HOW LABELLING OBJECTS AT DIFFERENT LEVELS OF ABSTRACTION INFLUENCE OBJECT CATEGORIZATION

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DISSERTATION

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Anyone who has conducted research on perception or cognition in infants has likely encountered colleagues, science writers, and others who have expressed disbeliefs at his or her findings. Evidence for perceptual and cognitive capacities in infants strains the beliefs of many people because it conflicts with prevalent conceptions about infants and intuitions about cognitive development. …When data conflict with intuition, however, intuition is rarely the best guide for advancing understanding.

Spelke, 1998

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Chapter 1

Introduction

Developmental researches have demonstrated that during their first year of life infants learn many things about the physical world and start organizing the experience they have with objects, separating them into classes (Mandler, Bauer & McDonough, 1991; Mandler & McDonough, 1993, 1998). This process is what is called *category formation in infancy*. At the same time, they learn words in their language which represent these categorical distinctions. Importantly, how advances within the domain of lexical acquisition and category development might influence one another has been an important topic of debate recently.

Following Gopnick and Meltzoff (1986, 1993, 1998), children seem to be particularly motivated to acquire words that are relevant to the cognitive problems they are working on at the moment. The attainment of preverbal concepts is also suggested to motivate infants to learn words by paying attention to the labels presented together with given stimuli. At the same time, studies conducted by Waxman and Markow (1995) suggest that the use of certain words may draw infants' attention to different aspects of a given stimulus, providing the opportunity to increase conceptual understanding. For example, given objects unique names (basic-level labels) are good ways to draw infants' attention to the dissimilarities that objects which belong to the same category may share. Concurrently, the use of common names (global-level labels) is suggested to draw infants' attention to the similarities among a selection of objects (Waxman, 2003).

As can be noted, although some recent researches have addressed this issue, the number of studies is so far limited. In addition, the available data mostly comes from children at the one-word stage, lacking data from younger infants. Therefore, the aim of the experiments conducted for this dissertation is to contribute to the understanding of how language and conceptual development might be related. More specifically, how the availability of labels at different levels of abstraction (basic-level label, global-level label) may influence 7-and-11-month olds' object categorization.

To investigate these issues, initially two sets of experiments were conducted:

Experiment 1, tested 7-month-olds' performance in a global-level object examination task, contrasting animals and vehicles in three conditions: (1) with basic-level labels, (2) with global-level labels, and (3) without verbal input. Experiment 2, tested 11-month-olds' performance using the same kind of task and the same conditions. Due to the fact that the impact of object labels on categorization tasks was not clear in Experiment 1 and 2, Experiment 3 was conducted. Finally, Experiment 3 tested 11 month-olds' performance in a basic-level task, contrasting cars and trucks in two conditions: (1) without verbal input, and (2) with global-level labels (i.e. "car", "truck"). The method of assessment used in these studies was the "familiarization-preference-for-novelty paradigm" which has been an important method of studying object categorization in early ages (see Chapter 4.6).

By comparing infants' performance between conditions within each experiment, it was expected to learn more about how the kind of verbal input given may influence infants' performance in an object examination task at the particular ages. Whether the level of abstraction of the task (global-level task, basic-level task) plays any systematic role, was also an issue to be investigated.

Chapter 2

The Course of Language Acquisition

One of the most remarkable achievements in early infancy is the acquisition of language. In this chapter, I will describe the components of language which children must master to be able to communicate effectively with other members of their culture. In addition, some prerequisites assumed to be necessary for language acquisition will be discussed. The major goal of this chapter is to give the reader an overview over different aspects related to the process of learning language during early childhood.

2.1. The components of language: Sound, Meaning, Order, Use

According to the Webster's Tenth New Collegiate Dictionary, language “is the words, their pronunciation, and the methods of combining them used and understood by a community".

This definition identifies four central aspects of language:

- sounds (phonology),
- words (semantics),
- methods of combining words (syntax), and
- the rules which permit language to be used effectively (pragmatism).

Thus, mastering these four aspects of language becomes a prerequisite for effective communication. Although each aspect refers to a distinct subsystem of cognitive abilities, they are connected to each other forming a larger system – language skills.

Phonology

The children’s first contact with language is mostly one-sided. Although they may gurgle or coo, most of the initial experience is experience as a listener. Among their first tasks, they have to learn to identify the sounds that make up their mother language and how they are combined to constitute words. That is, the infant must distinguish specific sounds in the stream of spoken language and perceive the speech sounds (phonemes) correctly. This includes ignoring the speech variations which do not provide a difference in meaning (e.g., a same word uttered by two different persons), and attending to other sounds variations which do mark a difference in meaning (e.g., the word "bada" *versus* "dada", which differ on the initial phoneme). The sound units of a given language and the rules for combining them are called *phonology*.

Cole & Cole (2001), suggested that the infants' control of the sound system of their native language does not necessarily occur at any specific time (e.g., some infants can master it earlier than others) and it can take several years for the infant to master correctly the pronunciation of words of their mother tongue. Some infants will find a particular phoneme especially difficult to pronounce, even after he/she understands many words that employ that sound. A particular example of this is offered by the above authors: at the age of two and a half years, Alexander could not say /l/ sounds at the beginning of words, making it difficult for him to pronounce the name of his friend's dog, "Lucky". Instead, he consistently pronounced the name "Yucky". This error did not concern Alexander at all; he always knew what other people were talking about when they referred to Lucky, at the same time that Lucky did not seem to notice it. When Alexander called him, he came.

Recent research conducted by Hohle and Weissenborn (2003), provided evidence that 7-months-old German-speaking infants do recognize unstressed closed-class lexical elements in continuous speech.

The stimuli for this experiment were consisted of four different German closed-class elements and four different text passages. The set consisted of two prepositions, *bis* (up to) and *von* (from), and two determiners, *das* (the) and *sein* (his). For each element, a six-sentence text passage was constructed in which the target word appeared once in each sentence. A female native speaker recorded the stimuli. She was instructed to read the passages in a lively voice. Afterwards, the target words were recorded in isolation 30 times each by the same speaker. These recordings were used later in the testing sessions.

During the experiment, the child was seated on the mother's lap in a testing booth. On the back wall of the testing booth a green lamp was fixed. On each of the side walls a red lamp was fixed at the same height as the green lamp. The loudspeakers were invisible to the child. A hidden video-camera recorded the behavior of the child during the experiment. A modified version of the head turn preference procedure was used. The procedure was the following: Each experimental session consisted of a familiarization phase, followed by a test phase. During the familiarization phase, the isolated words were presented to the child, whereas at test, the text passages were presented. Each trial was started by the experimenter causing the green lamp (on the back wall) to flash. When the child fixated on this lamp, the experimenter caused the green lamp to be extinguished and one of the red lamps on the side wall – on the side from which the next acoustic stimuli would be presented – to begin to flash. As soon as the child fixated on the blinking lamp, the acoustic stimulus was started by the experimenter (the push also started the computer timer measure the child's head turn duration). Each child heard two out of the four closed-class elements during the familiarization phase. The familiarization phase stopped automatically when for both familiarization items a listening time of at least 30 seconds was reached. During the test phase, all children heard the text passage for each of the four words. During the experiment, the experimenter observed the child on a video monitor e coded the head turn duration on-line. Mean listening times for every text passage were calculated for each child. Furthermore, the mean listening times for the passages containing the familiarized words and for the text passages containing no familiarized word, were calculated for each child and statistically compared. Twenty-one of the 28 children participating in this study showed longer listening times to the passages which contained the familiar words. As suggested by these results, the ability to detect unstressed closed-class elements in continuous speech starts early in infancy.

Semantics

A second basic language skill that infants must master is linking a specific combination of sounds (i.e. words) to corresponding objects or events in the world. This is known as *semantics***.** In the case of words that refer to objects, they must learn that some words refer specifically to one object, and others to an entire class of objects. For example, *cookie* is an arbitrary string of sounds, which English speakers use to refer to a specific class of objects. The task of the child is to attach words to conceptual groupings, learning when it is appropriated to use them and when it is not (e.g., cookie does not refer to all goods found in the bakery). That is, they must learn that some words refer to basic- level classes (e.g., dogs, cats), while others refer to a more general class of objects (e.g., animals).

Recent research has shown that infants ability to link words to corresponding objects in the world starts early in development (Friederich & Friederici, 2005). Friederich and Friederici have demonstrated that 14-month-olds show different reactions when looking at pictures of known objects presented with basic-level words that were either congruous or incongruous to the picture. The current study used a cross-modal event-related (ERP) priming paradigma, with coloured pictures and slowly spoken basic-level words. The electroencephalograms (EEGs) were continuously recorded for further analysis. The procedure was the following: The participants were seated in front of an LCD computer screen in a sound insulated experimental room. Concurrently with the presentation of each picture, a word or word-like was provided. Words were either the correct names of objects pictured or names of other objects, either congruous or incongruous to the picture meaning. The incongruous words were not semantically related to the pictured objects (i.e. apple-shoe). The data analysis of this experiment revealed difference between infants' responses of congruous and incongruous words. It shows that 14-month-olds already create lexical expectations from the picture content. Thus, lexical priming is already present at this age.

Another way to look at semantic understanding of infants and toddlers is to study overextension of early nouns. This is a common phenomenon in the process of early word acquisition. By the time of the second year of life, children go through a period where many of the first learned nouns are overextended. That is, they apply a label to a broader category than the term signifies. One explanation for this phenomenon is that initially the child must deal with a limited vocabulary when trying to communicate (Rescorla, 1980). Another explanation is that overextensions occur due to the uncertain assignment of the meaning of the word (Mandler, 2004). Mandler suggests that when a child uses the word "dog" to name a "cow" it might be that for the child the difference between them is not really clear, but this does not necessarily have to do with perceptual confusion. It might also be that the child misuses a word when objects share properties like functions, way of moving, kind of interactions, etc. The author exemplifies this by saying that we call two different looking dogs, i.e. Chihuahuas and St. Bernards by the same name ("dog"), so the fact that two things are different in appearance is not always sufficient to say how things will be labelled. According to Mandler (2004), production data alone is not sufficient to determine whether overextension results from uncertainty about the exact intention of the word, or from the inability to retrieve a known word when needed. Hence, more comprehension data are needed to explain this kind of error.

It is often difficult to identify the first words uttered by a child. Although parents are usually so eager to claim their child's ability to speak that they discover "words" in early cooing and babbling, genuine words usually appear late in the first year of life. Studies have demonstrated that although vocabulary comprehension can be seen by the age of 8 months, production starts sometime later, around the age of 11 months (Fenson et al., 1994).

Further studies have shown that although differences can vary widely among infants, on average, they have the ability to use approximately 10 words by the age of 13-to-14 months, 50 words by the time they are 17-to-18 months old, and from 200 to 300 words by the time of their second birthday. However, their receptive vocabulary is considerably larger i.e., when infants are able to produce 10 words, they demonstrate to understand over 100 words (Fenson et al., 1994).

Another aspect to be taken into consideration is the level of abstraction of words used by young infants, which tend to refer to objects at the basic level (e.g., chair, table). Words at the basic level refer to objects that usually share maximal perceptual similarities or provide the same kind of interactions (see Mervis & Rosch, 1981). For example, a young child usually says "car" rather than "vehicle" which has a more general meaning. Although infants tend to stick to the basic level in their first words, studies (Mandler & McDonough, 1993, 1998) have demonstrated that infants less than one year of age have knowledge about higher-level categories (e.g., vehicles, animals) as well as basic level categories (e.g., dogs, cats).

The children’s initial preference for basic-level words can be related to the fact that around the age when the first words are produced they also discover that every object has a name, by observing how adults label things. According to Gopnik and Meltzoff (1993), the production of names is an active form of categorization, not a passive (i.e. recognizer) one. By naming objects at the basic level, children produce different responses to different kinds of objects. And this process of differentiation is closely related to their ability to categorize objects at the basic level.

Syntax

Mastering the sound system of language and the meaning of words is not all that a child must accomplish. In most languages, the linguist must also notice the order in which words are arranged and the rules that govern what kind of words can be combined in which way. Another aspect to be grasped by the child is the inflection of words which means a change in the form of a word, especially its ending, that changes its functions within sentences (e.g., – ed, - est, - ing). This group of rules is called the *syntax* or grammar of a language.

As children begin to combine words and to form complete sentences, they increase the complexity of words and grammatical forms they use. With syntax, an infinitive array of messages can be generated even by using only a small number of words. Here is a set of examples illustrating this: "The horse kicked the boy", "The boy kicked the horse", "Did the horse kick the boy?", "The horse didn't kick the boy", "The boy was kicked by the horse", and many more.

According to Cole and Cole (2001), it is between the ages of two and six years that children begin to use a great number of grammatical devices – the "grammatical rules" or "syntax" which will be elaborated more and more in language classes through schooling programs. A number of these grammatical constructions are followed intuitively by people in their daily speech although most of them cannot say why they use them the way that they do.

A demonstration of the usual gap between people's ability to use language and their ability to understand the principles that underlie daily speech was brought by Cole and Cole with the help of the following examples:

1. John is easy to please.
2. John is willing to please.

In this particular case, both sentences seem to follow the same ordering principle. Despite their surface similarity, they differ grammatically. However, clarifying the difference becomes possible by adding a single word at the end of each sentence while preserving the order of elements. As the new sentences show:

3. John is willing to please Bill.
4. John is easy to please Bill.

In this case, sentence 3 is just as acceptable in the English language as sentence 1. However, although the order in sentence 4 is unchanged, it is not grammatically acceptable and cannot be interpreted.

Such examples suggest that acquiring the syntax of a language involves the mastery of highly abstract rules which even adult speakers of a language could not explain. Yet, such rules appear to be commonly grasped by children learning their native language.

Pragmatics

Besides the building blocks of phonology, semantics and syntax, a language learner must consider the rules of his/her native language which tell him/her how to communicate effectively in different contexts. This is called *pragmatics*. Pragmatics refers to the ways that the members of a community achieve their goals by using language. The way someone speaks to his/her parents is not the same way he or she interacts with a little child, for example. Taken into consideration the level of formality of the speech, the language used in a formal conversation may have little resemblance to what would be heard at a dinner with friends. Another example is that the conversational style of day-by-day interactions is quite different from the language used when reading a storybook to a child. Hence, knowing the difference and when to use which style is the essence of pragmatics.

Language is said to be effective when speakers and listeners come to share a common interpretation of what is being said. However, a major limitation in the language of a small child is that in many cases it leaves a lot of interpretative work for the listener, thus making it not fully communicative. It is through the child's increasing knowledge of syntax (grammatical rules) and semantics (word meaning) that this problem will be diminish with time.

Therefore, one important skill to be mastered by the child in order to be understood by others is to say things in such a way that the meaning will be clear to the listener. Besides, the child must also include in the speech all the necessary information to make it possible to the listener to understand the message.

Importantly, studies on language acquisition have demonstrated that this skill develops over years. Children as young as two and a half years of age have showed ability of engaging other people in communicate interactions and taking the listener into account by adapting messages according to the demand of the situation (Wellman & Lempers, 1977).

Clearly, learning a language is a multifaceted skill which involves a series of complex developments: from understanding and uttering sounds to appreciating the conventional rules of social communication. Despite the complexities, most infants manage it easily with the intention of communication.

2.2. What is required for language?

Taking into account that the ability for full-fledged language is an exclusive human skill, a question raised by Siegler and colleagues (2003) is: What does it take to be able to learn a language in first place? The authors suggest that some prerequisites are necessary to develop the language skill: a human brain and a human environment.

A Human Brain

Language is a *species-specific* behaviour. That is, only humans acquire language in the course of development in their environment. In addition, it is *species-universal,* that means, all young humans have the ability to learn language. It takes highly abnormal environment conditions or quite severe cognitive impairment to impede children to acquire language in the course of development. Therefore, Siegler and colleagues suggest that a probable prerequisite for language development is a human brain (Siegler, Deloache & Eisenberg, 2003).

In contrast, although animals can communicate with one another (i.e., birds claim territorial rights by birdsong) no other species naturally develop anything approaching the human language.

Some researchers have had some success in training nonhuman primates to use communicative systems (Hayes & Hayes, 1951). These authors raised a chimpanzee in their home, with their children. The aim of this field study was to see if the chimp would learn to speak. However, although the chimp clearly demonstrated a rudimentary understanding of some words and phrases, she produced no recognizable words. Hence, the authors concluded that nonhuman primates lack the vocal apparatus to produce speech. Later, researchers attempted to teach sign language to nonhuman primates (Patterson & Linden, 1981). As result, the animals showed ability to communicate with their trainers and caretakers by using signs. However, although one chimpanzee showed ability to name a number of objects, make requests (i.e., "more fruit") and comments (i.e., "Washoe sorry"), the general consensus was that these skills did not qualify as language skills because there was little evidence of syntactic structure in the chimps utterances.

Research with nonhuman primates has shown that even the most basic language achievements come only after concentrated effort by humans to teach the animals, whereas human children master to learn their native language with little explicit teaching. In fact, only the human brain seems to acquire a communicative system with the complexity of language naturally.

Concerning the "brain-language" relations, a vast number of studies have demonstrated that the human brain contains several areas associated with the understanding and production of language. Advances in the ability to record electrical activity and blood flow in the brain have made it possible to access very specific information on the brain's involvement in language. For example, researches developed by Mills and colleagues revealed that before children begin to speak, brain wave activity is distributed across many areas of the brain as they listen to words they comprehend. As they begin to speak, brain waves become more focused in the left hemisphere (Mills, Coffey-Corina & Neville, 1997). Furthermore, children who was detected left hemisphere damage at 16-to-24-months of age, showed delayed language acquisition at the age of four years (Chilosi, Cipriane, Bertucceli, 2001). Such studies suggest that some language processing is located in the left hemisphere shortly after the first birthday.

