel like martinis? Is it still a cocktail party? This aspect of concept formation is important to consider in a critique of Vygotsky's scheme that implicates concepts as objective truths, irrespective of the subtlety of everyday concepts.

In terms of Adam's work, the most appropriate question is *what kind of concept does he have?* As Nelson (1989) has demonstrated, conceptual thinking occurs over the lifespan. The main difference between the concepts of a 20-year-old versus a three-year-old is the amount of experience serving to provide situations and scripts with which to conceptualise. Thus, everyone has concepts. It is the nature of the concepts and their associations that are important to understand. Adam knew the meanings of the number prefixes and applied them appropriately. Again, had he had the experience that conveyed the specific characteristics of a triathlon and biathlon, he would have understood that the prefixes pertained to the number of events. Even within the two hours of assessment, Adam changed his concept of triathlons, biathlons and prefixes. It is true that the functional use of the word changed, but it was due not to a developmental stage, but to the acquisition of experience that broadened his conceptual framework.

The second scenario involves John working through a second phase of Stage Four where he reconsidered the matches of pictures with their groups (See Appendix I, Transcription Excerpts). I instructed John to abstract different attributes from the pictures so that he could match the planes with a different group. He initially abstracted the fact that they were in the air and in the second analysis he attended to the concrete aspects of the pictures, starting by

observing the the colours of the jetstream and then the v-shape configuration of the planes. He then correctly matched the planes with the co-/con-/com- group and conceptualised the group with the words *working together.*

The fact that the participants could abstract a number of attributes from the pictures has been discussed. According to the Vygotskian framework, this observation of multiple attributes would certainly exemplify complex thinking and more specifically, would be somewhere between chain complex and diffuse complex since the bonds are indeterminate and the attributes are all perceived as functionally equal (Vygotsky, 1986). Given that John's selection process would fit into the complex thinking mode, one would expect that he would never arrive at a concept of the prefix group later defined as co-/con-/com-. It is significant that John arrived at the match without assistance, that he first analysed the planes image for all its characteristics, connected that the v-shape implied some sort of co-operation and then made the match. John went through the same process in matching the chain break picture with ac-/ad-/at- once he differentiated between observing broadly that the people in the images were "doing something" so move to a more specific description of the action being performed.

John's performance indicates that contrary to Vygotsky's thinking, the study of all attributes may be necessary before individuals place them in a hierarchy with which they form the concept. Again, Vygotsky's experimental design assumes a limit to the number of attributes to think about; in the case of the images in this study there were actually a vast number of attributes to be examined and which correlated differently among all the pictures. Indeed sometimes the only clue that the participant had made a mistake was when they were left with a card that didn't match a group at all. Since the students kept both conceptualisation and the end of goal of appropriately matching all pictures to their groups, they had two different feedback mechanisms with which to guide their concept formation process. Still, the pertinent point here is

that the method of finding multiple bonds among objects that Vygotsky deemed thinking in complexes is not a precursor to conceptual thinking in a concept formation hierarchy but can rather be a sort of reconnaissance mission before establishing the concept. In fact, Carey (1986) points out that learning new word meanings is an inductive process whereby the child infers its meaning from the uses he hears and from the reactions of others to his usage. Part of the work in understanding an inductive process is to specify constraints on the hypotheses the child will entertain. This corroborates the idea that individuals must first gather information and test their conceptual theories. John was not learning a new word per se, but the hypothesising process is the same. Bruner (1956) also refers to rule-governed behaviour in his discussion of classification and concept formation; individuals devise rules simpler than the elements being grouped as a means of reducing cognitive load and becoming efficient in one's thinking. Placing objects in established contexts helps people just the accuracy of these groupings and aids in the decision to revise one's concept. Bruner and Carey, combined with the contextual approaches of Rosch and Nelson support the idea that in this example, John is not creating random connections between functionally equal attributes; he is engaging in a grouping experiment of sorts, testing concept hypotheses. In fact, it may be likely that these triggers that characterised John's concept formation process may have been the result of a private hypothesising, the flashes of insight or possible connection being the only aspects of John's thought that I was fortunate to witness.

This study has explored empirical support for Vygotsky's stage based theory of concept formation through an examination of the manner by which three participants developed concepts of Latin prefixes. It has been demonstrated that Vygotsky's theory is not reflected in this capacity due to the fact that it was not designed according to everyday conceptual phenomena. Due to the fact that the participants were dynamically assessed, the procedure is not easily replicable. Although the study constitutes a preliminary step in studying learning disabilities

from a concept formation perspective, comparisons among normally achieving and learning disabled populations must be carried out to entrench such findings. Future research could be aimed at expanding sociocultural models of concept formation; longitudinal studies of concept formation through the early years are important but possibly more compelling is deeper examination of the pre-adolescent and adolescent years when teenagers grapple with broadening academic and personal experiences that help them recontextualise old concepts and develop new ones. Indeed, concept formation is fundamental to learning and offers a rich and exciting approach to the ways people understand, construct and interpret themselves and their worlds.

References

Arievitch, I.M. & Stetsenko, A. (2000). The quality of cultural tools and cognitive development: Gal'perin's perspective and its implications. *Human Development, 43,* 69-92.

Bauer, L. (2003). *Introducing linguistic morphology, 2nd ed.* Washington D.C.: Georgetown University Press.

Bruner, J.S., Goodnow, J.J. & Austin, G.A. (1956). *A study of thinking.* New York: John Wiley & Sons.

Campione, J.C. (1989). Assisted assessment: a taxonomy of approaches and an outline of strengths and weaknesses. *Journal of Learning Disabilities, 22,* 151-165.

Carey, S. (1984). Constraints on semantic development. In J. Mehler & R. Fox (Eds.), *Neonate cognition* (pp. 154 - 172). New Jersey: Lawrence Erlbaum Associates.

Case, R. (1999). Conceptual development in the child and in the field: a personal view of the Piagetian legacy. In E.K. Scholnick, K. Nelson, S.A. Gelman & P.H. Miller (Eds.), *Conceptual development: Piaget's legacy* (pp. 23 - 51). New Jersey: Lawrence Erlbaum Associates.

Cocking, R.R. (1983). Early concept formation: Models from Nelson and Piaget. In E.K. Scholnick (Ed.), *New trends in conceptual representation: Challenges to Piaget's theory?* (pp. 151-164). New Jersey: Lawrence Erlbaum Associates.

Deacon, S.H., Parrila, R. & Kirby, J.R. (2006). Processing of derived forms in high-functioning dyslexics. *Annals of Dyslexia, 56(1),* 103-127.

Geschwind, N. (1982). Why Orton was right. *Annals of Dyslexia, 32,* 13-30.