Previous EEG studies have also offered developmental evidence for left hemisphere specialization for language (Molfese & Betz, 1988). These studies revealed that for both: adults and children, listening to speech is associated with more electrical activity in the left hemisphere of the brain than in the right. In addition, the hemispheric specialization for language increases with age.

A Human Environment

As mentioned earlier, the existence of a human brain is not enough for language to develop. That is, a human environment is crucial for the development of this exclusive human skill (Siegler, Deloache & Eisenberg, 2003).

It is worth to mention that different theories on language acquisition see the importance of a human environment at different levels. For example, for Chomsky (1975), children will set the correct grammar forms of their native language into the pre-existing innate constraints by hearing to adults speaking. In contrast, for Vygotsky (1986), language acquisition results from social interaction from the outset. Nevertheless, they all take the environment as a necessary prerequisite for language learning (see Chapter 3 for a discussion on different theories of language acquisition).

Most of the time children are exposed to different kinds of verbal input. In any culture, some speech is specifically directed towards them i.e., when mothers talk to their young children. As children grow older, they get increasingly involved in interactive conversations with their peers and adults. As a result, their communicative skills also increase.

Studies have showed that mothers have a very special way to direct speech to their young children (Snow, 1984). This infant-directed speech style, known as *motherese* or *parentese*, seems to be crucial on the children's early contact with language (a discussion on infant-directed speech is found in Chapter 3). For example, in one study, both Chinese and American children listened longer to a Chinese woman talking to a baby, than to the same woman talking to and adult (Werker, Pegg & Mc Leod, 1994). Therefore, one can conclude that infants are particularly attracted by the speech style adopted by parents and caregivers communicating with them.

Another research has also demonstrated that the more mothers interact and talk to their children, the more words children acquire (Olson, Bayles & Bates, 1986). In this particular longitudinal study, interrelations between mother-child interaction and children's developing speech progress were assessed. Forty mother-child pairs took part in this study. Assessment of interaction was conducted at 6, 13 and 24 months of age. At 6 months, videotaped episodes of face-to-face play in the laboratory were also obtained. Mothers assessed their children vocabulary competence at the age of 13- and 24 months, and measures of children's cognitive and linguistic competence were obtained by using the Bayley Scales of Infant Development and the Peabody Picture Vocabulary Test. Analyses revealed that children with large and more differentiated vocabularies tended to show superior developmental progress compared to their peers. In addition, vocabulary progress was closely linked to frequent, responsive mother-child language interaction, even when family social class and maternal education served as control variables.

Based on the presented evidences, it seems possible to conclude that infants begin life equipped with two basic prerequisites for acquiring language: a human brain and a human environment. Thus, as long as they do not suffer brain damage or grow up in conditions of extreme social deprivation, they will naturally acquire their mother language.

Chapter 3

Theories on Language Acquisition

Given the importance of the development of language in infancy, a number of theories have been formulated in order to explain this process. In this chapter I will describe the main ideas of four general approaches on language acquisition: (1) the Nativist View, (2) the Interactionist Views, (3) the Theory-Theory View and (4) the Connectionist View. In addition, I will present different theoretical attempts to explain how the process of early word learning occurs.

3.1. Nativist View

The nativist view of language acquisition has been strongly dominated by the work of the American linguist Noam Chomsky (1975, 1999).

Chomsky assumes that all human beings are born with a set of rules to combine words, which he refers to "Universal Grammar". The universal grammar is claimed to be the basis upon which all language skills are building up. Although different languages appear to be extremely diverse at first sight (i.e. they show a different *surface structure*), it is suggested that they share underlying similarities in grammar (i.e. they show a similar *deep structure).* Therefore, sentences might have the same surface structure but different deep structures. Zanden (1978) illustrates this point by using the following example:

"They are eating apples".

1. (They) [(are eating)(apples)].
2. (They) [(are)(eating apples)].

In the first case, the sentence means that people are eating apples. In the second illustration, the sentence means that the apples are for eating rather than cooking. The *surface structure* refers to the sound of the word sequence, while the deep structure refers to the intention of the sequence (or the thought behind it). For Chomsky, it is through the application of preverbal and intuitive rules, known as *transformational grammar,* that individuals translate deep structure into surface structure, and vice versa. Such processes are assumed to be biologically built in our organism.

Therefore, when children begin to listen to adults around them they will automatically recognize the language he/she is dealing with, and, as result, will set the correct grammar form. This is known as *setting the parameters.* Children initially absorb a number of sentences, but rather than simply reproducing them, they extract rules from them and create their own grammar which they apply to create new sentences never heard before. Over the years, when language is already mastered to some extent, children still keep on adjusting until parameters is matching that of their culture's adult spoken language.

In this context Chomsky (1975) makes two main arguments:

- Young children are mostly not exposed to correct language forms; when people talk they often interrupt themselves, change their minds and so on. Yet children manage to learn their language anyway.

- Children do not copy the language they hear, but deduce rules from it. These deductions enable them to produce sentences they have never been exposed to before. Thus, what they learn is not a repertoire of sentences but rather a grammar which enables them to generate a number of new sentences.

Accordingly, he suggested that children are born with a language-generating mechanism which he called *language acquisition devices* – LADs. And that means that the basic structure of the language is biologically channeled. At birth, the child's LADs are presumed to be still. As children grow older and interact with their environment, the maturation of the LADs enables them to fit more and more complex language structures into the preexisting ones.

Following the nativist framework, the growth of language begins early in life and is strongly influenced by the surrounding environment. Studies developed by Mehler et al. (1986) offer support to this view. Mehler and colleagues have shown that 4-days-old infants are already sensitive to particular characteristics of their mother tongue. The authors tested

French babies sensitivity to the difference between French and Russian input from the same speaker. In addition, they found that at birth infants fail to react to differences between languages. These data provide evidences that the stimuli received during the 9 months in the mother's womb does not provide sufficiently input for the child to show preferential attention to his/her native language at birth.

Therefore, language acquisition is assumed to be "something" that happens to the child placed in a determined environment in the same way that the body develops according to the nutritional condition and environmental stimulation. The difference between a stimulating and an impoverished environment may be essential in language acquisition as it is in physical growth. Capacities which are part of human development can flourish or be restricted, depending on the environmental conditions which are provided.

According to Chomsky (1975, 1999), Language Acquisition Devices work like a genetic code for the acquisition of language and is programmed to recognize the universal rules that underline any particular language which can be heard. At birth, the LAD is presumed to be still. As a child interacts with the surrounding environment, the maturation of the language acquisition device enables the child to gain more and more complex language forms into the already existing structures of the LAD. Thus, the basic structure of the language is biologically established. During the process of language acquisition, children have basically to learn the peculiarities of their native language and not the basic structures. Eventually, this process results in the adult's ability to use language.

In support of Chomsky's theory of "Universal Grammar", Jusczyk et al. (1989) demonstrated that the architecture of the human mind is such that it is sensitive at the outset to the structure of any language. Jusczyk and colleagues studied infants raised in an English-speaking environment and found that at the age of 4 months they were sensitive to cues that correlate with clause boundaries of both English and Polish input. However, by the age of 6 months infants had lost the sensitivity to Polish clause boundaries, but continued to demonstrate sensitivity to the clause boundaries in their native language (English).

Corresponding data suggests that some general features about the structure of the human languages are built into the child's system or will be learned very early on the basis of linguistic predispositions. With development, these early sensitivities guide infants to progressively select the appropriate structure of their native language and stabilize it.

As noted by Zanden (1978), Chomsky does not claim that a child is genetically endowed with a specific language. Rather, children possess an inborn capacity for generating grammar rules of a specific language when being exposed to it.

In sum, the nativist view assumes and the structures which make language acquisition possible operate on different principles, and are much more determined by the evolutionary history of the human kind than by the experience of particular children. Experience determines which of the many possible languages a child will acquire. For example, children who never are exposed to the Chinese language will not grow up speaking Chinese even though they are genetically capable to learn that language. However, the experience of being exposed to a particular language does not modify the language acquisition device (LAD); it just activates the innate mechanisms designed for the purpose of language acquisition.

3.2. Interactionist Views

Differently from the nativist theory on language acquisition (Chomsky, 1975, 1999), interactionist approaches link language development either to the development of general cognitive processes, or to the social organization of the environment.

Those who take the first approach tend to have ideas associated with Piaget's constructivism, emphasize the way in which cognitive development "prepares the field" for developing language (Piaget, 1971, 1986; Markman & Hutchinson, 1984; Markman & Wachtel, 1988; Markman, 1989).

Those who take the second approach (cultural-context perspective), emphasize the way in which the environment as well as social interactions influence children's developmental achievements (Vygotsky, 1986; Snow, 1984; Flom & Pick, 2003).

The Piagetian Infant

Born in Switzerland in 1896, Jean Piaget is one of the most influential experimenters and theorists in the field of developmental psychology and the study of human intelligence. Piaget's theory is based on the idea that the developing child builds cognitive structures by understanding and responding to physical experiences. These mental structures gradually increase with development. Hence, what in the beginning are only reflexes (e.g., crying, sucking) later evolve into highly complex mental activities such as the ability to think symbolically (Piaget, 1971, 1986).

Importantly, Piaget's theory suggests that the child progresses through four different stages of mental development:

- sensorimotor (0 – 2 years),
- preoperational (2 – 6/7 years),
- concrete operational (6/7 – 11/12 years) ,
- and formal operational stage (11/12 upwards).

The major transitions are reflected in thought, in which early action-based schemes turn into symbolic, logical, and finally abstract mental structures.

The classical Piagetian interactionist perspective suggests that conceptual development precedes linguistic development. Therefore, language is a verbal reflection of the child's conceptual understanding. Children must develop concepts before they are able to develop linguistic forms which represent them (Piaget, 1986).

As mentioned by Bukatko and Daehler (2001), Piaget's perspective of development suggests that throughout the first two years children increasingly use actions as means to obtain their goals. In the beginning, infants' first movements are reflexive, not planned. As children pass the sensorimotor stage, their actions become increasingly goal directed. In addition, children become able to distinguish themselves from the environment and learn about object's properties and how they relate to each other.

A remarkable feature which emerges at the end the sensorimotor period (and develops further during the preoperational period), is the child's ability to use symbols, i.e., an object or word to stand for something. Piaget called this emergent ability - *semiotic function.* He considered it to be a powerful cognitive ability, because it allows children to think about past and future events, and about objects without their presence. Moreover, Piaget asserted that language would not be possible without thought. Children must possess the cognitive ability to let one thing stand for another before they become able to use words to represent objects, events, and so on (Piaget, 1971). Hence, an important achievement of the children's first years of life is their ability to think symbolically.

In addition, Piaget argues that at the end of the sensorimotor period children have developed a basic understanding of themselves as being part of the world, but still have difficulty in understanding other peoples' point of view. Thus, if language is determined by thought, the child's early speech is suggested to be egocentric and fails when other people's point of view should be taken into account. An example of this is the child's early use of "private speech" (speaking aloud to oneself). This hypothesis was supported by data collected from preschool children's conversations (Piaget, 1986). Thereby, Piaget observed that although children seemed to be playing and talking to each other, their remarks were focused on what was being done by themselves and about their own concerns; apparently children did not care whether anyone else was interested or even listening. Hence, no intention to communicate could be detected. He called this the *collective monologue* and believed it to be a mirror of the children's early egocentric thought. As children mature, their ability to accept other people's point of view increases; thus, their linguistic abilities also increase. As a result, the early collective monologue gives place to genuine dialogues.

According to Piaget's framework, one of the most important statements about cognitive development is that it is the result of the active engagement of the child. For him, active learning promotes deeper and continuing understanding. Therefore, language comes to be a verbal reflection of the child's conceptual understanding.

Vygotsky's developmental perspective on language acquisition

Taken into consideration the cultural-context perspective of development, the most prominent theory of language and thought was developed by Lev Vygotsky (1986). Born in Russia in 1896, Vygotsky studied literature and cultural history at Moscow University. He graduated in 1917, the same year as the October Soviet Revolution.

As Vygostky formulated his ideas during the revolutionary period in Russia (when great emphasis was given to the way in which social organizations channel human potential), it is not surprising that he saw culture and social organization as having an important influence on the development of children's mind. These ideas can be seen in his theory of *zone of proximal development* or ZPD. Harris and Butterworth (2002) describe Vygotsky's ZPD as follows:

> The "zone of proximal development", or ZPD, may be defined as the difference between what a child can achieve unaided in a particular situation – such as completing a puzzle or playing with toys – and what can be achieved with the help of adults, older

children, or, even, with children of similar age (p. 188).

As noted, Vygotsky viewed language as a social tool which is derived from the child's social exchange. For him, speech has the pre-eminent role of carrying culture. Language both stores and carries the stock of social experience and can be regarded as a "tool of thought".

One of the main differences between Piaget and Vygotsky refers to their views on the relationship between language and thought. Vygostky put much more emphasis on the formative role of culture for development than did Piaget. While Piaget was mostly concerned to explain intelligence on the basis of biological roots (developmental stages), Vygostsky was concerned to show how culture influences development. Importantly, Vygotsky did not deny the influence of biological processes on development, but rather suggested that social and cultural factors make important contributions to the development of intelligence.

In contrast to the interpretation given by Piaget, Vygotsky believed that the child's initial utterances or "private speech", serve an interpersonal function, signalizing others about their affective state. Hence, it does have communicative intentions. In the pre-school years, speech seems to serve a different function. By observing infants making use of private speech, Vygotsky noticed that they often use this as a mean to plan and guide their own behaviour (Vygotsky, 1986). Like adults, children seem to make use of private speech when they are engaged in challenging tasks or find them particularly difficult. In his framework, the use of private speech which first seems to guide children’s actions later becomes interiorized into a form called *inner speech.* For example, a social rule that is first uttered by the parents, becomes later something that the child says aloud in private speech, eventually becoming an internalized concept.

To test the hypothesis that private speech (or collective monologue) serves no cognitive or communicative purposes (as proposed by Piaget), Vygotsky conducted a series of studies based on observations. The corresponding studies were described by Wertsch (1985). In one of the studies it was demonstrated that private speech fulfils important cognitive functions: When children were facing difficulties to solve a given problem, they raised the level of the externalised private speech in order to guide their problem solving. A second study also demonstrated that private speech serves communicative functions: In this study, preschoolers were placed among deaf-mute children. If private speech had no communicative function, language production should not be affected by the fact that their playmates could not hear their utterances. As a result, it was observed that the rate of private speech decreased in the presence of no hearing children.

As can be noted, the socio-cultural perspective proposed by Vygotsky assumes that children's experience with language is social from the outset. And language takes an increasingly important role in regulating behaviour as children develop. Like other behaviours, it results from social interactions.

Importantly, Vygotsky suggested the existence of a close link between language and thought. For him, initially language and other complex mental processes are something that only adults have access to. Thus, when adults explain something to a child, they give access to intellectual processes based on language. By this, social relationship provides the child’s initial contact with intellectual processes which are learned by the child. With further development these processes will operate as verbal thought.

Vygotsky (1981/1988) called the above described pattern of development as "the general, genetic law of cultural development". According to this view, intellectual processes move from being external – social – to internal. He described this process as follows:

> All the basic forms of the adult’s verbal social interactions with the child later become mental functions… Any function in the child’s cultural development appears twice, or on to planes. First it appears on the social plane and then on the psychological plane. First it appears between people, as an interpsychological category and then within the child, as an intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts and the development of volition (p. 73).

Following this line of thought, linguistic patterns used by adults during interaction with children might influence semantic and conceptual structure. Evidence supporting this assumption has been offered by Mervis (1987). Based on empirical data, Mervis suggests that particular features of adult's use of category names might lead infants to develop new types of language and categorization. In addition, the author argues that in many situations children choose to attend to or emphasize different attributes offered by adults because of their limited experience or lack of knowledge about appropriate functions and correlated attributes of objects.

Clearly, the socio-cultural perspective interprets children as social beings, shaped by their cultural context. In the "zone of proximal development", older and more skilled individuals help children to acquire skills like language and values of their culture. Infants take particular advantage of interactions with adults in order to develop their linguistic and cognitive abilities.

In sum, different interactionist perspectives try to explain how the child's linguistic and cognitive system are being formed throughout development. Importantly, as discussed by Gopnik and Meltzoff (1998), most of the researches investigating relations between language and thought have inferred the child's cognitive structures from the linguistic behavior. Very few studies have directly investigated the effect of language on nonlinguistic cognitive developments or vice-versa.

3.3. A Theory-Theory View

As stated by Mattes (2005), "essential to the existence of both social skills and culture itself is the ability to communicate with others through a system of shared understanding. Clearly, to thrive in such an environment, it is absolutely essential to have a good understanding of other people" (p.2). But how do newborns develop their understanding of others? Recent studies have shown that children do not fully develop what is commonly agreed upon as a *theory of mind* until they are about 4 years old (Tomasello, 1999). So what happens before that milestone and how do infants conceive of other people during that development? With the help of her research colleagues, Alison Gopnik has formulated specific ideas about this natural tendency to theorize about the world and has called it the "theory theory" (Gopnik & Meltzoff, 1986; Gopnik & Meltzoff, 1986; Gopnik, 2003).