Gardner, H. (1985). *The mind's new science: A history of the cognitive revolution.* New York: Basic Books.

Garner, W.R. (1974). *The processing of information and structure.* Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Gruber, H.E. & Voneche, J.J. (1977). *The Essential Piaget.* New York: Basic Books.

Hampton, J. & Dubois, D. (1993). Psychological models of concepts: Introduction. In I.V. Mechelen, J. Hampton, R.S. Michalski & P. Theuns (Eds.) *Categories and concepts: theoretical views and inductive data analysis* (pp. 11-33). London: Academic Press.

Hyde, D.M.G. (1970). *Piaget and Conceptual Development.* London.: Holt, Rinehart & Winston.

Individuals with Disabilities Education Improvement Act of 2004, 20 U.S.C. 1400 Retrieved April 13, 2007 from http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_cong_public_laws&docid=f:publ446.108

Karpov, Y.V. (2003). Vygotsky's doctrine of scientific concepts: It's role for contemporary education. In: A. Kozulin, V. S. Ageyev, S. M. Miller, & B. Gindis (Eds.), *Vygotsky's theory of education in cultural context.* (pp. 65-82). Cambridge: Cambridge University Press.

Keil, F.C. (1989) *Concepts, kinds and cognitive development.* Cambridge: The MIT Press.

Kemler Nelson, D.G., Russell, R., Duke, N. & Jones, K. (2002). Two-year-olds will name artifacts by their functions. *Child Development, 71(5),* 1271-1288.

Kenneth Gordon School, admissions page. http://www.kennethgordon.bc.ca/admission.html

Kirk, S. A. (1962). *Educating exceptional children.* Boston: Houghton Mifflin.

Kirk, S.A. & Elkins, J. (1975). Identifying developmental discrepancies at the preschool level. *Journal of Learning Disabilities, 8(7),* 18-20.

Lampert-Shepel (2007). Re: Translating Vygotsky. Retrieved 28 May, 2007 from: http://lchc.ucsd.edu/MCA/Mail/xmcamail.2007_01.dir/0223.html.

Lidz, C.S. & Gindis B. (2003). Dynamic assessment of evolving cognitive functions in children. In: A. Kozulin, B. Gindis, V.S. Ageyev & S.M. Miller (Eds.), *Vygotsky's educational theory in cultural context.* Retrieved October 16, 2006 from Netlibrary database.

Markman, E.M. (1983). Two different kinds of hierarchical organization. In E.K. Scholnick (Ed.), *New trends in conceptual representation: Challenges to Piaget's theory?* (pp. 165 - 184). New Jersey: Lawrence Erlbaum Associates.

Nelson, K. (1973). *Structure and strategy in learning to talk.* Monographs of the society for research in child development. 38, nos. 1-2, serial no. 149.

Nelson, K. (1978). How children represent knowledge of their world in and out of language: A preliminary report. In: R.S. Siegler (Ed.). *Children's thinking: what develops? (* Hillsdale, N.J.: Lawrence Erlbaum Associates.

Nelson, K. (1981). Individual differences in language development: Implication for development and language. *Developmental Psychology, 17,* 170-187.

Nelson, K. (1985). *Making sense: The acquisition of shared meaning.* New York: Academic.

Nelson, K. (1989). *Narratives from the crib.* Cambridge: Harvard University Press.

Nelson, K. (1991). Concept development in the perspective of the recent history of developmental psychology. In F.S. Kessel, M.H. Bornstein & A.J. Sameroff (Eds.), *Contemporary constructions of the child: essays in honor of William Kessen.* (pp. 93 - 107). New Jersey: Lawrence Erlbaum Associates.

Nelson, K. (1996). *Language in cognitive development: emergence of the mediated mind.* Cambridge: Cambridge University Press.

Nelson, K. (1983). Levels and modes of representation: issues for the theory of conceptual change and development. In E.K. Scholnick (Ed.), *New trends in conceptual representation: Challenges to Piaget's theory?* (pp. 131-150). New Jersey: Lawrence Erlbaum Associates.

Piaget, J. (1927). *The first year of life of the child.* The British Journal of Psychology, 18:97 - 120. Paper read before the British Psychological Society, March 7, 1927.

Piaget, J. & Inhelder, B. (1969). The Psychology of the Child. New York: Basic Books.

Piaget, J. & Inhelder, B. (1964). *The early growth of logic in the child: classification and seriation.* London: Routledge and Kegan Paul.

Poehner, M.E. & Lantolf, J.P. (2005). Dynamic assessment in the language classroom. *Language Teaching Research, 9(3),* 233-265.

Rosch, E. (1973). Natural Categories. *Cognitive Psychology, 4(3),* 326-350.

Rosch, E. (1974). Linguistic relativity. In A. Silverstein (Ed.), *Human communication: Theoretical explorations.* New York: Halsted Press.

Rosch, E., Mervis, C.B., Gray, W.D., Johnson, D.M. & Boyes-Braem, P. (1976) Basic objects in natural categories. *Cognitive Psychology, 8,* 382-439.

Rosch, E. (1978). Principles of categorization. In E. Rosch & B.B. Lloyd (Eds.), *Cognition and Categorization* (pp. 27-48). New Jersey: Lawrence Erlbaum Associates.

Rosch E. & Lloyd, B.B. (Eds.) (1978). *Cognition and categorization.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Rosch (1996). The environment of minds: Towards a noetic and hedonic ecology. In M.P. Friedman & E.C. Carterette (Eds.). *Cognitive Ecology* (pp. 3-27). San Diego: Academic Press.

Rosch, E. (1999). Reclaiming concepts. *Journal of Consciousness Studies, 6 (11-12),* 61-77.

Scholnick, E.K. (1983). Why are new trends in conceptual representation a challenge to Piaget's theory? In E.K. Scholnick (Ed.), *New trends in conceptual representation: Challenges to Piaget's theory?* (pp. 41-65). New Jersey: Lawrence Erlbaum Associates.

Scruggs T.E. & Mastropieri, M.A. (2002). On babies and bathwater: addressing the problems of identification of learning disabilities. *Learning Disabilities Quarterly, 25(3),* 155-168.

Siegel, L. S., Share, D & Geva, E. (1995). Evidence for superior orthographic skills in dyslexics. American Psychological Society, 4(4), 250-254. Smagorinsky, P. (1998). Thinking and speech protocol analysis. *Mind, Culture and Activity, 5(3),* 157-177.

Smith, J.Z. (1972). I am a parrot (red). *History of Religions, 11(4),* 391-413.

Society for Organizational Learning (1999). *Primary knowing: when perception happens from the whole field, conversation with professor Eleanor Rosch.* Retrieved April 27, 2007 from http://www.dialogonleadership.org/Rosch-1999.html

Tomasello, M. (2002). Things are what they do: Katherine Nelson's functional approach to language and cognition. *Journal of Cognition and Development, 3(1),* 5-19.

Tzuriel, D. (2000). Dynamic assessment of young children: educational and intervention perspectives. *Educational Psychology Review, 12(4),* 385-435.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge: Harvard University Press.

Vygotsky, L.S. (1986). *Thought and language*. Cambridge: The MIT Press.

Wadsworth, S.J., Olson, R.K., Pennington, B.F., & DeFries, J.C. (1992). Differential genetic etiology of reading disability as a function of IQ. *Journal of Learning Disabilities, 33,* 192-199.

Zaporozhets, A.V. (2002). Thought and activity in children. *Journal of Russian and East European Psychology, 40(4),* 18-29.

Appendix A

Informed Consent for Parents/Caregivers to Recruit Pariticpants

Concept Formation Study
Information Sheet

My name is Seanna Takacs. I am an M.A. student in the Faculty of Education at Simon Fraser University. I am studying the ways in which exceptional (gifted and learning disabled) students form linguistic concepts. I am conducting this research in order to understand how exceptional students create understandings of language at the fundamental concept level. The students in the study are between 10 and 13 years old; this age group has been selected because it is believed that this is when students begin to complete the developmental course of concept formation and begin to form sophisticated concepts the way that adults do.

Participants in the study will complete one session that will last for approximately two hours. In the session, I will dynamically assess students as they work through worksheet and conversational activities on root words, prefixes and suffixes. Dynamic assessment is a type of assessment where students work through problems with an instructor; the instructor poses questions and shapes the activities in such a way that they can witness the student's thought process and tailor the session to address the student's learning needs. The session will essentially be a one-on-one tutoring session through which students will learn about Latin roots and affixes. Each session will be videotaped for the purpose of data analysis. Data collection will take place at the students' school either during or after school hours.

Once the study has been completed and I have written up the project, you are welcome to have a copy to read for yourself. The project should be done in the late spring. Please notify me now if you'd like an email or hard copy; I will make a note and forward it on once I have completed my defence and have made any necessary revisions.

If you have any questions or concerns about the rationale or execution of the study, please do not hesitate to contact me, either by phone at (604) 420-6090 or by email at sltakacs@sfu.ca. Thank you very much for your participation.

Sincerely,
Seanna Takacs

Appendix B

Initial Parent/Caregiver Approval Form

Concept Formation Study

Is your child between 10 and 13 years of age?

Has your child been diagnosed with a learning disability and/or found to be gifted?

Would you be willing to allow your child to participate in a study of linguistic concept formation?

My name is Seanna Takacs. I am an M.A. student in the Faculty of Education at Simon Fraser University. I am studying the ways in which exceptional (gifted and learning disabled) students form linguistic concepts. I am conducting this research in order to understand how exceptional students create understandings of language at the fundamental concept level.

Participants in the study will complete one session at (school name) that will last for approximately two hours. In the session, I will dynamically assess students as they work through worksheet and conversational activities on root words, prefixes and suffixes. Dynamic assessment is a type of assessment where students work through activities with an instructor so that the instructor can witness the student's thought process and tailor the session to address the student's learning needs. Each session will be videotaped for the purpose of data analysis; once the study has concluded the videotapes will be destroyed to ensure complete anonymity.

Currently I am in the process of identifying potential participants for this study. Please check whether you are interested or uninterested in having your child participate in the study. Drop the form in the box at the front office and for those interested, I will contact you in the next few days. If you have any questions about the study and what it involves, I can be reached by phone at (604) 420-6090 or by email at sltakacs@sfu.ca.

Sincerely,

Seanna Takacs

_____ **Yes, I would like my child to participate in your study.**

Name: _____

Phone number/Email _____

_____ **No, I am not interested in having my child participate.**

Appendix C

Child Script

Forming Concepts and Understanding Parts of Language

My name is Seanna Takacs. I am an M.A. student in the Education Department at Simon Fraser University. I am studying the ways in which 10 - 13 year-old students understand the concept of root words, prefixes and suffixes. I will work with you on a series of activities to see how you're thinking about the words and how you understand their meanings. You will not be given a score because it's not a test. I am just interested in working with you to see how you learn and what you talk about when you're learning something new.

We will have one two-hour session at your school where I will teach you about English words that have Latin roots, prefixes and suffixes. We will work together on worksheets and talk about the activities. I will videotape the session so that I can later go back and see what happened in the session.

All of your information including your name will be kept confidential; when I write the final paper I will be writing about what you did in the session but nobody will know it's you I'm referring to. You and your parents are welcome to read a copy of the final paper; it should be finished sometime in the late spring of 2007.

Even if your parents give me permission to work with you, you can say you don't want to be part of the study anymore, even during the session. If at any point you feel uncomfortable or you want to stop, just tell me how you're feeling and we'll stop at any time.

I am very excited about my research and I am looking forward to working with you. If you're interested in hearing more about the study, I am happy to talk about anything you're curious about.

Thank you so much for participating.

Yours Truly,
Seanna

Appendix D
Stage Two - Compound Words

lady

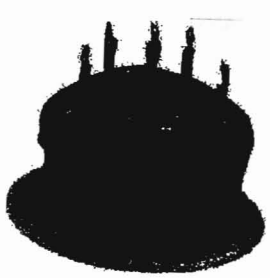
bug

cat

fish

cup

cake

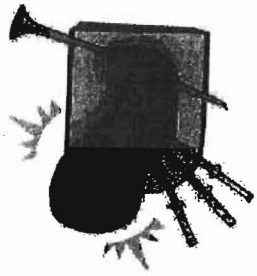


ear

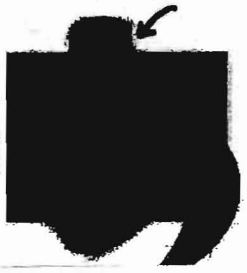
ring

bag

pipe



head

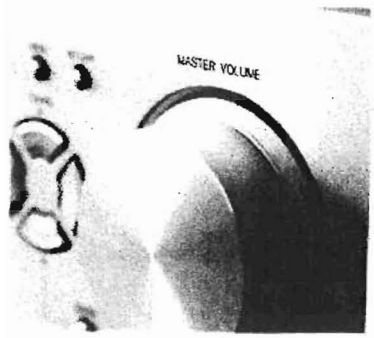


?