As stated by Gopnik and Meltzoff (1998), the central idea of theory-theory "is that the processes of cognitive development in children are similar to, indeed perhaps even identical with, the processes of cognitive development in scientists" (p.3). The everyday experiences are viewed as "evidence", and theories are developed to interpret that evidence. To put it in other words, the basic idea is that children develop their knowledge of the world by using similar cognitive devices that adults use in science. Particularly, children develop abstract and coherent systems of entities and rules. That is, they develop theories.

According to Gopnik (2003), children actively explore the world, testing predictions of the theories and gathering relevant evidence. Eventually, however, when the predictions of the theory are falsified, the child begins to search for alternative theories. In this case, if the alternative theory does a better job of predicting and explaining evidences it replaces the existing one. Importantly, this account has been successfully applied to explain children's understanding of the world.

Studies conducted by Gopnik and Meltzoff (1986) suggest a relation between linguistic and cognitive development which is different from either one described by the interactionist perspectives (Piaget, 1971; Vygotsky, 1986).

According to a "Theory-Theory View", semantic and cognitive developments emerge simultaneously; neither one precedes the other. Instead, a bidirectional interaction between conceptual and semantic development is suggested (Gopnik & Meltzoff, 1998).

Following the *specificity hypothesis* (Gopnik & Meltzoff, 1986), the attainment of preverbal object concepts may motivate children to learn words by drawing attention to the verbal input which is presented together with a given object. At the same time, the use of particular linguistic patterns may direct children's attention to different aspects of a given object, hence providing the opportunity to solve cognitive problems and to increase conceptual understanding. For example, evidence provided by Waxman and Markow (1995) suggests that novel words might promote category formation by drawing infants attention to properties that objects labelled similarly may share (for a detailed description of the experiment, see chapter 5).

In support for the assumption that language shapes conceptual understanding, recent work suggests that infants may take particular advantage from the words they hear, connecting them to objects or events that they are standing for. For example, a study conducted by Baldwin and Markman (1989) showed that 10-to-14-month olds paid more attention to given stimuli when adults presented them accompanied by labeling phrases such as: "See the robot! It is a robot!", than when the same stimuli were presented without being labeled. In a follow-up study, the authors explored the effectiveness of labeling as compared to pointing. This study tested 10-to-14-month olds as well as 15-to-17-months old infants.

Two tasks were presented in different contexts: Infants saw pairs of unfamiliar toy-objects when either the experimenter was pointing to the target alone, or pointing at the target at the same time the labeling phrase was used. As a result, infants of both age-groups looked at the target object equally long in both conditions. In a subsequent playing phase without any verbal input, infants looked longer at the toy-objects that had been labeled. From these findings, one could conclude that both pointing as well as labeling increase infants' attention to the target objects. However, labeling seems to have particular effects on infants' subsequent interest to objects. This provides a good example for the claim that language shapes our thinking, even at the very beginning or word learning.

The specificity hypothesis would also allow predictions in the other direction in the following sense: The acquisition of certain milestones of cognitive development (such as symbolic play) or the development of rather specific competences (such as object permanence) can provide the ground for word learning in general or for specific linguistic concepts: Imagine a 15-months-old infant who knows that objects sometimes are put into groups by adults, either linguistically or physically. Such a child may notice that all objects of a particular kind are called "bottle" and may use this word to refer to these objects. As he/she pays more attention to the object's names, he/she notices that names are not only applied to objects like "bottles" but to a variety of objects. When the mother shows a picture book, for example, she names the objects exclaiming "horse" or "elephant" every time they come into view. Based on these experiences, the child could conclude that every object has a name to be discovered (this is considered a central issue of the naming spurt). The infant might also realize that all objects belong somehow to a category and that in general are divided into kinds. In dealing with objects, the child might demonstrate it by sorting out behaviors and placing objects into different locations. By this behavior, the child would parallel how he/she and his/her mum linguistically place different objects into categories.

Gopnik and Meltzoff (1998) argue that in all these cases it seems that infants take particular advantage from the linguistic signs if they see them as relevant to the problems they are trying to solve. For example, infants who can find hidden objects after they have been moved from a particular location to another, begin within weeks to use words such as "gone" to indicate disappearance (Gopnik & Meltzoff, 1986).

As reported above, the theory-theory perspective provides a helpful model to understand the relation between language and conceptual organization. Gopnik and Meltzoff (1998) offer an interesting example for the proposed model. The example demonstrates that we can think about the child's acquisition of early words as being similar to a physics student hearing about a new theoretical possibility from a scientific innovator. So it goes: Consider the acquisition of a particular scientific word; in these circumstances, "entropy". According to the authors, developing an understanding of such words and the ability to use them appropriately is one sign of theory formation.

Considering the acquisition of "entropy" helps us to understand the process of theory change in young children: We pay attention to words like "entropy" because they are relevant to a given scientific problem we try to solve. Learning words is an important part of learning the concepts. Moreover, hearing the same word in different contexts may lead us to see similarities which we might not have considered in the absence of those contexts. In a classroom situation, for example, hearing the professor saying the word "entropy" when discussing two different phenomena, may lead us to link them although apparently they do not have anything in common. Besides, this linkage might have implications for other aspects of our further understanding of physics.

By using the above described example, Gopnik and Meltzoff intended to show that humans do not simply have an innate repertoire of concepts and are merely waiting to map the correct term onto the pre-existing concept. It is also not the case that we simply match our linguistic behavior to a pre-existing one and eventually our cognition is shaped accordingly. Rather, both types of developments, learning the words and the related concepts, seem to emerge simultaneously facilitating one another.

Summarizing data reported above, one can conclude that there seems to be a complex interplay between linguistic and cognitive developments. And, rather than being the result of some general relation between linguistic and cognitive abilities it seems to involve quite specific links between conceptual developments and related semantics development. Thus, semantic and conceptual understanding emerges simultaneously, influencing and facilitating each other, and they are closely linked from the very beginning of language learning.

3.4. Connectionist View

Another contemporary approach which emphasizes the role of general learning processes for language acquisition refers to *connectionist models* (Elman et al., 1996). The general idea is that language acquisition can be explained through associative learning of neurons which can be simulated in computer network models. This is true for all mental processes, including language learning. By using connectionist models together with genetic algorithms and artificial life models, connectionist researchers have studied evolutionary change at the level of neural networks, besides maturation and learning in individual networks and the interaction between them.

Connectionism and the functioning of neural networks

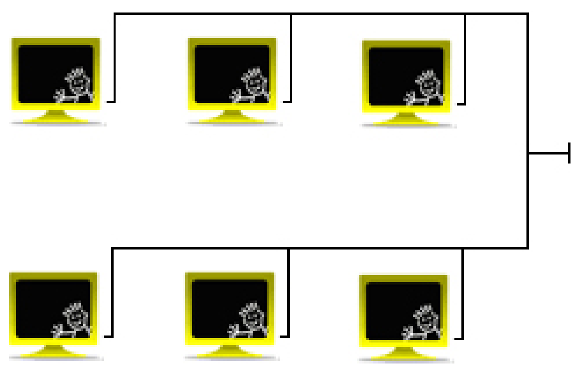
According to Elman and colleagues (Elman et al., 1996), for most people knowledge comes from two different sources: what is given to us by our nature, and what we know as a consequence of nurture. But what do nature and nurture mean in this context? Nature is mostly understood as what is present in the genotype, and nurture usually means what is learned by experience. The difficulty, however, is that when someone looks at the genome, he/she does not see arms or legs, or even complex behaviours. But as he/she learns about the basic mechanisms of genetics, it becomes possible to understand that the effects of gene products are indirect and often depend on interactions not only with other gene product but also with external stimulus.

Hence, it seems obvious that for connectionists knowledge comes from the interaction between nature and nurture, or what has been called "epigenesis". The genetic constraints interact with internal and external stimulus, which together give rise to the phenotype.

Based on this general insight, some researchers saw the late advances in developmental neuroscience and computation as appropriated tools for understanding neural processing (Elman et al., 1996). As noted, the inspiration for connectionism has emerged from advances in two fields: genetics, embryology, and developmental neuroscience from one side, and computation from the other.

To conceptualize connectionism or neural network modelling, Garson (2002) described it as a framework in cognitive science which hopes to explain human intellectual abilities using artificial neural networks based on the architecture of the brain. Because neurons are the basic information processing units of the brain, and every kind of information processed in the brain occurs in networks of interconnected neurons, the connectionist models try to explain how computation occurs in neural networks.

One can imagine the neural networks as a computer network (see Figure 1). Different units are connected to one another, because no group of elements qualifies as a network without being connected to other members. It is the existence of connections between the units within a computer that identifies them as a network. As units in a connectionist model are analogous to neurons, the connections are analogous to synapses. In fact, synapses are gaps between neurons through which chemical messengers leave one neuron and enter another. Consequently, synapses are where information flows from one neuron to another. Hence, connections within a neural network are synapses. Synapses in a connectionist model are represented with lines.



Computer Network

Figure 1: A sample computer network

Units are to a connectionist model in a computer what neurons are to a biological neural network in an organism – the basic information processing structures. The units of a neural network are usually divided in three classes: *input units*, which are the ones that receive the information to be processed, *output units* where the results of the processing are found, and the *hidden units*, which are responsible for conducing information from the input units to the output units (see Figure 2).

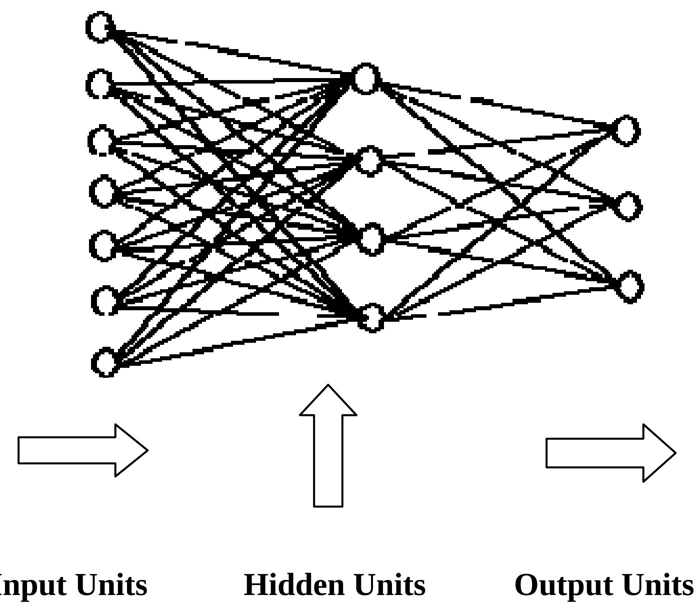


Figure 2: A sample neural network

Based on Garson (2002), the functioning process of the neural networks goes like this: Each input unit receives some activation from external sources (e.g., sensory or motor). Then, each input unit sends its activation value to the hidden units to which it is connected. Each of these hidden units calculates its own activation value depending on the activation values it receives from the input units. This signal (or information) is then passed on to output units or to another layer of hidden units. Those hidden units compute their activation values in the same way, and send them along to their neighbors. Eventually the signal at the input units propagates all the way through the net to determine the activation values at all the output units. Output units, then, send signals out of the system. To put it in other words, when our organism encounters a familiar input, the input units of our system become active and this activation spreads out around the net. Eventually, certain units in a response layer are turned on associating the received input to the input obtained in previous occasions. This process is also known as parallel-distributed processing (PDP).

According to Siegle (1998), a connectionist network's response to a stimulus generally involves the activation of a number of units in the network. This pattern of activations can represent an association in memory between two stimuli or a reaction to an external stimulus based on the network's architecture and the designer's conception of the network. Thus the processes operating within connectionist networks can be assumed to correspond to neuronal, cognitive, or behavioral events based on the intuitions of the network's designer.

The child's sensitivity to language: predicting the next sound

As already mentioned in Chapter 2, by four days infants have the ability do discriminate the prosody of their native language from that of another languages (Mehler et al. 1986). Clear predispositions with respect to the discrimination of different speech sounds have also been detected early in infancy (Kuhl, 1991).

Based on this evidence, Elman and colleagues (1996) discussed a network (Elman, 1990) that discovers word boundaries in a continuous stream of phonemes without built-in representational constraints. According to the authors, "the linguistic-relevant representations simply emerge from the processing of the input" (p.119).

Elman's network attempted to simulate the infants' task of identifying words from a sequence of input phonemes. The proposed network was fed one phoneme at a time and was expected to predict the next phoneme in the sequence.

As described by Elman et al. (1996), the input consisted of a string of words made up of a sequence of phonemes (see example below):

Manyyearsagoaboyandagirllivedbytheseatheyplayedhappily.

The phonemes themselves go together to make up English words and the words make up sentences. Attempting to predict the next phoneme in the sequence, the network must exploit statistics regularities implicit in the phonotactics of the language. It was not given any further information about the structure of the language.

Results showed that the error tended to be high at the beginning of a word but decreased until the word boundary was reached. Before it was exposed to the first phoneme in the word, it was not sure of what would come next. However, the input of the two first phonemes was usually enough to enable the network to predict with confidence the following phonemes in the word.

It is important to report that the network made segmentation errors. For example, the string of phonemes "*aboy*" (see above) was treated as a single unit by the network. According to Elman and colleagues the explanation for this error is quit simple: this prediction is a consequence of the distributional characteristics of the article "a" and the noun "boy" in the English language – they often go together like phonemes in a word do. Interestingly, current literature brings evidence that children also make this kind of mistake (Peters, 1983). An illustration of infant's segmentation errors is offered by Elman et al., (1996). Young infants often temporarily say: "*the nelephant*" having missegmented the indefinite article "an" and the noun "elephant".

Another error produced by Elman's network was an undershooting segmentation error based on orthographic missegmentation. For example, in the sequence "they" the network recognizes the sequence "the" as legal, and leaves the "y" unattached to any word. The previous example "aboy" was also an example of overshooting segmentation error.

The network, however, demonstrated the ability to learn to rectify some of these errors. On exposure to further training examples, where the article "a" is combined with a range of other nouns, it will eventually learn to separate "aboy" into two different words. In contrast, the network will continue to have difficulty to work out whether "the" should be continued into "they" once the word "the" is a legal unit itself. To solve this problem, the network would require further information.

By these examples, Elman's work has shown that as with most connectionist networks, a long initial period is essential to learning. The next section shows that it is also true in vocabulary learning.

Vocabulary development

A particular aspect investigated by developmental researchers is why there is a period of slow vocabulary growth, followed by a dramatic change during which there is a considerable increase in the number of words the children can produce (Thal, Bates, Goodman & Jahn-Samilo, 1997). A connectionist simulation of the intra and inter-domain processes involved in concept formation and vocabulary growth has suggested that these kinds of phenomena are emergent properties of the dynamic learning (see Plunkett et al., 1992). The networks' task used to investigate this issue was to associate images with labels.

Elman and colleagues (1996) describe this connectionist simulation as follows: the images used for the simulation task were random dot patterns, grouped in categories that have an internal prototype structure. No prototype pattern had more than two dots in common with any other prototype. Hence, the network was not able to categorize purely based on perceptual similarity. The network must take into account the label assigned to each pattern in order to find the correct conceptual classification.

Before being presented to the network, the image patterns were pre-processed in a retina in order to compress the representation of the pattern on the image plane, forming a distributed representation of the random dot patterns with a corresponding retinal representation. Each group of images was associated with a discrete label. It consisted of 32 bit vectors in which only one bit was active for each label. This means that there was no internal categorical structure built into the set of labels and there was an arbitrary relationship between the labels and its associated group of images. The task of the network then, was to reproduce at the output level the appropriated retinal and label representations that were presented at the input level. The network was trained in a "three-phase cycle":

1) a retinal representation was presented at the input units and activity was spread through the network to the output units,
2) the activity on the retinal output units were then compared to the initial retinal representation,
3) finally, image and label were simultaneously presented and error signals were used to adjust weights (the strength or weakness of the connections) on both sides of the network.

These three-phase learning sequence was successively applied to all image-label pairs during training (see Plunkett et al., 1992 for more detailed description of the simulations' network).

The performance of the network in producing output labels and retinal representations were evaluated at various points during training in terms of comprehension and production. However, the results described here focus basically on the networks' production performance and its relation to the phase of vocabulary spurt seen during children's development. Once given a retinal image, production was measured in terms of the network outputting the correct corresponding language representation, among other evaluations.

The results of the network training revealed several features that are characteristic of infants' early conceptual and language development. For example, the network took longer to discover the appropriated clustering when labels were not included as input in the training. It suggests that the network also exploited the predictive power of the label in identifying category membership, pointing also to a rich inter-domain interaction between label and visual representation.

The described results resemble a set of findings obtained by using object examination tasks, which reveal that the presence of object labels promotes object categorization in 12-to-13-month-olds (Waxman & Markow, 1995).

Another important observation within the network training was that production scores remained low in the initial phase of training, but subsequently increased dramatically. Again, as stated earlier, the same kind of behavior can be observed in lexical development (Thal et al., 1996).

Although many connectionist simulations of children language acquisition are not necessarily well known outside the connectionist circle, this research has made enormous contributions to our understanding of how particular developmental processes occur.

3.5. Lexical development as one important aspect of language acquisition

As will be shown in this section, the general theories of language development outlined above have implications for lexical development (i.e. word learning).

Word learning as guided by innate constraints

As mentioned earlier in this chapter, the nativist view on language development has been strongly influenced by the work of the linguist Noam Chomsky (1975, 1999).

For nativists like Chomsky, the language children hear and the feedback they get in their early attempts to produce words provide insufficient information for them to induce the rules of grammar. The fact that children produce a range of sentences which they have never heard before makes it unlikely that language could be acquired through learning mechanisms such as conditioning or by imitation as proposed by Bandura (1977). Most importantly, it is believed that the capacity for language comprehension as well as language production are innate, and that the principles on which language develops are not the same as those responsible for other behaviors.

According to Markman (1989), when an adult points to an object and labels it, the meaning of this label is quite arbitrary for a young child. It could be that the novel word refers to the object category, part of the object, or even to its substance, color, and so on. One solution children would initially find in order to constrain the number of word meanings, is to assume that a novel word refers to the whole object and not to its part, substance or color. But it is not all. Once assumed that a word refers to the whole object and not only part of it, a child must still decide how to extend it to other objects. There are a number of possibilities for this: It could be that the novel word refers to some external relation between objects. Spatial and causal relations are examples of common relations between two objects that a word could in principle label. More generally, objects can be also related through the way they participate in specific events or themes (e.g. dogs play with balls; birds build nests). However, the existence of a thematic relation between two or more objects does not necessarily make them the same kind of thing. An interesting question here is: how do children work it out?

In an attempt to answer this question, Markman and Hutchinson (1984) proposed that children constrain the possible meaning of words by ruling out thematic meanings. Despite of considering thematic relations a good way of organizing objects, children do not consider these relations when trying to find what a novel label might mean. It is believed that when children learn a new word, they transfer their attention from thematic to taxonomic organization. Thus, it is assumed that when hearing a novel label, children take into consideration the whole-object and the taxonomic assumptions. It means that, when infants hear a new word in connection with some object they might assume that the word refers to the whole object and not to its parts or properties. In addition, children may assume that the new word can also be extended to classes of similar objects (taxonomic categories) and not to objects that are thematically related. For example, when the word "cup" is used in conjunction with the object that holds their milk, the new word is applied to the whole object and not just to the handle. Another example is that infants use the word "dog" not only to refer to a particular family of dogs, but tend to extend it to other dogs and not to objects which are thematically related to dogs (e.g., a ball).

To test these predictions, Markman and Hutchinson (1984) conducted a study which compared children's performance on organizing objects when they were not given an object label versus the presence of a novel label.

In one set of experiments, Markman and Hutchinson investigated whether hearing a novel word would cause 2-and-3-years old children to shift attention from thematic to categorical relations. Basic-level categories (e.g., dogs, chairs) were used with this age group of children. These set of studies had two conditions: *no word,* and *word condition.* In the no word condition, in each test trial the experimenter first placed the target picture against a frame in front of the child, and said "Look carefully now! See this?" as he/she pointed to the picture. Then the experimenter placed the two choice pictures on the table and said to the child "find another one that is the same as this", while he/she continued pointing to the target picture. One of the choice pictures was a member of the same basic-level category as the target. For example: the target might be a dog (e.g., a poodle) and the choice another dog (e.g., German shepherd). The other choice picture was thematic related to the target (e.g., dog food). In the novel word condition, the material and procedure was the same. The only difference was the presence of an unfamiliar name when the target picture was presented. For example, the experimenter said "See this? It is a sud!" And then said: "find another sud that is the same as this sud". As a result, children in the no word condition tended to chose the thematic related object, i.e., dog and dog food. In the novel word condition, when the target picture (e.g., a dog) was given an unfamiliar label, the children were more likely to select categorically, it means, to pick another dog.

In the same opportunity, another set of experiments tested the hypothesis that hearing a novel word will induce children aged 4-and-5-years old to look for superordinate-level taxonomic relations. Each child took part in one of the two conditions. The material and procedure were the same as in previously described study. In one condition (no label condition), the children were asked to find a picture which was the same as the target (e.g., "See this! Can you find another one?"). The other condition (label condition) took the same principle, except that a nonsense syllable was used to label the target picture (e.g., "See this Dax! Can you find another Dax?"). In both conditions the children were first presented the target picture. After that, they were shown two other pictures and had to pick one of them as being the same as the target. One of the pictures was related to the target in a thematic way (e.g. milk – cow), and the other picture was a member of the same superordinate category as the target (e.g., cow – pig).

As a result, when no label was provided, the children tend not to make categorical distinctions. When they had to make a choice between another member of the same category and a thematic related object, they often selected the thematically related one. As predicted, children who heard the target picture being labeled with an unfamiliar word were much more likely to search for taxonomic relations than the ones who heard no labels. Again, the fact of hearing a new label caused the children to select objects categorically.

Following this line of arguments, the whole-object assumption leads children to treat novel words as labels for whole objects and not for parts or objects properties (Markman, 1991). Nevertheless, children must also learn words which refer to parts or other properties of objects. Based on this framework, in addition to using the whole-object and taxonomic assumptions to constrain the number of word meanings, children are also said to expect that words are mutually exclusive, it means, each object has only one label. This way, *the mutual-exclusivity assumption* helps children to acquire terms other than object names by over-riding the whole-object assumption.

The advantage of assuming the mutual exclusivity constraint is that children avoid forming redundant hypotheses about the meaning of category labels. In this case, as children assume that an object can have just one name, if they already know a label for "dog", they will conclude that a novel word they hear while they are looking at a number of animals (including dogs) such as "pig", does not apply to dogs. Another advantage of the mutual exclusivity is that if a child knows that the word for an object is "cup" then he or she can later learn the word "handle" for a part of a cup. In essence, this assumption gives children the chance to consider both the situation and context in making an informed decision. Haryu and Imai (1999) put it the following way:

> The mutual exclusivity assumption is a very useful constraint for learning basic- level category terms: children can map a novel word on to an object whose label has not yet been learned. It can also help children exclude a newly labeled object from the extension of an originally overextended old category and establish a new category (p.21).

Studies of children's language comprehension support the hypothesis that young children expect terms to be mutually exclusive (Markman, 1989). Researches have demonstrated that when hearing a novel word, children assume that it refers to another object rather than to the object for which the label is already known (Golinkoff et al., 1995). In this case, children maintain mutual exclusivity by mapping the new word onto the new object. For example, if children already know the word for a specific object and a novel label is applied in the presence of the target object, they reject the second label. Assuming that there is no other object present in a given situation, they cannot treat the novel word as a label for a novel object. Thus, a new strategy must be elaborated by children in order to adhere to mutual exclusivity. It might be, for example, that children come up with no meaning for the second label. Or, they might try to find a property to which the novel label can be applied to. As an example, 3-to-5-years old children have demonstrated to use the mutual exclusivity assumption to learn part and substance words (Markman & Wachtel, 1988). In one of the studies conducted by the authors, infants were taught a new part term or a new substance term by showing them an object and saying, "This is a trachea" or "It is pewter." For unfamiliar objects, infants tended to interpret the term as a label for the object itself. For familiar objects, they tended to interpret it as a part or substance term. By this study, it was concluded that mutual exclusivity motivates children to learn terms for attributes, substances, and parts as well as for objects themselves.

Following this line of arguments, one can assume that all three postulated word-learning constraints contribute to very young infants quickly figure out the meaning of words. The whole-object assumption seems to serve as a first hypothesis, which can be later overridden in a range of different ways as language develops.

Word learning as the result of associative learning

A traditional version of the associative learning theory – the learning that occurs when two or more events are paired together – was developed in the 18th century by the philosopher John Locke (1964). Locke argued that, if two thoughts occur at the same time, they become automatically associated, and one gives support to the other. For example, children learn the meaning of *rabbit* because the word is used when they are observing or thinking about rabbits. Thus, the word and the thought become associated and children could be said to have learned the meaning of the word.

Another traditional version of the associative learning theory was adopted by Skinner (1957). He proposed that learning the meaning of a word depends on establishing a connection – through reinforcement and punishment - between a set of stimuli and a verbal response.

In the last few decades the traditional learning theories play a lesser role in current explanations of language development than it did earlier. One contemporary approach that emphasizes the role of general-learning process includes connectionist models of language acquisition (see Chapter 3.4). This approach suggests that the process of language acquisition as well as the acquisition of some particular aspects of grammar can be explained through associative learning of neurons, which can be simulated in computer network models (i.e. Plunkett et al., 1992; Rumelhart & McClelland, 1986) .

To remind the reader, the central connectionist principle is that mental phenomena can be described by interconnected networks of simple units. That is, each unit is connected to every other unit either directly or via connections to intervening units. Basically, a connectionist network (c-net) consists of three different layers: an input layer, an output layer, and a hidden layer. Learning in a c-net takes place by altering the strength of the connections between units in the different layers. At the start of a study all the connections between the different layers are of equal strength. As learning occurs, the strength of connections is altered so that some become stronger and others weaker.

As stated by Siegler, Deloache and Eisenberg (2003), for the connectionist account children do not need innate linguistic knowledge or special language-specific mechanisms to learn the many statistical regularities in the speech their hear. Instead, language development is claimed to be primarily based on general-learning mechanisms, resulting from the gradual strengthening of connections in the neural network. Interestingly, this account is consistent with the speech-perception research, which suggests that infants tend to focus on the speech sounds that are used in their native language, becoming increasingly sensitive to many of the numerous regularities in that language (Jusczyk, Cutler & Redanz, 1993).

As discussed earlier, the connectionist approach is based on computer models of neural networks that have the capacity to modify themselves as a result of input. The network is provided with a large number of language input similar to what children are exposed to. The goal is to see if the network produces output that simulates the speech of real children. Importantly, this account has offered valuable contributions to the understanding of how children manage to acquire some specific grammatical aspects such as the acquisition of the

English past tense (Rumelhart & McClelland, 1986).

The connectionist model designed by Rumelhart and McClelland was developed in order to demonstrate how the past tense might be learned without using a rule. For example, it has been shown that from input of a large number of English sentences with regular and irregular verbs, neural network models can learn to form the past tense correctly. In the process, the models are observed to make the same kinds of errors that children make. In English, the past tense of a number of verbs is formed by adding "ED" at the end of the verb stem as "hunt – hunted", "talk – talked". These verbs are described as regular verbs. However, in some cases the past tense can be formed in one of a number of different ways as in "sing – sang", "fall – fell", "go – went", and so on. These verbs are known as irregular verbs. Rumelhart and McClelland's connectionist network was quite simple. There were 460 input units and 460 output units with each input unit connected to every output unit. They presented 420 different word stems as the input and the task of the network was to learn to produce the appropriate past tense for each stem. As a result, the performance of the c-net was similar to that shown by children when learning to produce past tense forms. Regular and irregular verbs were treated differently, and the c-net produced overregularisation errors just like children do. These kinds of errors occur where the "ED" ending is used incorrectly with an irregular verb as for example "sing – singed", "go – goed". As discussed by Elman et al. (1994), the network must learn to deal with both regular and irregular verbs in the same way that children do. It must learn that the past tense of "go" is "went" while the past tense of "show" is "showed". The model learns through exposure to the different verbs as children learn from the input they receive from the environment. Repeated presentations of the stem will eventually eliminate the output error, i.e., the network will have learned to produce the correct past tense form of the verb given its stem.

By simulating the functioning of neural networks, this approach has demonstrated that the great deal of information which is latent in the environment can be extracted by the infants using simple but powerful learning mechanisms.

In disagreement with the explanations offered by the traditional associative learning theories, Bloom (1999, 2000) has developed an alternative approach for language acquisition. According to his account, children learn words with the help of general associative principles and thereby draw extensively on the children's understanding of the thoughts of others. As

Bloom (2000) explained it:

> When children learn that rabbits eat carrots, they are learning something about the external world, but when they learn that *rabbit* refers to rabbits, they are learning an arbitrary convention shared by a community of speakers, and implicitly, agreed-upon way of communicating. When children learn the meaning of a word, they are – whether they know it or not – learning something about the thoughts of other people (p. 55).

Bloom argued that many facts about word learning are consistent with the traditional perspective. Importantly, he pointed out that children's first words often refer to things they can see and touch. This is exactly what one would expect in the process of associative learning. If you want to teach someone the meaning of *cat,* the best way to do this is to point to a cat, make sure that the person is paying attention to it, and say the word 'cat'. In case you wait until there is no cat around and nobody is thinking about cats, and then say the word cat, the word will fail to be learned. According to Bloom, this line of argument has some problems, however.

One of the problems has to do with the learning of names for things which cannot be seen or touched. It includes, for example, abstract entities such as numbers, ideas, fictional characters, and so on.

Another problem is that words are not always uttered when the referred object is in sight. In fact, concrete objects are also often mentioned without the object being in sight. A sentence like, "Do you want some milk?" would typically be uttered when the child is not looking at milk but rather looking at the parents' face. However, it is not very likely that children will make errors such as calling faces "milk". In this case, a solution offered by Bloom is that some of the time the word "milk" is used, children are not attending to milk, but the percepts that are most associated with the word are those elicited in the situations where "milk" is involved. Children who start associating "milk" with faces, after hearing the word uttered many times (in specific contexts i.e., when milk is present) milk.

There is a third problem for the traditional idea that children learn words by having an adult naming the objects for them; this behavior might not be universal. It might be typical in our culture, but completely lacking in other cultures. But even in these cultures, children learn to speak their native language at roughly the same speed and the same richness as the language spoken in "our" culture (Lieven, 1994). However, this is a common problem for all theories that take the interaction child-adult as a crucial factor for language learning.

A fourth and last problem pointed out by Bloom, which was originally raised by the philosopher Quine (1960), is a situation where a linguist visits somebody who speaks a language he does not know, and tries to understand the words in this language. For example: A rabbit runs by, the native speaker says "Gavagai", and the linguist notes the word "Rabbit" as a possible translation, subjecting the word to testing in further situations. As Quine argues, it is impossible for the linguist to be sure that the translation is correct. It can also be true that the word "Gavagai" refers to a particular rabbit; or that the word means "animal"; or even means the left leg of the rabbit, and so on. However, Bloom suggests that some of the formulated possibilities are quite obviously wrong. For example, we know by intuition that ‘gavagai’ uttered in this context does not mean the right front leg of a rabbit or a rabbit and half of a bush. The question here is: how do we come to this conclusion? In an attempt to offer an explanation for mentioned question, Bloom (2000) states:

> These problems of reference and generalization are solved so easily by children and adults that it takes philosophers like Quine and Goodman to even notice that they exist. If we see someone point to a rabbit and say “gavagai,” it is entirely natural to assume that this is an act of naming and that the word refers to the rabbit and should be extended to other rabbits. It would be mad to think that the word refers to undetached rabbit parts or rabbits plus the Eiffel Tower. But the naturalness of the rabbit hypothesis and the madness of the alternatives is not a logical necessity; it is instead the result of how the human mind works (p. 4).

As mentioned earlier, traditional associative perspectives assume that words are initially learned by association of a word (by hearing it) with an object perceived by seeing it. Bloom (1999, 2000) argues for an alternative hypothesis: Words are learned by working out what people are making reference to when they are using the words. Thus, children's word learning relies extensively on their understanding of the thought of others – on their *theory of mind*. To make things clearer concerning Bloom's alternative hypothesis for associative learning, an experiment conducted by Baldwin (1991) should be taken into consideration: the aim of the study was to examine whether young infants actively contribute to the achievement of joint reference. In one experiment 18-months-old infants were first given an object to play with. In the mean time, another object was put in a bucket placed in front of the experimenter. While the infant was playing with the object, the experimenter would look into the bucket and say a novel phrase like "It's a doll!" According to the traditional associative learning perspective, in this situation, the child should associate the word uttered by the experimenter with the object he/she is looking at. However, this was not what happened. Instead, infants would look at the experimenter, and redirect their attention to what she was looking at, that means, to the object in the bucket. Furthermore, the infants were shown the two objects at the same time and asked: "Find the doll!" Interestingly, infants would then pick the object that the experimenter was looking at in the bucket and not the objects they were playing with (and looking at) when the word was uttered. These results point to the existence of early sensitivity to the linguistic significance of the speakers' non-verbal cues, raising also the possibility that young children use particular abilities such as *gaze-following* to help them work out what adults are intending to refer to when words are being used.

According to the alternative hypothesis offered by Bloom, to learn what object a word refers to, the child must have a way of connecting/associating the object with the word. However, this connection does not need necessarily to be direct, but needs to be established by an intentional act of naming. Thus, a prerequisite for word learning is that the child can recognize and understand the intention of the other person to refer to something. It is not true only for objects, but also for actions, ideas, properties, and so on. The next session offers a further discussion on the importance of social interactive contexts for language development.

Word learning as the result of social interaction

Many researchers of child language support the idea that language is a social activity which arises from the desire to communicate with others and results from social interactive contexts (e.g., Snow, 1984; Vygotsky, 1986).

According to the behaviorist theory, adults shape children's behavior through reinforcement (Skinner, 1957) by rewarding desired responses, which results on a gradual shaping of child’s behavior. Social learning theorists, such as Bandura (1977), also add modeling and imitation as tools which are believed to influence socialization.

In contrast to the behaviorist theory, the psychoanalytic theory (Freud, 1924/1952) assumes that children have intrinsic motivations and behavioral dispositions – which Freud named *drives* – that are contrary to those of their parents and society. In this case, parents and other adults are responsible for restraining children's natural tendency, and, at the same time, impressing behaviors and values which are acceptable by the society.

However, socio-cultural theories of socialization have challenged traditional approaches (e.g., Vygostky, 1986). Unlike the psychodynamic and behavioral perspectives, the socio-cultural view highlights the social as well as the cultural forces on individual development – including the process of language learning.

It is important to note, that although the socialization process is universal, the content of socialization may vary substantially across cultures. Despite these differences, the general goal of linguistic socialization is always to promote communicative competence.

According to Gleason (1988), language intersects with socialization in three different domains:

1. The first domain consists on the language parents and/or caregivers use to instruct the child about what to do, feel, and think – the child's "marking orders". Here, the social and moral rules are the topic, and the language is the medium. A variety of linguistic forms such as explanations and anecdotes can be used to convey social and moral rules.