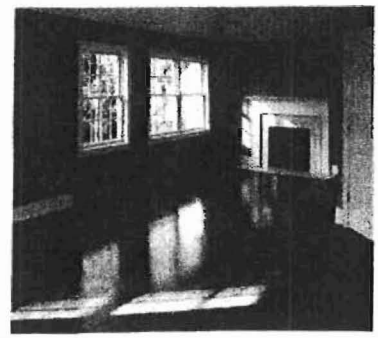
time

rock

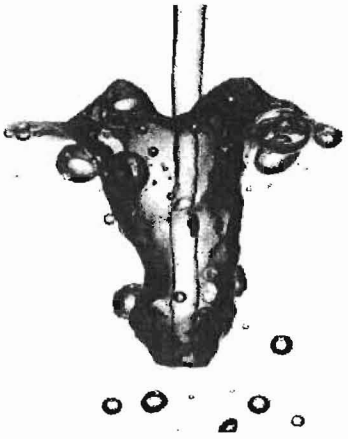
knob



room

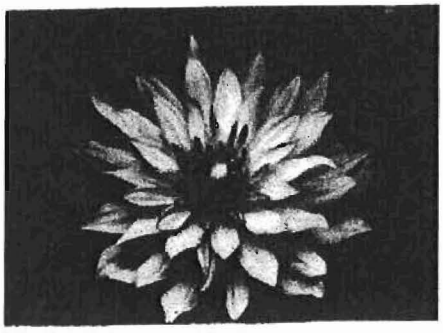


water



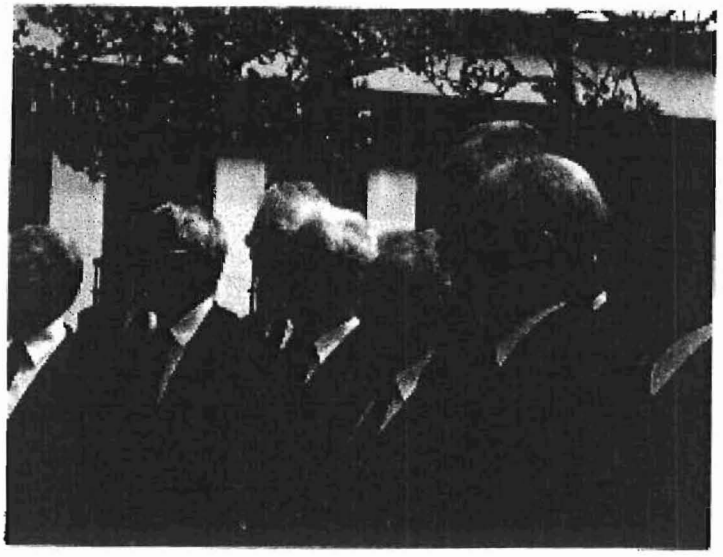
sheet

flower

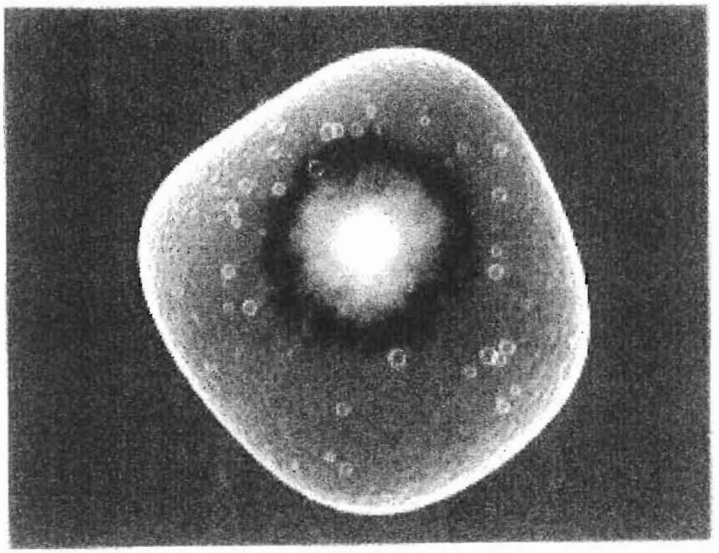


Appendix E

Stage Three - Number Prefix Words

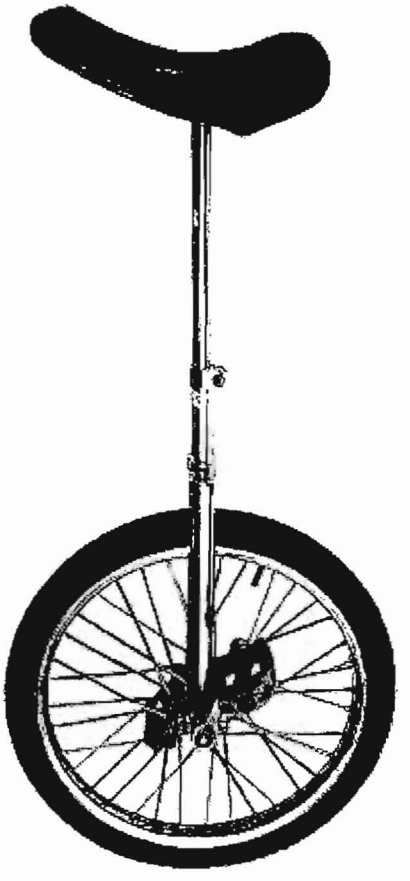


unison

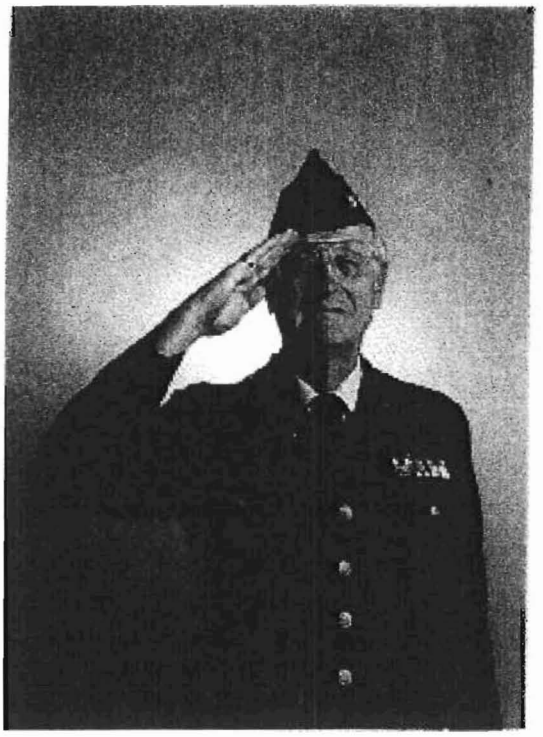


unicellular

unicorn



unicycle

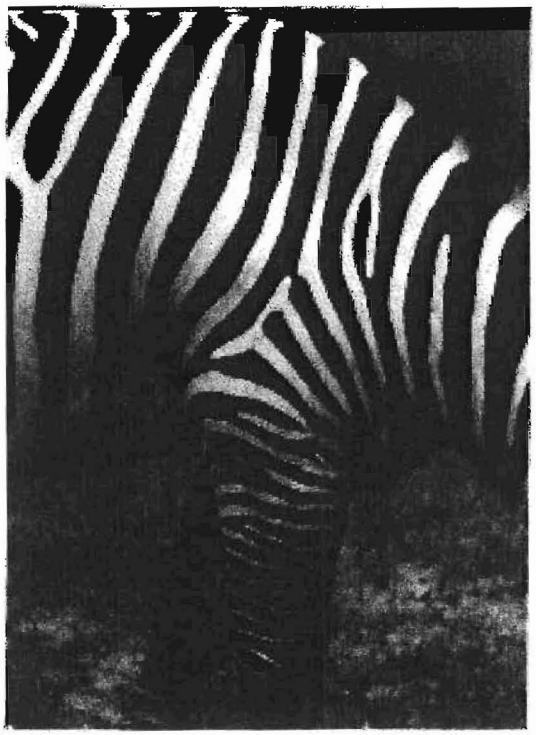