2. The second domain is explicitly linguistic. Parents and/or caregivers teach the children what to say (or not to say) on different occasions. Children are instructed to use particular speech forms (e.g. saying "thank you", saying "please", etc).

3. The third and final domain in which linguistic socialization occurs is in the indirect aspects of the linguistic interaction. Certain features vary systematically and are correlated with individual or group variables (e.g. gender, age, social class).

Ely and Gleason (1995) mention an interesting example of how language behavior indirectly intersects with socialization and can be influenced by it: A report entitled "How Schools Shortchange Girls" (American Association of University Woman, 1992), summarized a study showing that boys in elementary and middle school called out answers (interrupted) eight times more often than girls. Moreover, boys' remarks were treated as appropriate, whereas girls were told off for speaking without being called upon (Sadker, Sadker & Thomas, 1981). The results of these studies offered evidences that socialization of gender specific speech is many times accomplished through differential interactions with boys and girls. And this kind of social experience may influence further communicative behaviors.

As stated by Snow (1984), much of the child's earliest socialization experiences take place at home during caregiver-child interactions. Two general principles operate during these interactions which are assumed to result in language learning. Bukatko and Daehler (2001), describe these general principles as follows:

> First, parents generally interpret their infants' behavior as attempts to communicate, even when that interpretation may not seem warranted to an objective observer. Second, children actively seek relationship among objects, events, and people in their world and the vocal behavior of their caregivers. The result of these two tendencies is that parents are motivated to converse with their children and children have a mechanism for learning language (p. 259).

Parents and caregivers have a unique way to communicate with their young children. Motherese or parentese – as this way of communicating is called – may serve a number of functions in the child's acquisition of linguistic competence. In most cases, this form of communication contains simple, well-formed sentences and is punctuated by exaggerated intonation. Clear pauses between segments of speech have also been observed (Newport, 1977). In addition, during the interaction with the child mothers tend to say names for objects more saliently than other words (Messer, 1981), and move objects as they label them (Gogate, Bahrick & Watson, 2000). Interestingly, a study developed by Olson, Bayles and Bates (1986) also revealed that the more mothers talk to their children, the more words their children acquire.

By the time children begin to produce language, they have already established with their parents and caregivers a variety of social-communicative routines (Tomasello & Farrar, 1986). An important aspect to be observed during the caregiver-child interaction is the emergence of shared or *joint attention.* Well defined by Baldwin (1995), “joint attention simple means the simultaneous engagement of two or more individuals in mental focus on one and the same external thing (p. 132).

Following Flom & Pick (2003), it is within the second half of the first year of life that infants begin to establish joint attention by looking, for example, in the same direction as the adult, as well as an adult’s action such as a pointing gesture or contingent head motion.

Although much is known about the developmental importance of joint attention, not much is known about what factors promote infants´ interaction in social exchanges. How infants use information such as pointing and direction of gaze in establishing join attention is also a major focus of recent debates.

In an attempt to find out about the importance of verbalizations for promoting joint attention, Flom & Pick (2003) developed a study with 18-month-old infants. There were three conditions in this study: (1) the objects were presented with verbal information alone, (2) the objects were presented accompanied by looking and pointing, and (3) the objects were presented accompanied by looking, pointing and verbal encouragement. Out of the eight objects presented during the test setting, four were “familiar” to the infants, and, four were “unfamiliar” to them (the infants´ familiarity or unfamiliarity to the objects was identified by their parents).

As a result, it was found that 18-months-old infants can establish joint attention when they are given a label for a familiar object, but not when they are given a label for an unfamiliar object. Furthermore, it was found that when an adults´ gestures are accompanied by a verbal label, infants spend proportionately more time being engaged in join attention towards unfamiliar objects than to familiar ones. However, the addition of verbal information to looking and pointing gestures did not promote a greater frequency of joint attention to both familiar and unfamiliar objects compared to looking and pointing alone.

These results demonstrate that verbal encouragement promoted basically longer periods of joint attention, but not more instances, and it happened only towards objects which infants were unfamiliar with. Infants seemed to use information such as looking and pointing to determine where the adults´ attention is directed, and the verbal input to get information about the target object. This data also shows that physical gestures may direct or redirect infants´ focus of attention to objects, while verbal encouragement may promote continued attention towards particular objects or events. As a result, children might learn about the relationship between verbal input and objects or events. Thus, the present data could be taken as a helpful tool to understand how infants make the first word-world linkages.

In this context, recent research conducted by Brooks and Meltzoff (2005), examined the development of gaze following and its relation to language by testing infants at 9, 10 and 11 months of age. In this set of studies, infants watched as an adult turned the head towards a target with either open or closed eyes.

The procedure used in this experiment was the following: Infants sat on their parents' lap across a table from the experimenter. After a warm-up phase, the experimenter placed two identical, colorful targets (toys) at eye level on either side of the infant. For the open-eyes condition, she silently turned her head and open eyes towards the target. For the closed-eyes condition, she closed her eyes immediately before performing the same head movement. Two synchronized cameras made separated recordings of the experiment for further scoring purposes. One recorded the frontal view of the infants' face, the other recorded the experimenter. The infants' vocalizations during the trials were also scored. Language assessment: When the infants were 14 and 18 months old, parents of the infants in the 10- and 11-month-old open eyes condition were asked to complete the infant form of the McArthur-Bates Communicative Development Inventory.

Results obtained by these experiments revealed that 10-and-11-month-olds followed adult head turnings significantly more often in the open-eyes than the closed-eyes condition. Nine-month-olds did not respond differentially. Results also showed a positive correlation between gaze-following behavior at 10-11 months and subsequent language scores at the age of 18 months. That is, infants who followed the adults' gaze and simultaneously vocalized had significantly higher language scores at 18 months.

As stated by Brooks and Meltzoff, the results suggest the existence of an important change in infants' gaze-following during a three months window just before one year of age. At 9 months, infants followed adult head turns towards a target as often whether she turns with eyes open or closed. In contrast, the majority of the older infants look at the adults target specifically when the adult turns with open eyes, suggesting that genuine gaze-following develops at about 10-11 months of age.

Moreover, the findings concerning vocalizations suggest that gaze following plays a role in language acquisition. In the current experiment, gaze following plus simultaneous vocalization predicted later vocabulary comprehension but not word production. According to the authors, one possible interpretation to these results is that infants who are advanced in recognizing the connection between looker and object may have a leg up in word comprehension because they use the adults' gaze to disambiguate the referent of the adults' utterances.

Needless to say is that for social learning theorists the process of word learning results from the interaction infants have with adults and more language-skilled subjects. Among these interactions the use of motherese by parents or caregivers seems to play a crucial role. Importantly, motherese seems to be "multipurpose". Emotionally, it provides a framework for social interaction. Socially, it shows the child how to carry on a conversation, to comment on an idea, and to take turns in talking. Linguistically, besides teaching children new words, it teaches how to structure phrases and put ideas into language. Therefore, it is considered to be vital for language development.

Word learning as the result of developing meaning

While some theorists argue that children are born with an innate capacity for language development (e.g. Chomsky, 1975, 1999), others support that children are actively involved in constructing meaning (e.g. Piaget, 1971, 1986). That is, each infant constructs an understanding of the world on the basis of his/her own activity and interactions with the physical world.

According to Piaget's theory of development, the general language ability depends on the sensorimotor achievements of infancy. Thus, language is part of the child's general cognitive development (Piaget, 1971, 1986). In his view, children cannot use language in its symbolic- representational function until they have developed the internal representation of objects, events, and people. Moreover, the foundation for the representational capacity is said to be settled during the sensorimotor period of development (0 – 2 years), which is marked by a number of changes in the infants' cognitive system. The following paragraphs will approach some important concepts of Piaget's theory of cognitive development, which work as "pre-requisites" for the attainment of the language ability.

Piaget's version of development was based on two assumptions regarding intelligence: 1) it is a form of biological adaptation, and 2) it becomes organized by the interaction which the physical world. For him, thinking exhibits two basic qualities: The first one is *adaptation*, which is a tendency to adjust or become attuned to the conditions imposed by the environment; the second is *organization*, which is a tendency for intellectual structures to become systematic and coherent.

In his theory, much of the sensorimotor period is taken up with developing perceptual categories of objects (Piaget, 1971, 1986). In addition, he saw no evidence that during this period infants have any conceptual representation that would enable them to think about objects without their presence.

In Piaget's analysis, concepts only develop when sensorimotor schemes become inherent, and it relies very much on learning about objects through physical interaction. In his approach, *scheme* is the basic mental structure, a kind of template for acting or thinking applied to similar situations or classes of objects. For example, the child who sucks his/her mother's breast, and at her thumb, is exercising the scheme of sucking. Piaget believed that schemes change throughout processes which he called *assimilation* and *accommodation*, and the earlier schemes set the stage for constructing more sophisticated ones, i.e. for categorizing objects, relating to family, and so forth. Assimilation and accommodation are the two complementary processes of adaptation described by Piaget, through which awareness of the outside world is internalized. Assimilation is the process by which external stimuli are taken in and interpreted by the organism without changing the structure of the internal world. For example, infants tracking a visual object with their eyes are assimilating it visually. As stated by Anisfeld (1984), "assimilation is the process that turns sensory data into psychological experience and knowledge" (p.16). Accommodation, however, is the process whereby internal structures are adjusted to facilitate the assimilation of incoming stimuli.

Thus, assimilation and accommodation are basic processes which govern the adaptation of all organisms to their environment. These changes, however, depend on the opportunity to have experiences by interacting with the surrounding environment (i.e. play, touch, handle). The transition from sensorimotor activities to interiorized schemes is said to occur at the end of the sensorimotor period.

In a Piagetian view, imitation plays a crucial role in this stage of development. He suggested that it was some special aspects of imitation that created images, which he considered the first true symbols. The aspects of imitation that interested Piaget most was that it could not take place without active analysis of the model (Mandler, 2004). That is, it requires the imitator to actively analyze what the model is doing. Thus, when active analysis has taken place and imitation carried out, it eventually become interiorized in the form of an image. Imagery, however, enables infants to re-present objects and events to themselves, providing the foundation of thought. Bukatko and Daehler (2001) describe an interesting example:

> At age sixteen months, Piaget's daughter Jacqueline was playing with a boy who suddenly had a dramatic temper tantrum. The next day, the normally well-behaved Jacqueline mimicked the little boys' behaviors with remarkable accuracy. To do so, she must have had the ability to *represent* the boys' overt behaviors in internal form and to draw on that representation hours later (p.274).

An important accomplishment of this period is the attainment of what Piaget called object concept or *object permanence*. As described by Bukatko and Daehler (2001), infants who possess this ability realize that objects continue to exist even though they no longer can be seen. Before the attaining of object permanence, an infant will not look for a dropped toy. Once object permanence has developed, the child will search for objects due to the realization that the object exists even without their direct contact or involvement with it. Thus, with the attainment of object permanence, the infant is able to develop mental symbols and use words to represent them.

As stated by Barrett (1995), another important accomplishment of the sensori-motor infant is the attainment of means-ends behavior (Piaget, 1971, 1986). Piaget considered this attainment crucial for the acquisition of words. This behavior consists of the ability to use means (i.e. tools) in order to achieve a particular goal (i.e. an object). As the child's first words are commonly used as means to an end (i.e. as means to communicate what they want), this correlation between the emergence of the first words and the achievement of means-ends behavior seems to be reasonable.

In fact, according to the Piagetian perspective, cognitive development precedes linguistic development. In order for the child to acquire object names, she/he should first overtake the cognitive chances of sensori-motor period. More specifically, the child's acquisition of object names is dependent upon the child's prior acquisition of object permanence and the emergence of the capacity for mental representation.

More recent studies, however, have moved away from studying such global relationship between cognitive and linguistic development, and have focused upon the possible relationships between specific cognitive achievements and the acquisition of particular words (e.g. Gopnik & Meltzoff, 1986).

A set of studies conducted by Gopnik and Meltzoff (1986), have found that at the age of 18 months the acquisition of words encoding disappearance is related to the development of object concept, while the acquisition of words indicating success and failure is related to the development of means-ends understanding. Furthermore, testing infants aged 13-to-19-months the authors found that there were no similarly close relations between disappearance words and the means-ends tasks or between success/failure words and object-permanence tasks.

For the language assessment, Gopnik and Meltzoff used a questionnaire that described disappearance and success/failure contexts. Mothers received the questionnaire before testing began and were asked to focus their attention on these particular words, rather than recording everything the children said in an open-ended diary. To ensure that children were not simply imitating words, or using them in a single context, children were only counted as having acquired a word if they were reported to use it spontaneously in at least three appropriated and different contexts. In addition, any spontaneous use of disappearance or success/failure words during the recorded session were also scored as long as they use it appropriately. The scoring always took into account the meaning of the child's words which were deduced from the context, and not only the form of words themselves.

For the cognitive assessment, the children received a number of tasks adapted from Uzgiris and Hunt infant assessment scales (1975). They were scored as having passed an object-permanence task if they searched for the appropriated object on more than half of trials. In the case of the means-ends tasks, children were scored as having passed if they found the correct solution without a period of trial and error (see Table 1 for the description of the object-permanence and means-ends task).

Evidences provided by this first study, suggest a clear relation between children's performance on the object-concept tasks and the use of disappearance words. Children who successfully accomplished the tasks were more likely to use disappearance words than those who did not. In addition, children who used insight to work out difficult means-ends tasks were more likely to use success-failure words than those who did not.

The above described findings were replicated and strengthened in a follow up study. Therefore, 19 children were followed longitudinally. The children's ages during the first session ranged from 13- to 19 months. Infants participating in this study were tested every one, two or three weeks, until they had acquired both disappearance words and success/failure words and had passed both object-permanence tasks and means-ends tasks. The procedure and scoring were the same as in the previously described experiment. In addition, children had to pass a particular task in two successive sessions before they were considered to have gained that particular cognitive skill. It ensured that the particular skill was consistent and stable.

Results revealed by this study, show that there is significant correlation between the age at which children acquire disappearance words and the age at which they solve object-permanence tasks. At the same time, there is a significant correlation between the age at which infants acquire success/failure words and the age at which they work out means-ends tasks. The cross-correlations, however, are much smaller. There are much smaller correlations between disappearance words and means-ends tasks and between success/failure words and object-permanence task. In addition, the longitudinal study demonstrated that there were very short temporal gaps between the solution of object-concept task and disappearance words, and between the solution of means-ends tasks and the acquisition of success/failure words. In sum, these results suggest that children are particularly motivated to learn words which are relevant to the cognitive problems they are working out at the particular moment of development.

Following Mandler's (2004) approach on language development, "the most crucial aspect of the relation between preverbal concepts and words is that language is mapped onto concepts and not onto perception or sensorimotor schemas" (p.243). That is, when infants acquire their native language they build it on conceptual information which helps them to discriminate and create categories for objects and events they experience.

Table 1

Description of the Object-Permanence and Means-Ends Tasks

Task No.	Task Description
Object-concept tasks:	
4 …………………………	Finding a completely covered object (3-5 trials). Object is hidden under cloth A. Child must search at A.
8 …………………………	Finding an object after successive visible displacements (3-5 trials). Object is hidden at A, then hidden at B, then hidden at C. Child must search at C.
10 ………………………..	Finding an object following one invisible displacement with a single screen (3-5 trials). Object is hidden in hand, hand is placed under A, object is left under A. Child must search at A.
13 …………………………	Finding an object following one invisible displacement with three screens (5-7 trials). Object is hidden in hand; hand is placed under A, B, or C; object is left under A, B, or C. Child must search at correct cloth.
14 ………………………....	Finding an object following a series of invisible displacements (5-7 trials). Object is hidden in hand; hand is placed under A, then under B, then C. Object is left under C. Child must search under A, then B, then C, or directly under C.
15 ……………………….	Finding an object following a series of invisible displacements by Searching in reverse order. After child has searched at C three times on task 14, object is hidden in hand, hand is placed under A, then under B, then under C; object is left under A. Child must search under C, then B, then A.
Means-ends tasks:	
9 …………………………	Use of string vertically to obtain object
10 ………………………..	Use of a stick to obtain object
11 ………………………..	Placing a necklace in a bottle
12 ………………………..	Stacking a set of rings on a post, avoiding one solid ring

Source: Gopnik & Meltzoff, 1986.

Contrasting Piaget's ideas on how infants build their conceptual system, Mandler argues that the infants' concepts start to be built early in life and are based on a process called *perceptual analysis* (Mandler, 1992a), by which they analyze aspects such as how objects move. For example, when infants look attentively at moving objects they do not only perceive their characteristics and their motion, but also begin to interpret what they see (i.e. kinds of paths objects take, the interactions of these paths, spatial information such as support and containment). Hence, besides seeing the perceptual differences of objects, infants gradually begin to associate what objects look like with what they do (see Chapter 4 for a further description of this process). For example, to say that a 6-months-old infant has a conceptual category of "animals" along with the perceptual category of "dogs" does not imply to have two disassociated categories. On the contrary, the concept of "animals" is just the interpretation of the dog the infants is observing and analyzing. The same concept of "animal" will be re-called when observing cats, cows, and a number of other mammals (Mandler, 2000b). In fact, the interpretation infants give to events around them, and the inferences drawn from them set down the foundation on which the conceptual system is organized (Mandler, 1992a, 2003, 2004).

In support for the assumption that the infants' conceptual system start to be built early in life, studies conducted by Mandler and McDonough (1993, 1998) have demonstrated 7-and-11-month-olds' ability to discriminate objects when the global domains of animals, furniture and vehicles are contrasted. (Chapter 4 offers a more detailed description and discussion of studies on infants' concept formation).

As can be noted, in Mandler's point of view language is mapped into preverbal concepts and not onto perceptual schemes as suggested by Piaget. It seems quite obvious, however, that there is at first a mismatch between the adults' language and the preverbal concepts onto which language is being mapped. Overextension of nouns is a common phenomenon in infants' first attempts to produce language. As discussed in Chapter 2, during their second year of life children go through a period where the first-learned nouns are given too broad a meaning. One of the reasons to such a phenomenon appears to be the result of having to deal with a limited vocabulary when trying to communicate with others. In some cases, however, it seems to be due to the relationship of one thing to another i.e. categorical membership (see Rescorla, 1980). Finally, "at least some of it appears to be due to the uncertain assignment of the extension of a word" (Mandler, 2004, p. 245). For example, when infants use the word "dog" to name a "cow" it may be that for young children there is a lack of clarity of what the difference between them is. Such confusions seem not to cross global domain boundaries, however. Recent research supports this assumption (McDonough, 2002).

As described by Mandler (2004), McDonough studied word comprehension in a paradigm in which distractor items were drawn from the same global category as well as from different global categories. Results indicated that at 2 years of age children are still unclear about the extension of words in the animal, vehicle, food and clothing domains. Although overextensions were rare across domain boundaries, they occurred frequently within domains. For example, when asked to point to a dog among a number of pictures, they tended first to point to a dog, but then included a fox. They rarely pointed to an item from another global category.. According to Mandler, it seems that 2-years-old infants know what a typical dog and a typical fox looks like, but tend to pick a prototypical example first. What they are not sure about is the extension of the labels. A likely reason for this is that infants at this age still lack the conceptual differentiation between dogs and foxes, for example. Finally, it seems that differentiated meaning is required to limit such words correctly i.e. a set of facts which make the differentiation between dogs and foxes possible.

Another interesting characteristic of the infants' early nouns is that they tend to refer to objects at the basic-level (Mervis & Rosch, 1981). Young children say "car", for example, rather than "vehicle" which has a more general meaning. But what would be the explanation for this once the first concepts formed by infants tend to be at the global-level (Mandler, 1993, 1998; Pauen, 2000a)? As recent study has shown (McDonough, 2002), young infants are often unclear about the differences among certain animals and plant kinds. Following Mandler's ideas, parents play a crucial role in helping their children to work out basic-level concepts such as dog and fox. One of the ways to do this is using a superordinate term to identify new basic-level labels, saying things such as "This is a fox". "It's an animal". "This labeling strategy places the referent of a new term in a known conceptual class" (Mandler, 2004, p.246). However, even though parents sometimes use superodinate-level nouns to clarify basic-level ones, they are infrequent in speech. Hence, it is not surprising that superordinate-level nouns usually appear late in acquisition.

Taking into consideration that most of the terms used by parents and care-givers while talking to children tend to be at the "basic-level", it is not surprising that infants first nouns also tend to be at the basic-level. Thus, it seems likely that the language parents use is the major contributor to the development of more "refined" concepts (i.e. basic-level concepts) as well as to the development of the general linguistic ability.

As can be seen, Mandler's approach differs from Piaget's in the sense that when infants start to acquire language they build first on concepts they have already formed and not onto sensorimotor schemes. The conceptual representation infants set up during their first year of life i.e. objects, properties and events, provide a cognitive basis onto which they can map words from the speech that is directed to them. This child-directed speech draws their attention to specific categories of those categories (i.e. basic-level categories).

Summary

So far, the previous sections have reviewed major theoretical approaches in language development research as well as their implications for the process of word learning. As can be noted, the current theoretical accounts differ in many different respects. See below a brief summary of each theoretical view approached in this chapter:

1. The nativist view (i.e. Chomsky) assumes that all human beings are born with a set of rules to combine words in their minds, called "Universal Grammar". Importantly, this set is rules is argued to be common to all languages, thus children require only minimal input to trigger language development.

2. The interactionist approaches (i.e. Piaget, Vygotsky) link language development either to the development of general cognitive processes, or to the social organization of the environment. For example, while Piaget suggests that children must develop concepts before they learn linguistic forms to represent them, Vygotsky saw language as a result of the child's social exchanges.

3. The theory-theory view (i.e. Gopnick and Metzoff) suggests that semantic and cognitive developments emerge simultaneously. For example, the attainment of preverbal object concepts may motivate children to learn words by paying attention to the verbal input presented together with a given object. At the same time, the use of some particular words may direct infants' attention to different aspects of objects, thus increasing conceptual understanding.

4. The connectionist approach, is a contemporary framework in cognitive science which attempts to explain human intellectual abilities using artificial neural networks based on the architecture of the brain. Importantly, the general idea of this view is that

language learning can be explained through associative learning of neurons which can be simulated in computer network models.

As can be seen, the vast literature on language development provides some support for all of these views, but none of them seems to provide the full story of the children's language acquisition. Importantly, in attempt to explain the routes of language development the current views have offered important insights concerning the tools infants may use to the mastering of the complex language system (i.e., connectionist models of language development).

Chapter 4

Object Categorization

So far, the course of language acquisition has been approached in terms of components of language which infants must master to be able to communicate in their culture. In addition, the main ideas from different views on language acquisition have been described.

This chapter will turn to the process of category formation in infancy.

4.1. Why studying infant categorization?

The world consists of an infinitive number of stimuli which can be perceived by the humans from very early on.

Yet in the first year of life infants start organizing their experiences with objects by separating them into different classes (Mandler & McDonough, 1998), based on similarities and differences perceived. This process is called *category formation in infancy*.

The mature system organizes the input and knowledge it has about objects at different levels of abstraction (i.e., Rosch et al., 1976; Pauen 2002a). How this system develops and what kind of processes are activated in order to organize the experiences infants have with the physical world is still a topic of debate.

Following one view (Rosch et al., 1976; Mervis & Rosch, 1981; Eimas & Quinn, 1994), *"basic-level categories"* develop first in early infancy. The basic-level of abstraction is considered the most inclusive level, at which the objects of a category possess a number of attributes in common or can be used in similar ways. Hence, the basic-level category formation would be guided by physical similarities among exemplars of a given category. It suggests that the first categories developed by infants are based on perceptual features. According to this view, the "earliest" developed perceptual categories would work as a foundation for a later construction of conceptual thinking.

Following another view (Mandler & McDonough, 1998; Mandler, 2000a; Pauen, 2002a), infants perform a *"global-to-basic-level shift"* in early categorization. According to this framework, infants younger than one year old are able to develop concepts through the experience they have with objects in the material world. Thus, identifying an object as member of certain category would allow access to broader representation including features that may be invisible. These representations would rely on what the objects do (e.g., functional and causal properties) and not on what objects look like.

In sum, most studies on categorization in infancy explore what kind of distinction infants are able to make at different ages. However, the role of perceptual and conceptual representation in the infants´ early thinking is still not clear. Hence, further studies on this issue seem necessary.

4.2. Do categorization studies reveal perceptual or conceptual processes?

As already mentioned, categorization research not only focuses on the question at what level of abstraction infants form object classes, but also on the question, what kind of information they use to make these distinctions. Two different processes of category formation have been described in the literature: One process is perceptual categorization. Here, categorization is based on what objects look like. The other process is the conceptual categorization. In this case, categorization is based on what objects do, their function, or how they interact (Rosch et al., 1976; Mervis & Rosch, 1981; Quinn, Eimas & Rosenkrantz, 1993; Eimas & Quinn, 1994; Haith & Benson, 1998; Mandler, Bauer & McDonough, 1991; Mandler & McDonough, 1993, 1998; Pauen, 2002a).

So far, most developmental research on infant categorization focus on the development of perceptual categories. Only recently, this focus has shifted slightly towards the process of concept formation (conceptual categories).

According to Mandler (2000b), one of the mysteries of the human mind is how we begin to form concepts which are not the ones provided by our senses, being an even greater question how concepts are formed in first place. For example, when do infants develop the concept of a dog or animal? How do they do it? What constitutes these concepts in first place?

Some researchers assume that infants less than one year old are too young to develop conceptual categories. Therefore, early categories rely exclusively on perceptual processes (Haith & Benson, 1998). In support for this assumption, Rosch and colleagues (1976) found that children under 5 years of age readily put together four pictures of different shoes or four pictures of four different cars. That is, they sorted objects according to "basic-level" groupings. These researchers believed that one way of grouping objects together can be described as ´”basic level”. That is, objects go together when they have physical resemblance to each other and can be used in similar ways. "Chair" is an example of a basic-level concept because they share similar properties: All chairs have seats, legs, and backs, and are used for sitting. Thus, when someone thinks about such properties he/she is thinking about a "typical" chair (see Figure 3 for an example of basic-level grouping).

Figure 3: An example of basic-level grouping (from Bukatko & Daehler, 2001, p. 282)

In contrast, other categories are located at the superordinate-level. Members of a superordinate level grouping do not necessarily need to share perceptual features, and can be broader than the basic-level concepts. "Furniture" is an example of superordinate-level concept. Rosch and her colleagues believe that because basic-level groupings carry a larger number of similarities (especially perceptual information) they are easier for children to process (Figure 4 shows an example of superordinate-level grouping).

Figure 4: An example of superordinate-level grouping (from Bukatko & Daehler, 2001, p. 282)

In fact, studies have demonstrated that three months old infants show ability to categorize at the basic-level, discriminating pictures of dogs from pictures of cats (Quinn, Eimas & Rosenkrantz, 1993). Quinn and Eimas (1996) also found out that infants' ability to discriminate dogs from cats is based on their facial features. In the light of these findings, it has been concluded that cues from facial and head region may provide the kind of information that allows infants to differentiate basic-level categories within the animal domain.

Corresponding studies have all used the visual fixation task. In this kind of task pictures of real or artificial stimuli are presented within a habituation-dishabituation paradigm. A typical design first presents a series of exemplars from one category and than presents a new exemplar from the already known category paired with an exemplar of a contrasting category. The infant is considered to categorize when he/she looks longer at the contrasting category exemplar.

As can be seen, the traditional view supports that perceptual categories (e.g., dogs, cats) provide the foundation for the conceptual thought (Quinn, Eimas & Rosenkrantz, 1993).

According to this view, infants first learn about individual instances and then generalize to the other members of the same basic category. Following this line of arguments, infants first learn what a dog or a cat in general look like, and later learn to associate other properties and behaviors with the perceptual ones. Hence, only later in development infants become able to generalize the perceptual basic categories to other category members, resulting in the formation of a more general category (e.g., animal). Following this line of reasoning, concept formation is built on perceptual processes which gradually become more abstract (Madole & Oakes, 1999).

In contrast, another view has demonstrated that infants are able to develop conceptual categories within their first year of life (Mandler & McDonough, 1993; Pauen, 2002a). According to the conceptual view, categorization depends less on what objects look like than on what they do.

In order to investigate whether early categorization is conceptual from the outset, Mandler & McDonough (1993) tested 9-and 11-month-olds using the *object examination task*[1]. In one of the experiments infants were presented a global task (birds versus airplanes) with a very high between-category perceptual similarity. The question asked by the authors was whether infants would have difficulty to make a categorical distinction between a set of animals and vehicles despite their high between-category similarity (see Figure 5). One of the authors had previously hypothesized that the type of motion is an important factor in the initial conceptualization of what animals are (Mandler, 1992a, 1992b). Thus, if infants have already conceptualized one class as self-propelled (e.g., animals) and another class as non-self-propelled (e.g., vehicles), these meanings might draw infants attention to the relevant parts.

[1] The task is an habituation-dishabituation paradigm and will be described later in this chapter (see also Ruff, 1986).

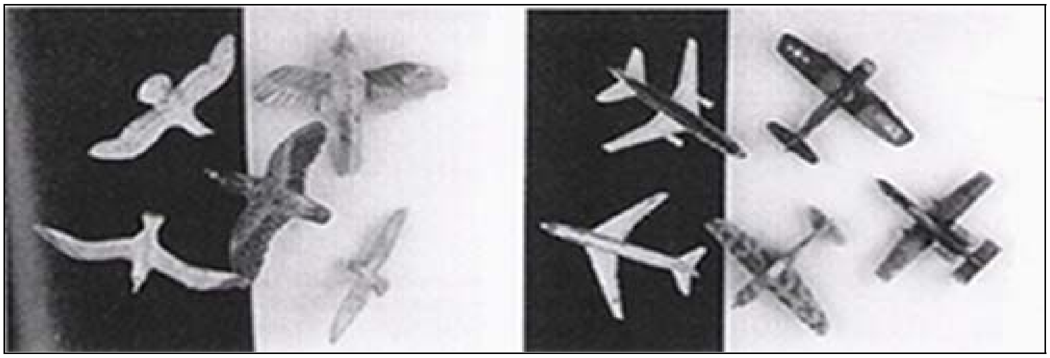


Figure 5: Stimuli – birds and airplanes (Mandler & McDonough, 1993)

The first study was conducted with 11-months-old infants. The airplanes all had outstretched wings and mostly the same shape. Most of the airplanes were made out of metal whereas the birds varied in material. While the experiment was in progress, the researchers got concerned about the different material the exemplars were made of. Therefore, the same study was conducted with 9-months-old, but all exemplars presented were made out of plastic, thus showing the same texture.

As a result, both groups (9-and-11-months old) successfully categorized birds and airplanes as different domains, despite the physical between-category similarity. The same task was later presented to 7-months-old, who also showed a tendency to discriminate both categories. The pattern presented by the 7-months-old suggests that the process of global categorization begins by this age.

Results obtained in the corresponding studies provide strong evidences suggesting that the process of category formation can not be explained by perceptual features alone but might include properties which are invisible (e.g., functional or causal). Hence, the formation of conceptual categories seems to start early and life and relies much more on how the objects interact with the physical world than on physical attributes, as suggested earlier.

4.3. How do categories develop within the first year of life?

All the objects in the world exhibit a reasonable number of attributes which enable them to be classified in many different ways (e.g., shape, color, function). Thus, every existing category has principles or rules which relate its members to each other.

While there have been many studies describing infants' categorization abilities at different ages (Mandler & McDonough, 1993, 1998; Pauen, 2002a) there have been still few researches concerning how the first categories emerge in infancy. The kind of information used by infants for making categorical distinctions is also a remaining question.

Do children form categorical representations based on perceptual features or based it on factors which are more abstract? As mentioned earlier in this chapter, one line of research supports that the first categories developed by infants are based on perceptual attributes of objects (Rosch et al., 1976, Eimas, 1994; Eimas & Quinn, 1994, 1996). Another research group argues that the process of category formation is based on what objects do and the way they interact (Mandler & McDonough, 1993, 1998; Mandler, 2000b, 2003; Pauen, 2002b).

According to those who support the early categories as being based on perceptual attributes, infants first learn about individuals such as one or more cats, and than generalize the observed properties to cat as a class. They first learn what a cat looks like and than associate other kinds of properties or behaviors to this perceptual category. With experience, infants become able to generalize the properties from the basic categories they have learned to other perceptually different creatures to build a more general category which is the global category of animals.

In this framework, it is through experience that the infant becomes aware of aspects of categorical distinction which are more abstract. Later, the child uses this categorical distinction in order to make inductive inferences about new members of the categories ((Madole & Oakes, 1999).

In contrast to the traditional view, researches on early conceptual development lead to different findings. This assumption assumes that categorization is based on concepts and depends less on what objects look like than on what objects do. The physical appearance or similarity among objects can serve as a predictor for its behavior or function but it is not an essential component to be considered a member of a distinct category (Mandler, 2000b, 2003).

Taken together, one could conclude that more than one kind of categorization can be observed in infancy. More importantly, perceptual and conceptual categories seem to serve different functions. That is not all, however. Concerning this issue, Mandler (2000b) presents her point of view as follows:

> Perceptual categorization is used for recognition and object identification. Conceptual categories, on the other hand, are used to control inductive generalization (and for other kinds of thought as well). Infants, like adults, make their inductive generalizations on the basis of kind and not on the base of perceptual similarity. Of course, adults do make use of perceptual similarity in their inductions, but they use it to help determine kind and not on the basis for induction in its own right. No matter how much something may look like an animal, if we think (for whatever reason) it is not an animal, we will not ascribe animal properties to it (p. 31).

Given the evidences, it seems quite wise to consider that the process of category formation cannot be explained by one view alone. In many cases perceptual and conceptual attributes are closely linked. However, it is important to take into consideration that recent researches have indicated that infants less than one year old are able to distinguish categorical domains (e.g., birds vs. airplanes; animals vs. furniture) even when the between-category perceptual similarity was high (Mandler & McDonough, 1993, Pauen, 2002b). The reported findings suggest that infants overrode perceptual attributes provided by the given stimuli in order to make categorical distinction. Therefore, suggesting that infants make use of information others than perceptual attributes for categorization. The nature of the information used seems to be still a question, however.

4.4. Levels of categorization: the global-to-basic-level shift in infancy

For a long time basic-level categories were said to develop first in infancy (Mervis & Rosch, 1981; Rosch et al., 1976). Using a Visual Fixation Task (for a description of the task see Methods of Assessment later in this chapter), Quinn and Eimas (1996) showed that 3-to-4-month olds discriminate basic-level categories within the animal domain. In contrast, more recent developmental studies show that the initial categories developed by infants may be broader in nature, suggesting the existence of a “global-to-basic-level shift” in infancy (Mandler & McDonough, 1993, 1998; Pauen, 2002a).