uniform

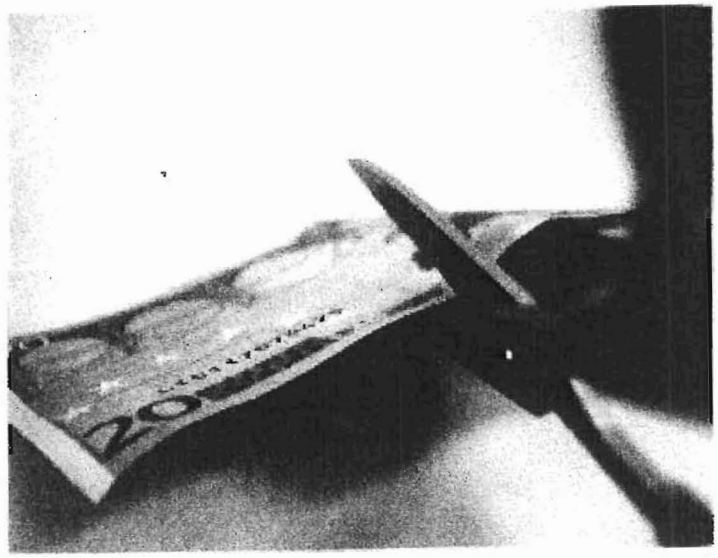
biped

binoculars

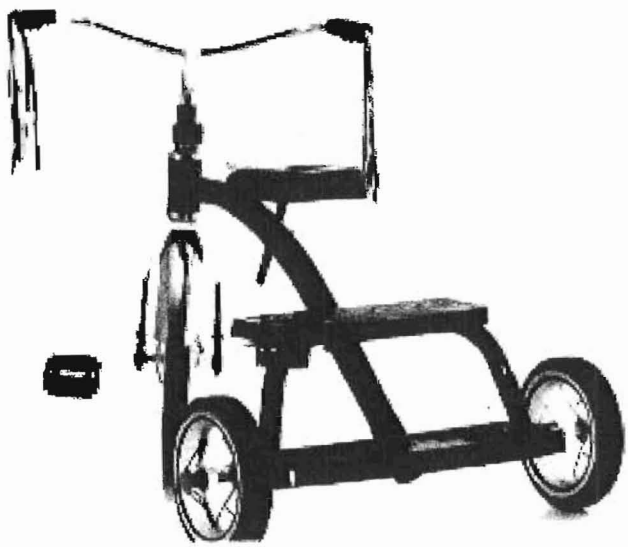
bicycle



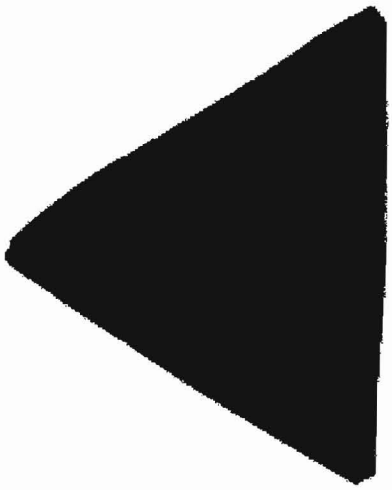
bicolour



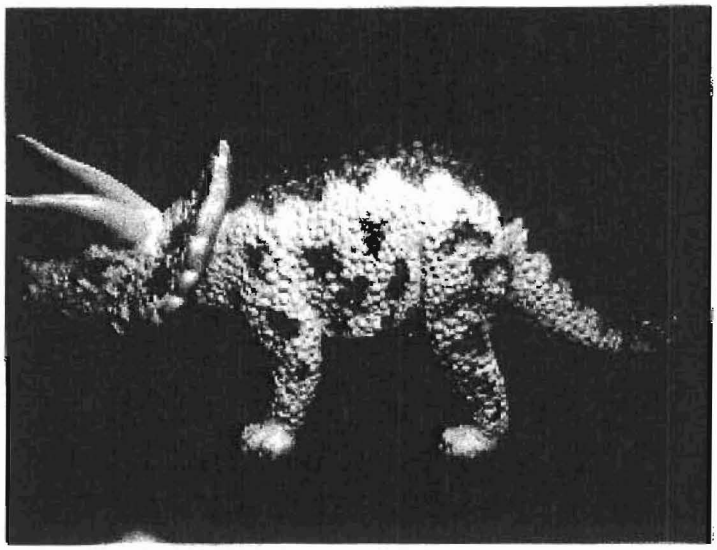
bisect



tricycle

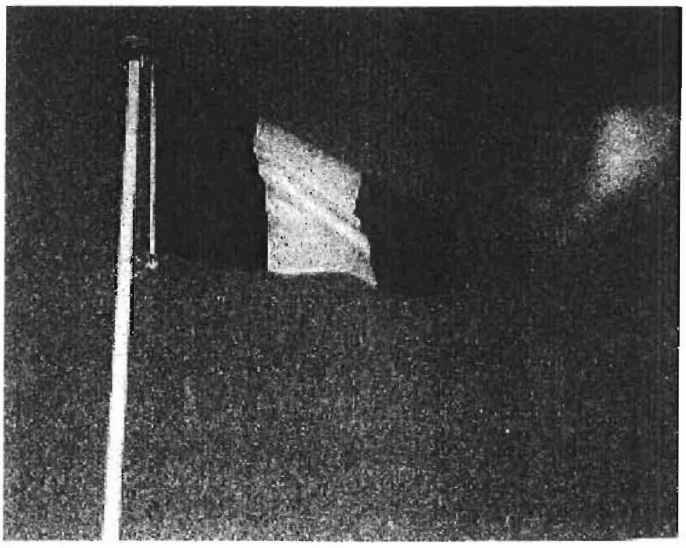


triangle



triceratops

tripod



tricolour

Appendix F

Worksheet Questions - Stage Three

Stage Three - Analogies

If a triceratops has three horns, a uniceratops has _____ horn.