Using an Object Examination Task (see also Methods of Assessment) , Mandler & Mc Donough (1993) found that at the age of 7 months infants begin discriminating animals and vehicles as different domains. At the age of 9-and-11-months they did it robustly. Although global categorization was successfully accomplished by the mentioned aged-groups, basic-level categorization within these domains was more variable. Infants showed no category discrimination when presented to the basic-level contrast dogs versus rabbits or dogs versus fish. At the same time, birds and airplanes were treated as different even though the between-category similarity was high.

Furthermore, Mandler & McDonough (1998) demonstrated that 7-to-11-months infants can successfully accomplish the task when the global domains of animals, vehicles and furniture are contrasted. Plants and kitchen utensils were tested at 11 months and these domains were also categorized. At the age of 11 months, infants did not discriminate the subcategory tables and chairs. In the animal domain, 9-and-11-month-olds responded to the life-form distinction between dogs and birds, but did not differentiate dogs from cats until the age of 11 months.

Following this line of reasoning, Pauen (2002a) developed a set of studies to investigate whether the global-to-basic-level shift occurs within the first year of life. In a longitudinal study, 20 infants were tested twice, at the age of 8 and 12 months. In this study, half of the infants solved a global level task with the contrasting categories animals and furniture, followed by a basic level task which varied systematically: dogs and birds or chairs and tables. The other half solved a basic level task only. Following the classical OET design, in a total of eight trials the infants saw each object twice. At the test phase, first a new same category exemplar was presented, followed by an exemplar of a contrasting category. As a result, at the age of 8 months the infants did discriminate the categories at the global level but failed to discriminate in the basic level task. Yet, at 12 months of age, infants solved successfully the tasks at both, global and basic level but treated both test items as equally new in the global level task.

Taken together, the above mentioned data provide considerable evidences that infants´ categorical thinking undergoes systematic changes with age. They show a global-to-basic-level shift within their first year when an Object Examination Task is being used. This task is said to provide infants the opportunity to show categorical knowledge based upon factors others than perceptual attributes alone (which is said to be the case of the VFT). This issue will be discussed further in this chapter.

4.5. What kind of information is important for categorization?

In an attempt to answer this question, it has been suggested that representations such as causality and functionality provide conceptual basis for categorization. Corresponding information may lead infants to form a global-level distinction between animates and inanimates very early in life (Mandler, 1992b).

According to Mandler, the theory of the foundation of conceptual thought proposes that infants make use of perceptual information not only for perceptual categorization proposes but also to form summary representations and to constitute meaning of objects. These early meanings are assumed to be represented in the form of image-schemas which abstract dynamic aspects of objects such as capacity to perform self-propelled movements (besides the analysis of static perceptual attributes). For this reason, image-schemas allow infants to form concepts like animates and inanimates (see Chapter 5.1).

As stated by Pauen and Traeuble (under revision), a number of developmental studies suggest that the human being is born with the capacity to form categories based on perceptual similarities and dissimilarities between objects (e.g., Mervis & Rosch, 1981; Rosch et al, 1976). In contrary, recent conceptual studies reveal that 10- and 11-month-olds show evidence for knowledge-based reasoning, promoting categorical distinctions such as animates and inanimates (Pauen, 2002b).

Moreover, recent experiments conducted by Pauen and Traeuble (under revision) showed that after watching an unfamiliar animal toy and a ball performing self-propelled motion together, 7-and-11-month olds expected only the animal to start moving again by itself. The corresponding results suggest that infants´ motion expectation to the unfamiliar animal and not to the ball give evidences of an existing previous knowledge about behavioral properties of object kinds. It includes knowledge about the ability to perform self-propelled motion, which is the case of the animal.

It can be summarized that existing evidence supports the idea that object categorization cannot be explained by an analysis of static perceptual information alone. As described earlier in this chapter, infants less than one year of age demonstrate conceptual categorization (Mandler & McDonough, 1993). They go beyond the information about the appearance of objects to make conceptually based judgments and inductive inferences. For example, Mandler (1992a) suggested that infants understand animals as self-starters which interact with other objects, and this characterization is true for animals in general and not to specific kinds of animals.

4.6. Methods of Assessment

The general familiarization-preference-for-novelty paradigm

The familiarization-preference-for-novelty paradigm is an important method for studying category formation in early infancy (Mandler & McDonough, 1993, 1998, Pauen, 2002a, 2002b).

In a typical task a set of exemplars from one category is being presented (familiarization phase), prior to a pair combining a new exemplar from the familiarized category with a new exemplar from a contrasting category (test phase). Longer attentive looking at the new category exemplar is assumed to reflect category discrimination.

Two different tasks have been developed based on the general familiarization-preference-for-novelty paradigm: the Visual-Fixation task (VFT) and the Object Examination Task (OET).

The Visual-Fixation Task (VFT)

In a typical visual-fixation task infants are presented 2-D pictures. The procedure is the following: infants are firstly familiarized with a number of pairs of exemplars from one category. Following the familiarization phase, infants are presented a new exemplar from the familiar category paired with a contrasting category member (test phase). Infants are considered to categorize when a longer looking at the contrasting category member is perceived (see Figure 6).

Using the visual-fixation design, studies have demonstrated that young infants are able to make categorical distinction at the basic level (Quinn, Eimas & Rosenkrantz, 1993; Eimas & Quinn, 1994; Quinn & Eimas, 1996). Eimas and Quinn (1994) demonstrated that 3- and-4-month-olds categorized horses as different from cats and zebras, and cats as different from tigers, failing to discriminate cats as different from female lions. Furthermore, Quinn and Eimas (1996) have shown that 3-and 4-months-old infants are able to distinguish perceptually similar natural species (e.g., dogs and cats). The corresponding study suggests that cues from facial and head region provide the critical source of information which allows infants to discriminate dogs and cats as different classes and presumably a number of other members within the animal domain.

Figure 6: Visual Fixation Task – stimuli presented by Quinn & Eimas (1996)

As stated by Pauen and Traeuble (under revision), it has been suggested that infants performance in visual-fixation tasks reflects basic processes of visual abstraction called on-line categorization. It has been proposed that infants may abstract perceptual similarities between the presented pictures, creating a perceptual representation of the category during familiarization. Thus, at test, the categorical distinction is explained by the perceptual dissimilarity of the contrasting category object. As the out-of-category exemplar does not share similar properties with the familiarized class, infants pay more attention to it, inferring category discrimination (Eimas & Quinn, 1994; Quinn & Eimas, 1996).

Based on corresponding findings, the traditional view assumes that the first categories to emerge in infancy are based on perceptual features and gradually turned into concepts by having additional information associated with the perceptual ones.

However, although a number of researches have supported this view, it has not been without criticism. Mandler (2000a) particularly suggests that the visual-fixation technique has been a rich source of information about categorization but it is less informative about how infants conceptualize the stimuli they are looking at. Mandler also argues that through this technique infants can discriminate, for example, pictures of dogs from pictures of cats, but do they know what dogs and cats are? If so, what have the infants learned about this kind of animals? These questions remain on debates, however.

The Object-Examination task (OET)

In a typical object-examination task infants are presented 3-D miniature models. The task is suitable for testing infants 6- to 7 months or older. The procedure is the following: during the familiarization phase, infants are presented a series of 3-D miniature models which have different looking although belonging to the same superordinate category (e.g. different looking animals). At test, infants are presented an exemplar from a contrasting category (e.g. a vehicle). Category discrimination is inferred when a longer attentive looking (examining) at the contrasting category member is observed. In the classical OET version, infants are presented four different exemplars from the same category twice (familiarization phase). At the test phase, a new member of the familiar category is presented, followed by a contrasting category exemplar. Yet in a modified OET version, a larger number of members that all belong to the same category are presented only once. Following the familiarization phase, at test, infants are presented a member of a contrasting category. Category discrimination is inferred when a longer examining at the contrasting category member is observed. In both versions infants are allowed to freely manipulate the objects.

In contrast to findings on visual-fixation tasks, studies using object-examination tasks have demonstrated a global-to-basic-level shift in early infancy (Mandler & Mc Donough, 1993, 1998; Pauen, 2002a).

Using the object-examination task in a classical version, Mandler & McDonough (1993) showed that 9-and 11-months-old successfully categorized animals and vehicles as different classes. The same study was developed with 7-months-old, who also demonstrated a categorization pattern although not significant. However, performance on basic-level tasks was more variable. Sub categorization was just found for vehicles, and no categorization was found for the animal domain.

The object-examination task has been by many applied since then – some of them focusing explicitly on methodological concepts (e.g. Ruff, 1986; Oakes, Madole & Cohen, 1991). Conducting studies with 7-and-12-months-old, Ruff (1986) demonstrated that during examining infants focus their attention on the object and actively take in information. It was also demonstrated that examining declined with increasing familiarity, while behaviors such as mouthing and banging did not. Other important insight obtained in corresponding studies is that the duration of examining has no clear relationship with age. However, although examining did not vary systematically with age, it decreased with familiarity to objects.

Interestingly, recent research investigating the relations between examining time and heart rate (HR) during an object examination task, revealed that HR was lower during states of focused attention (examining) than during states of casual attention (looking) or non-looking (Elsner, Pauen & Jeschonek, 2006). During the familiarization phase, while examining stayed about the same, mean HR increased. At test (where a new exemplar from the familiar category is followed by a contrasting category item), the examining increased and mean HD decreased, indicating that infants focused their attention on the out-of- category member. This data suggests that HR provides a suitable objective measure to study infants' performance during object-examination tasks.

Oakes, Madole and Cohen (1991) conducted two studies in order to investigate the object-examination effectiveness to explore early discrimination and categorization. A first study was conducted with 6-and-10-month-old infants and aimed exploring simple stimulus discrimination. In this study infants were first familiarized with a single object, followed by the presentation of two novel objects at test. More specifically, the aim of this study was to determine whether infants´ examining decreases with familiarization and subsequently increases when the novel objects are presented. As result, the infants demonstrated a significant decrease in attention to the objects throughout familiarization. At test, an increase in attention to both novel objects was perceived, indicating clear discrimination. In a second study, also conducted with 6-and-10-month-old infants, the aim was to explore infants´ categorization responses when familiarized with a category of objects. As result, after familiarized with a category of objects, infants clearly responded to the categorical change.

It has also been suggested that the participation in object-examination tasks permits the infants to activate previously acquired world knowledge (Mandler & McDonough, 1993; Mandler, 2004) by manipulation of objects. Thus, the representation of animates and inanimates may be especially activated through this technique. As will be shown in the following paragraphs, a number of studies support this idea.

4.7. The application of knowledge during the test setting

As suggested above, the participation of infants in Object Examining Tasks (OET) may allow the activation as well as the application of previously acquired real-world knowledge.

The process called knowledge-based categorization supports that categorization responses are at least partly based on previous representations which have been formed by the infants prior to the start of the experimental session. It includes properties others than the perceptual attributes which is assumed to be the case of Visual-Fixation Tasks.

It has been suggested that visual fixation tasks provide an on-line category formation which is mainly based on perceptual features of the given objects. Quinn & Eimas (1996) assumed that during the familiarization phase infants form a perceptually based representation that generalizes to novel items of the familiar category member, but not the out-of-category item. This would result in a longer looking at the out-of-category member during the test phase.

Supporting the assumption that infants’ performance in object-examination tasks is influenced by previous acquired real-world knowledge, Pauen, Babocsai, Löffler and

Traeuble (2003) demonstrated that 11-months-old performance in an OET contrasting dog with cats varied according to whether infants had a dog or a cat as a pet. Infants living with either a cat or a dog at home were able to categorize cats and dogs as different classes whereas those who did not have a cat or dog at home failed to succeed in this task.

Following this reasoning, Pauen (2002b), tested 11-months-old (Group A and B) where the infants examined four different exemplars from a superordinate category (animals or furniture) twice, followed by a new exemplar of the familiar superordinate category and an exemplar of a contrasting category. Group A explored natural-looking toy-replicas with low similarity between categories whereas group B explored artificial-looking toy-models with high similarities between categories. Following this experiments, another study was conducted where the same artificial-looking toys (animals) were presented as familiarization objects (Group B) but no contrasting category was presented. Responses varied only with the presence of category change, and not with the degree of similarity between categories.

Results obtained through the above described experiments demonstrate that infants less than one year old show knowledge-based categorization when the object examination task is used. In addition, the manipulation of perceptual between-category similarity does not influence their performance on the task.

4.8. Which method is best suitable for studying concept formation?

Empirical evidence has demonstrated that the visual-fixation task (VFT) and the object-examination task (OET) lead to different results (Pauen & Traeuble, in preparation). While evidence obtained with the VFT demonstrated infants' ability for perceptual category formation at 3 to 4 months of age, evidence provided by OET studies suggests that processes other than on-line category formation may be involved (Mandler & McDonough, 1993; Pauen, 2002b).

It has been suggested that the participation of infants in visual-fixation tasks activates processes of visual abstraction, providing a categorization based on the perceptual attributes of the objects (Quinn & Eimas, 1996). According to this view, category recognition is inferred from differential looking at the objects infants have been familiarized with and at the novel category exemplar. As described by Mandler (1988), the participation of infants in visual-fixation tasks requires basically perceptual recognition and not conceptual categorization (which can be accessed independently of perception).

In contrast, the participation of infants in object-examination tasks seems to promote the activation of previously acquired real-world knowledge. This knowledge activates conceptual representations developed based upon experience with real-world objects before the start of the experimental session. Allowing infants to explore realistic toy-models may permit infants easier activate previously real-world knowledge than looking at pictures in a more passive task.

Clearly, it has been suggested that the use of object-categorization tasks provide infants the opportunity to build categories based on information others than perceptual representations. Thus, concept formation is effectively accessed by object-examination tasks.

Chapter 5

Preverbal concept formation and its relation to early word acquisition

The current chapter is divided in three parts. The first part offers a brief description of the process of *perceptual analysis* (Mandler, 1992a) in infancy and its role for concept (category) formation. Second, some ideas about perceptual and conceptual processes in infancy will be presented. In the next step, empirical findings concerning the origins of word-to-world mapping will be described, before potential links between cognitive and linguistic abilities can be discussed.

5.1. The process of perceptual analysis and its role in concept formation

As discussed in Chapter 4, one of the remarkable achievements of the first year of life is the ability to sort objects into groups – process called object categorization. While some researchers (e.g., Rosch et al., 1976) support the idea that our first categories are perceptually based, others argue that infants less than one year old have the ability to form conceptual categories (e.g., Mandler and McDonough, 1993, 1998). That is, categorization is based on concepts which infants build based on information other than the perceptual input. More specifically, it is assumed that infants use information about what objects do or the way they interact to each other.

In an attempt to develop a theory that explains how the very first concepts are formed, Mandler (1988) proposed that *perceptual analysis* is the mechanism which is firstly used by infants in order to form early concepts. A definition of this process is presented by Mandler (1992a). Part of it goes as follows:

> Perceptual analysis is a process in which a given perceptual array is attentively analyzed, and a new kind of information is abstracted. The information is new in the sense that a piece of perceptual information is recoded into a non-perceptual form that represents a meaning. Sometimes, perceptual analysis involves comparing one object with another, leading to conceptualizing them as the same (or different) kind of thing,

> but often it merely involves noticing some aspects of a stimulus that has not been noticed before… (p. 589)

According to Mandler, the capacity to engage in perceptual analysis begins very early in life. However, it seems likely that such analysis primarily requires the development of some sensorimotor schemata (e.g., stable schemas of three-dimensional objects). In her view, a crucial aspect about perceptual analysis is that it works as a "concept-making engine", transforming perceptual information into another format. For example, a young baby does not have any concept of "apple" in the first place, but has the ability to attend to and analyze perceptual cues. This analysis results in the meanings that establish concepts - in this case, the concept of apple. Furthermore, she argues that, perceptual analysis seems to be the unique way which concepts can be formed before language comes into play.

Moreover, Mandler (1992b) proposes that infants make use of perceptual information not only for the purpose to do perceptual categorization, but also to transform representations into meanings of objects and relations involved. These early meanings are represented in the form of *image-schemas* which abstract aspects of objects like their capacity to perform self-propelled movements, besides the analysis of perceptual features. Thus, the image-schemata allow infants to form concepts which depend more on what objects do than on what they look like (e.g., animate-inanimate objects and relational concepts, such as containment and support). Figure 7 illustrates the concepts of animacy and inanimacy. As the figure shows, "animates" demonstrate capacity for self-propelled movement (i.e. animals) whereas "inanimates" need to be caused to move (i.e. vehicles).

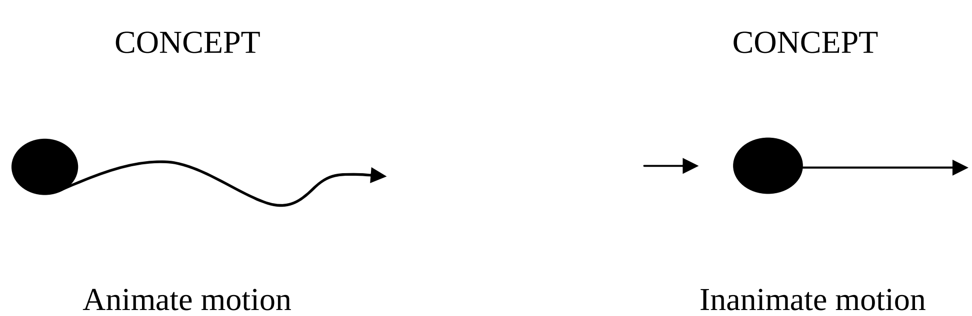


Figure 7: Concept of Animates versus Inanimates (Mandler, 1992a)

Although Mandler's view of concept development has offered important insights to the research community, a number of researchers have seen her view with some criticism (Quinn & Eimas, 2000; Quinn, Johnson, Mareschal, Rakison & Younger, 2000). While Mandler (1992a) believes that the process of perceptual analysis functions to recode and redescribe perceptual data (which results on the formation of concepts), Quinn and others (see above) argue for an alternative framework of concept development. According to them, the development of "knowledge-rich concepts" can be explained without appealing to specialized process and representational structures such as perceptual analysis and image schemas. Stating Quinn and Eimas (2000), "mature concepts have their start with the joining together of the surface features and dynamic movement properties of objects that may be perceived and represented directly by infants. Many less apparent features may be acquired subsequently through the informal and formal tuition that can occur via language" (p. 56). Language, in their view, can serve as a rich source of information about objects that may not be immediately (or even ever) apparent to our senses (i.e. looking, hearing, tasting).