If a unicorn has one horn, how many horns would a bicorn have?

You are a biped. How would you move around if you were a uniped?

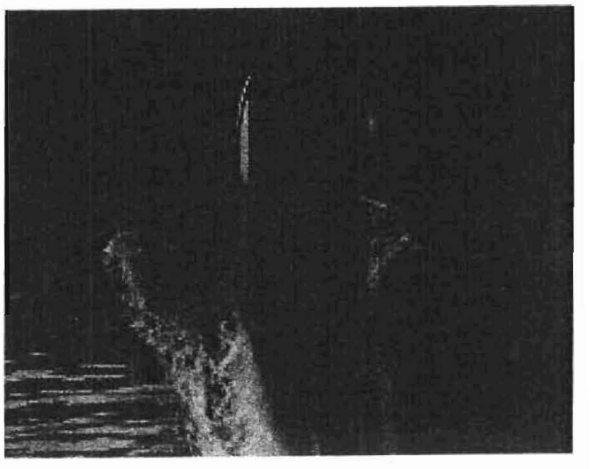
A new type of triathlon has three events: skipping, tricycle riding and hoop jumping. Which events would you keep if you were running a biathlon?

If you need two eyes to look through binoculars, would you ever be able to use trinoculars?

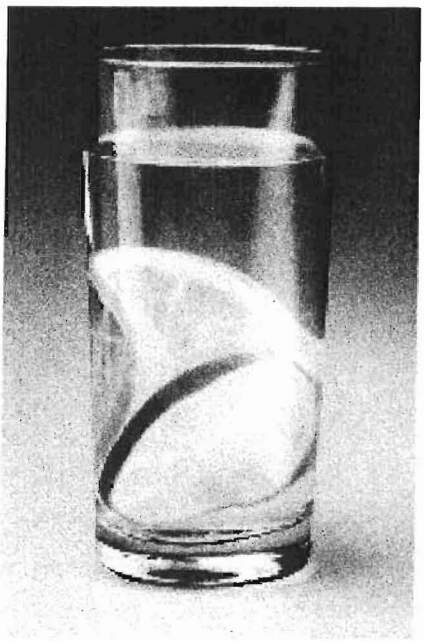
Appendix G

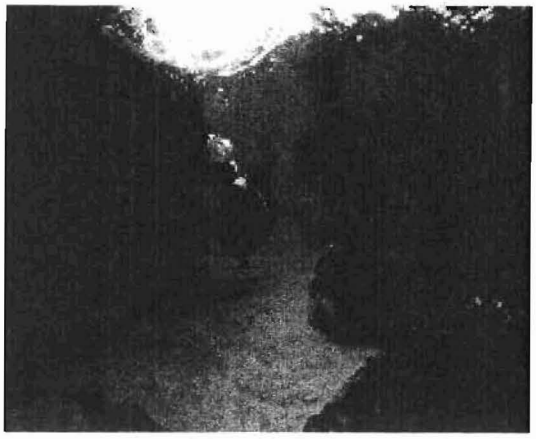
Picture Cards - Stage Four

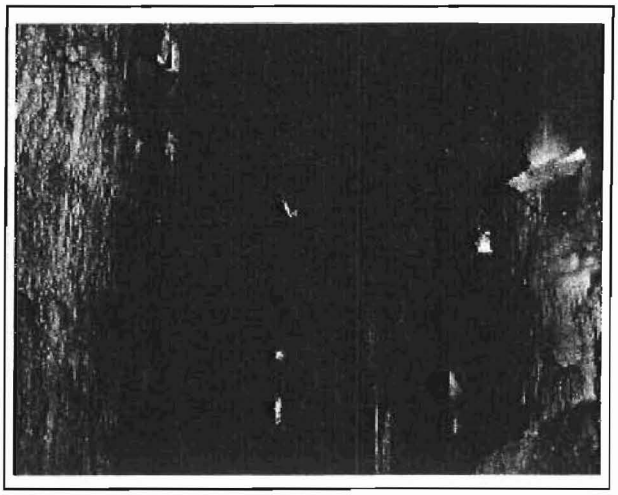
ex-



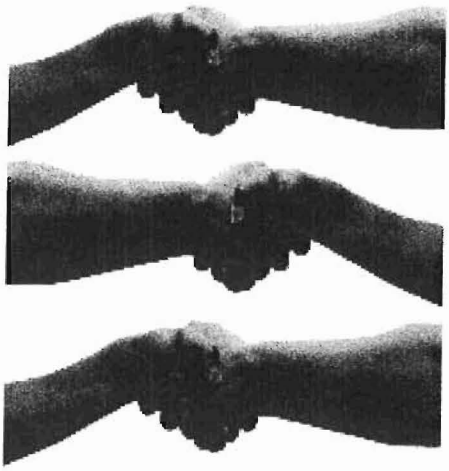
sub-

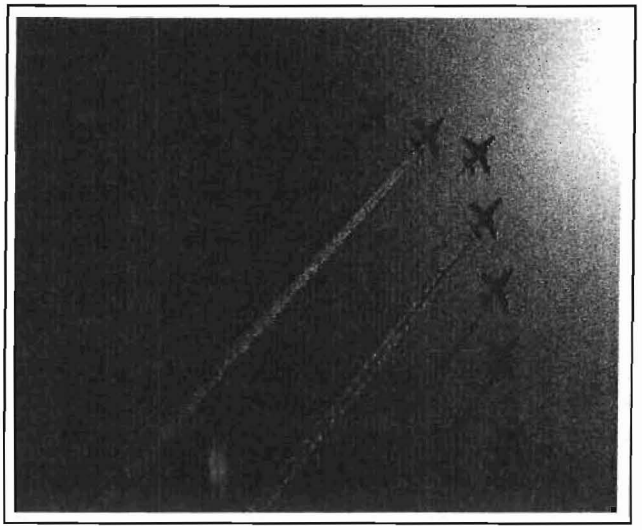




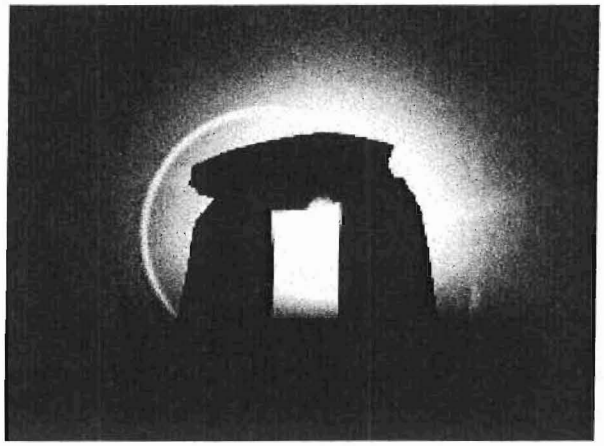


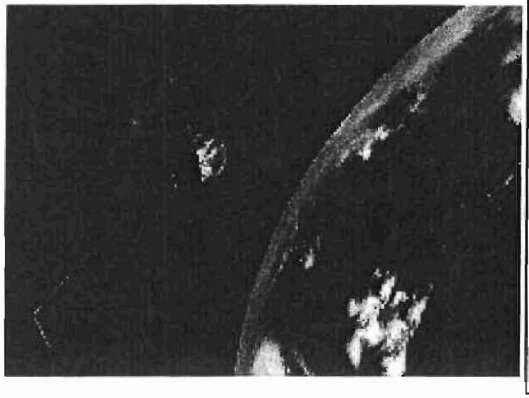
co-/con-/com-

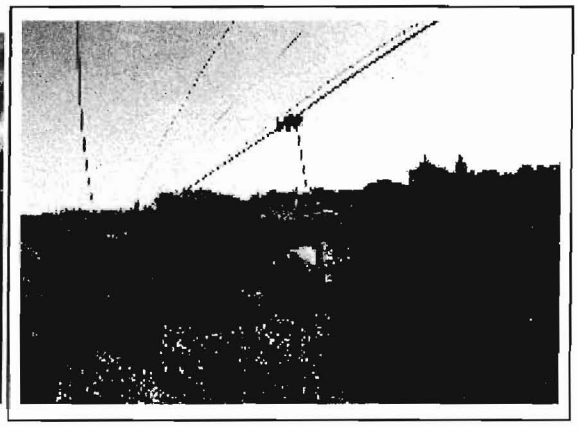




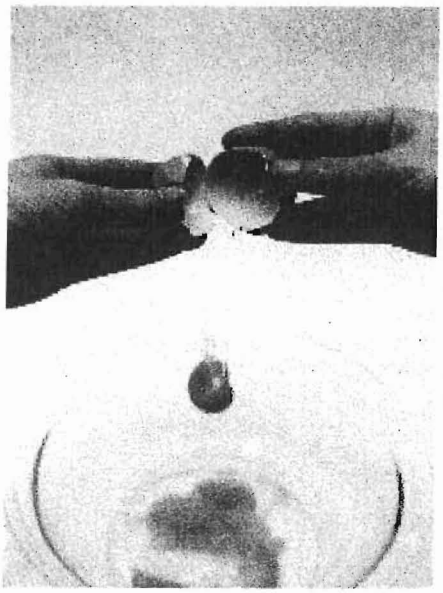
super-/supra-

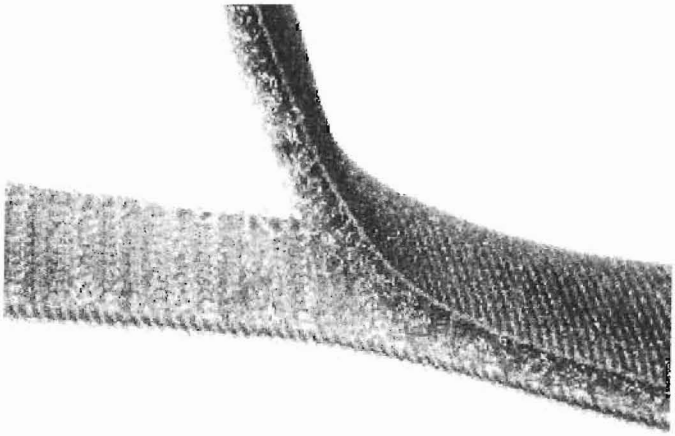


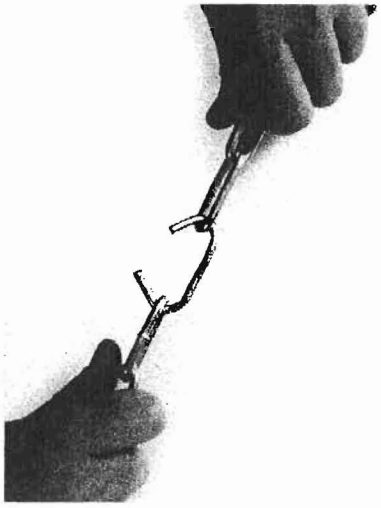


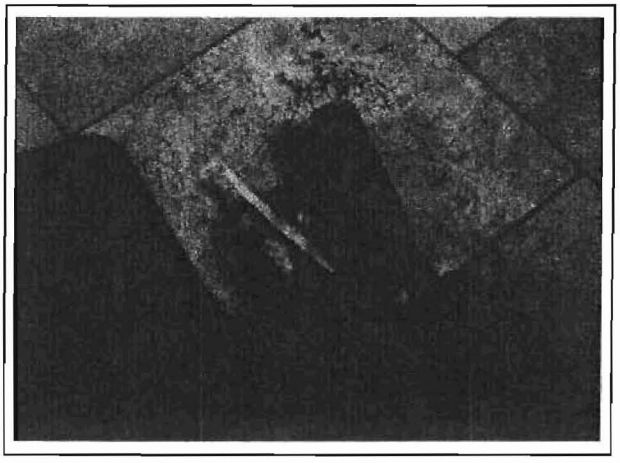


dis-/de-

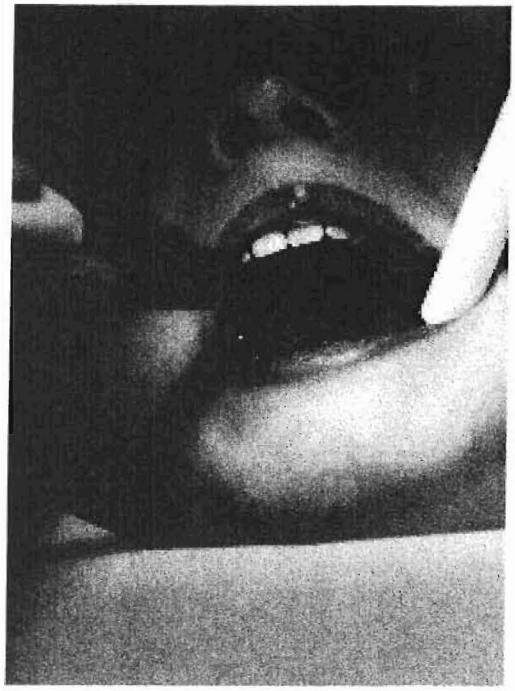




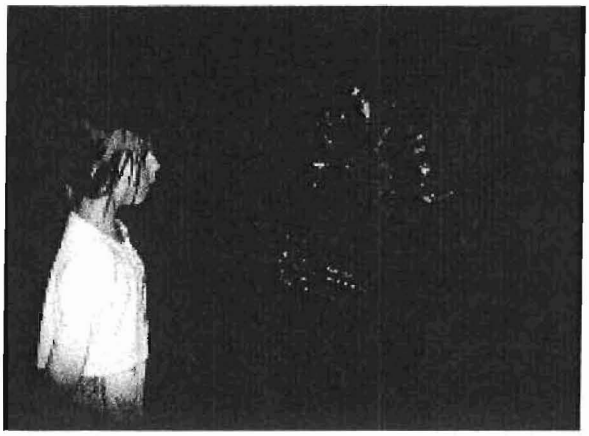




in-



ac-/ad-/at-



Appendix H
Worksheet Questions - Stage Four

Stage Four

Exercise A
Fill in the blanks with the correct word.

I spilled cranberry juice all over my new shirt! I need to _____ my shirt.

The three-legged pod creature is running towards me! The creature is called an _____.

The balloon hung just above the candles on the cake, ready to pop. It is a _____ balloon.

My cat threw up a mouse. It is an _____ mouse.

In this race, you always cycle with a partner. It is a _____ race.

Exercise B
Circle the correct word.

Working in a group and **co-operating / disoperating** can make the work go faster.

I have had too much to eat and my belly is sticking out. My belly is **distended / substended**.

My brother threw my favourite shoes in the pool and **submerged / demerged** them.

I have read ten books about Pluto and I can only **include / conclude** that it is not a planet.

My friend Josh would not stop sneezing milk from his nose so my mother refused to **exclude / include** John on our trip to the beach.

Appendix I
Transcription Excerpts

Adam

Adam: (reads question) Tricycle riding... (long pause) Because a tricycle's like a bike.
ST: OK.
Adam: (starts reading next question)
ST: Hang on one sec, let's go back to this. Tell me what the question's asking you...
Adam: (rereads the question)
ST: So you're going to change this from a *tri*athlon to a *bi*athlon...
Adam: Oh, so skipping and hoop jumping? So out of these three?
ST: Yep. So you've said you'd keep tricycle riding...
Adam: But would a tricycle count as a bike?
ST: Why are you wondering if it counts as a bike?
Adam: 'Cause like, tricycle is like the same thing as a bicycle except three. I'm just wondering if I put tricycle riding would it count as a bike or still as a tricycle?
ST: It would count as a tricycle.
(pause)
ST: I'm wondering why you feel you need to choose between bicycle and tricycle...
Adam: Oh, 'cause like, tricycle has three and bicycle only has two and in a biathlon I thought you'd ride, like, two stuff.
ST: Ok, so you're saying in a triathlon you ride things that have three? Like three wheels or three blades or something like that?
Adam: Oh, I know the answer now.
ST: OK, what's the answer?
Adam: Skipping, 'cause bi means two, so skipping and hoop jumping because you're on like, two legs (writes the answer down).
ST: OK, so let's stick with that question for a minute longer, because I just want to ask a couple more things. So you're saying that with a triathlon, the events involved there has to be three of something like three people or three wheels or three skipping ropes, right?
Cole: Yeah...
ST: Whereas with a *bi*athlon the events would have to have two. So you could have... you chose skipping and hoop jumping so there would be say, two skipping ropes.
Adam: Yeah, or two legs, like two legs for jumping.
ST: OK, so what if I told you that - because your answer is right, but it's right for different reasons. So, what if I told you that the 'tri' in triathlon and the 'bi' in biathlon refers to the number of events?
Adam: Oh, so there would be two events.
ST: Right. So it doesn't really matter what the two events are.
Adam: Oh...
ST: Right. So it could be 'hop on one leg jumping'.

Adam: Oh, so I didn't really get this - which *events* would you keep.
ST: Right. So that's the... when you're talking about meanings, when you're combining two separate meanings of the word, you have to be sensitive to the prefix, right, the bi meaning two, the tri meaning three, and also the last part of it, the 'athlon' part which is referring to the event rather than what you actually have to have to participate in the event.

John

(looking at the super- group where he matched the planes)
ST: so you said these are all the same because they're in the air, right?
John: right.
ST: Now what I want you to do is I want you to have a look at some of these pictures in a different way. So you're absolutely right (gesturing to the group where planes is matches with super-) that they have air in common, but if you look at this picture (planes) in a different way... So have a look at the planes instead of the fact that they are in the air.
him: (strokes each jetstream) Umm, that one's pouring out blue, that one's pouring out blue, that's pouring out blue, and that's pouring out white, that's pouring out black, pinkish-purple, pinkish-purple, pinkish-purple.
ST: Have a look at the configuration of planes so look at the way they are organised.
John: Making colour
ST: Ok, so don't look at the colours, just look at planes. So *abstract* the planes.
John: It's a v-shape
ST: If you had to pick another category... where would that go? So have a look at all of them again, Here hold onto that (plane picture) and have a close look. See what that would go with.
John: (matches with co-/con-/com-) Maybe here?
ST: That's right, so why does it go there?
John: (examines pictures serially) That's in, together, that's together, that's together...
ST: So when you say together, tell me a little bit more.
John: They're like, all working together, they're shaking hands with each other and they're walking with each other.
ST: So that's like co-operation, right?
John: Yeah.
ST: Great.
ST: OK, and you've got this one right (point to ac-/ad-/at- grouping), for the reason you said before, that everyone is standing at something (gesture with hand up) or going towards something. Right? She's going into the building, he's handing the present to you, right? She's standing at the work of art and he's standing at the mushroom, taking a picture.
John: I said she's just... they were all doing something.
ST: It's the action, the meaning that they're doing. Ok, so...

John: (suddenly) Ohhhh! (matches chain with dis-/de-) - they're being taken apart!
ST: Great, well done! That is really good! (laughs)