Following Quinn and Eimas' framework, one may begin to acquire a concept such as "animal" from the recognition of many static perceptual attributes i.e. faces, overall body shape, and leg-like appendages among others (Quinn & Eimas, 1996; Rakison & Butterworth, 1998). These properties are often correlated with the capacity to perform self-propelled movements (Mandler & McDonough, 1993). Furthermore, the representations of animals as a conceptual kind can the secured when the representations of biological functions (i.e. eating, reproducing) are acquired, at times by means of language. Finally, the result of this acquisition process is a representation for "animal" that is defined by multiple attributes.

In fact, according to the alternative framework of concept development (see Quinn & Eimas, 2000), a representation like "animal" that may begin by picking out simple perceptual attributes (mostly from looking and other sensory modalities) comes over time to have sufficient knowledge to permit specifying the kind of thing something is. Importantly, this process is argued to the continuous and integrative.

5.2. Perceptual and conceptual processes in infancy

For the past two decades, a number of researchers have concentrated their efforts to find out how infants form their first concepts (Mandler & McDonough, 1993, 1998; Quinn, Eimas

& Rosenkrantz, 1993; Eimas & Quinn, 1994; Quinn & Eimas, 1996; Pauen, 2002a, 2002b). Nevertheless, a problem which still remains unresolved is what the processes involved in early cognitive organization really are.

Perceptual categorization is assumed to be an automatic part of perceptual processing that analyzes the perceptual similarities between different objects. According to this view, perceptual processing creates perceptual schemas based on what objects look like. This line of thought also assumes that the representations of natural kind categories and artifacts occur primarily at the basic level. Only later in development infants are able to establish hierarchically organized superordinate categories (Eimas & Quinn, 1994).

Contrary to this view, *conceptual categorization* is considered to rely on what objects do and how they interact. For this kind of categorization the role that objects play in events and not their physical attributes matter. That is, the appearance of an object is not sufficient to say what kind of thing an object is. This process is assumed to enable the notion of kinds such as animals, vehicles, plants, and furniture (see Mandler & McDonough, 1993, 1998).

As mentioned by Madole and Oakes (1999), research from the conceptual perspective has suggested that perceptual processes or physical attributes are insufficient to explain category formation. Since categorization is basically a process of grouping discriminably different objects and responding to them as equivalent, it is important to have a reliable basis for this grouping. However, according to the conceptual perspective such a basis is difficult to be found in the perceptual world. In this theoretical framework, categorization is conceptually based from the outset.

Using the visual-fixation paradigm, studies on perceptual categorization found that three months old infants categorize pictures of dogs as different from cats (Quinn, Eimas & Rosenkrantz, 1993), and also zebras as different from horses (Eimas & Quinn, 1994). Furthermore, Quinn and Eimas (1996) suggest that infants treat dogs as different from cats because they refer to their facial features rather than overall appearance. Hence, cues from facial and head region provide a kind of information that allows infants to differentiate basic categories of animal species that otherwise show a close resemblance one with another. These studies used the visual-fixation paradigm. Comparable findings could not be obtained when an object manipulation task was applied, however (e.g. Mandler & McDonough, 1998).

As mentioned by Mandler (2000b), according to the perceptual view basic-level categories such as dogs and cats are the foundation on which concept formation is built. Only later in development they acquire the ability to generalize the perceptual basic categories they have already learned to other different category members in order to build a superordinate category which in this case is the category of animal. Thus, the process of concept formation is assumed to begin at a concrete level and gradually becomes more and more abstract (Madole & Oakes, 1999).

The traditional view that infants categorize objects solely in terms of perceptual features has been criticized. Supporters of the conceptual view suggest that object categorization is conceptual from the outset and depends less on the perceptual appearance of objects than on what they do (Mandler & McDonough, 1993, 1998; Pauen, 2002b).

Illustrating the viewpoint of the conceptual perspective concerning the origin of the earliest concepts, Mandler (2003) states:

> The meaningfulness we ascribe to objects and events is due to our conceptual interpretation of them… Quinn and Eimas (2000), for example, say that to posit conceptual representations in addiction to perceptual one is cumbersome and poses a heavy biological burden. In particular, they object the notion that there might be two representations, one perceptual and the other conceptual, for each category of objects and events. But, of course, that is not the implication of having a conceptual representational system in addition to the ability to form perceptual schemas. Infants do not just lie in their cribs and form perceptual categories; from a very early age they interpret what they see. (p.104)

In addition, Mandler argues that to say that an infant has the concept of animals along with a perceptual category such as dog, does not imply purely perceptual processes. On the contrary: having the concept (category) of animal just means that the infant has interpreted the "dog" he/she has observed. This way, the same concept (category) of animal will be recalled when observing any other mammal or land animal (i.e. cats).

Following this line of reasoning, it is possible to understand what the conceptual view means by saying that early concepts tend to be more global than many early perceptual categories. Infants are able to see the difference between dogs and cats in early age, but it is by interpreting either one that they come to the concept of animal. Thus, the foundation of the adult conceptual system relies on the interpretation infants give to objects and events as well as by the inferences they draw from them.

In attempt to find out how far infants generalize behaviors they observe, Mandler and McDonough (1996) studied generalization infants make. They used a technique they called *generalized imitation* which is basically the following: the experimenter modeled a simple event using small replicas of real-world object and encourage the infants to imitate what they had observed. As an example, the experimenter first showed the infants a dog being given a drink from a cup. In the following step, infants were given the cup but instead of the dog used for modeling, they received two other objects. The infants might have received an elephant and a car along with the cup, or even a different dog or a cat with the cup, to see which object they would choose for their imitations. According to the authors, it is possible to test what the infants have understood from the events they have observed by varying the selections of objects available to them; infants' imitations are based on what they have understood from observations they make.

As result, it was found that 14-month-olds generalize very broadly. When drinking or sleeping was modeled with a dog, infants generalized it to all animals but rarely demonstrate these behaviors with vehicles. In addition, when experimenters modeled keying a car or giving a child a ride, infants generalized it to all vehicles, including forklifts and airplanes, but rarely generalized the behavior to animals. When these behaviors were modeled with both, appropriate and inappropriate objects, such as giving both a dog and a car a drink, infants were reluctant to cross domain boundaries in their imitation when inappropriate actions were modeled to them.

This work was extended to 9- and 11-month-olds (McDonough & Mandler, 1998). The technique was simplified. To make the task suitable for this age-range, the experimenters modeled the same events used in the first two experiments (Mandler & McDonough, 1996) but included an opportunity for direct imitation, eliminating also the choices which were possible in the procedure. After modeling, infants were encouraged to imitate what they had observed using the same objects. Following this, a single generalization object was presented along with the prop, in order to find out whether or not the infant would imitate using the new object. On half of the trials infants received an appropriate object to go along with the prop (e.g., a bird and the cup) and on the other half they received an inappropriate object (e.g., an airplane and the cup). In general, 9- and 11-month-olds showed similar results as the ones obtained with 14-months-old infants. They showed ability to broadly generalize behaviors and infrequently performed behaviors with inappropriate objects. Despite the fact that the simplified procedure worked well with 11-month-olds, 9-months-old infants just were able to produce some of the events with direct imitation. When they had to generalize imitative response to a new object, the level of difficulty seemed to be even higher. The data reported so far suggests that 9 months seems to be about the lower limit for using imitation techniques to test their conceptual understanding.

In parallel to research on inductive generalization, the development of conceptual categories from 7-to-11-months of age was explored by Mandler and McDonough (1998) using an object categorization task. Infants of this age range showed category discrimination in the global domains of animals, vehicles and furniture (recall chapter 4 for more details on these studies).

According to the authors, although information about the bases infants use to make these broad categorizations is still lacking, they speculate that for animals and artifacts there might be behavioral property that specify animacy and inanimacy (i.e., type of movement and nature of interactions of objects when they take part in events). These speculations are supported by the work of Pauen and Traeuble (under revision) which demonstrates that after watching an unfamiliar animal toy and a ball performing together, infants less than one year of age expected only the animal to start moving by itself. Infants' motion expectation to the unfamiliar animal toy and not the ball give evidences of existing previous knowledge about properties of object kinds such as the animal ability to perform self-propelled motion.

A statement by Mandler (2003) expresses the main differences between perceptual and conceptual categories very nicely:

> The final and most important difference has to do with the function that categories serve. Perceptual categories are used to recognize objects and identify them. This function provides stability and the sense of familiarity but in itself does not provide the meaning of what is being categorized. It is concepts that give patterns meaning, and

> it is concepts that infants use (just like adults) for purposes of making inductive generalizations. Both adults and infants are influenced by perceptual appearance, of course, but they use it to help determine the kind something represents and not as the basis of induction in its own right. No matter how much something looks like an animal, if we think, for whatever reason, that it is not an animal, we will not ascribe animal properties to it. (p.118)

In sum, evidence provided by the conceptual view has suggested that infants are responsive to factors other than static perceptual attributes from very early on. Moreover, corresponding researches demonstrate infants' ability to form abstract object representations relying on behavioral attributes. The animate-inanimate distinction provides a prominent example.

5.3. Early concepts and lexicon development: the puzzle of word learning

Within their first years, infants form categories which capture both, commonalities and differences among objects. As reported by Waxman (2004), most of these early categories will be at the basic-level (e.g., dogs) and the more inclusive global-level (e.g., animal). Concurrent with conceptual advances, infants learn words which represent these categorical distinctions. How infants come to establish an initial mapping between objects and their labels in the early phase of language acquisition has been an important focus of debate lately.

As postulated by Waxman (2004), in the course of word learning the infant is faced with a difficult three-part puzzle:

> Typically one individual points to an object and provides its name. To succeed, the infant must (1) parse the relevant word from the on going stream of speech, (2) identify the relevant entity in the ongoing stream of activity in the world, and (3) establish a word-to-world correspondence. To put matters more formally, successful word-learning rests on the infants' ability to discover the relevant linguistic units, the relevant conceptual units, and the mappings between them. (p.106)

Seeking for an explanation of how infants come to accomplish the puzzle of word-to-world mapping, it has being suggested that infants may take particular advantage from the language sounds they hear, linking speech sounds to the objects they see (Baldwin & Markman, 1989). Assuming that infants can hear words as units, and that they have object classes in their mind, they must realize that these phonetic packages are meant to "map to" objects in their environment.

But how do the sounds of language map to the world? As mentioned by Baldwin & Markman (1989), it has been assumed that ostensive definition plays a critical role in helping young infants discover the reference of object labels. In this case, ostensive definition includes at least two components: (1) some way of nonverbal indication of a direction such as pointing to an object, and (2) naming an object. As it has been suggested, these components may provide information which could help infants to figure out the reference of object labels.

In order to investigate whether infants in their early phase of language acquisition tend to treat language as related to things in the world, Baldwin & Markman (1989) developed a study with 10-to-14-months-old infants. They assumed that infants should pay more attention to objects when those were accompanied by words (labels). Thus, if infants attend more to objects when labeling occurs, it would help explaining how they start establishing the first word-object relations – connecting the sound patterns they hear (words) to objects they see in the environment.

To test this hypothesis, the study conducted by Baldwin and Markman compared how long 10-to-14-months-old infants looked at unfamiliar toys when a labeling phrase accompanied their presentation, versus when no labeling phrase accompanied the presented objects. It was found that infants attended longer to objects they were accompanied by labeling. Infants examined a given object longer when an adult offered them labeling phrases such "See the robot! It is a robot," using natural intonation of adult speech to a child.

In a second study infants from two age groups were tested (10-to-14-month-olds and 17-to-20-month-olds). This study aimed to examine whether the presence of labeling phrases increased infants´ attention to objects compared to what pointing (which is also a nonlinguistic method of directing infants´ attention) could accomplish. The infants were first presented pairs of unfamiliar toys in two different situations: (1) a pointing condition alone, where the experimenter pointed a number of times at one of the toys, and (2) a labeling plus pointing condition, where the experimenter labeled the toy while pointing to it.

Results have shown that infants looked an equal amount of time at the target object whether it was labeled or not, thus suggesting that pointing is a powerful method to direct infants´ attention to objects. However, in a subsequent play period, when no labeling phrases were applied, infants looked longer to the objects which had previously been labeled than at the ones that had not, thus suggesting that labeling has some lasting and attention enhancing effect. This tendency of language to sustain infants´ attention to objects may help them learn the connection between words and objects.

This issue was also investigated in a recent study conducted by Flom and Pick (2003). Studies developed by the authors suggested that within the second half of the first year of life infants begin to establish join attention by looking at the same direction as an adult through a pointing gesture or head motion. The infants´ first responsiveness to physical ostensive gestures may foster their later understanding of the relation between the words they hear to objects they see. Thus, well before they start producing their very first words, infants may take particular advantage from the labels adults frequently offer to objects. In other words, infants begin figuring out the reference of labels when they notice that the sound patterns they hear people uttering are connected to things they see in the world.

After the infant recognizes the link between objects and labels, he/she must learn that a word refers to a class of objects and not only to the object specific to the particular event in which the word was learned. That is, the infant must take advantage of the economy and power of object labels.

As described in Chapter 3, Markman and colleagues (Markman, 1991; Markman & Hutchinson, 1984) offer a solution for the problem of word-to-world mapping which is based on principles which they called "constraints". In spite of having opponents (e.g., Nelson, 1988), this "principles approach" has become important because it reduces the number of possibilities which infants might use to find out the meaning that novel words may have.

It is important to note that the mapping problem is often considered to be one-way. That is, concepts are learned non-linguistically and then labeled by the child. However, mapping may be two-way, where language also influences the categorical organization that infants make. To put it in other words, it is suggested that a close interaction between language and conceptual organization might exist influencing and facilitating one another (see Gopnik & Meltzoff, 1998).

Stated by Golinkoff and Hirsh-Pasek (1990), once the infant has learned the lexical mapping problem, the next part is the acquisition of rules to put words together. Sentences are successions of words and the infants must learn that, just as words map to objects and object classes, sentences map to events and relation in the word.

Slobin (1985) has demonstrated that infants are more likely to pay attention to one word at a time in the input, usually the first or the last word. However, at some point the infant must realize that sentences are greater than the sum of its parts and usually map to a specific relation. For example, hearing a sentence such as "She is kissing the keys", infants must realize that it is not sufficient to look at the action of kissing and to the set of keys. Instead, the intention of sentences like this is to specify particular relations between the action of kissing and the set of keys.

In order to see whether infants go beyond word-by-word mapping, Hirsh-Pasek and Golinkoff (1987) tested 13-to-15-months-old infants. Described by Golinkoff and Hirsh-Pasek (1990), the referred experiment used the *preferential looking paradigm.* In this study, infants were shown simultaneous videos of a woman kissing keys and holding a ball in the foreground and a woman kissing a ball and holding the keys in the foreground. When the infants heard the sentence "She is kissing the keys" they watched the video which contained the matching event significantly longer than the video which showed the non matching event. Although preliminary, this study suggests that besides mapping objects and object classes, language may be also mapped to events even before productive speech.

To summarize, the problem of language learning has been mostly stated as requiring world's knowledge, segmenting the sound stream, and discovering the rules for the mapping that exist between these domains. The problem of language acquisition, however, still requires an explanation of how infants come to perform the mapping between the sounds and their corresponding meanings.

Searching for an alternative explanation for the problem of word mapping, Waxman (1999, 2003) developed an integrative possibility. She proposed that infants begin the process of word learning equipped with a broad expectation, linking words to commonalities among objects. This initially broad expectation is later fine-tuned in accordance with the form-to-meaning mappings which are realized in the native language under acquisition. Thus, the infant begins the process of language acquisition with a broad expectation regarding word-to-world mappings and not as a *tabula rasa* without any a priori expectations to guide the process of acquisition (Smith, 1999). Some studies have being given growing evidence supporting this view. For example, a study conducted by Balaban & Waxman (1997) showed that novel words highlight commonalities among objects in 9-months-old infants, promoting also object categorization in 12-to-13-months old infants (Waxman & Markow, 1995). This early expectation seems to be supported by several domain-general principles as (1) a perceptual preference for listening to novel words over other kind of auditory stimuli and also (2) the ability to notice similarities and differences among objects. This broad initial link may serve at least three essential functions. First, as words direct attention to commonalities, this link facilitates the formation of a growing repertoire of object categories and concepts. Second, it supports infants´ first intention to establish symbolic reference, e.i., to establish a lexicon. And third, this initial broad expectation may set the stage for the evolution of more precise expectations linking particular grammar forms (e.g. nouns, adjectives) to types of relation among objects (e.g., object categories, object properties) in the language under acquisition. The next chapter will provide more evidence for this line of reasoning.

Chapter 6

The effect of labelling and other kinds of auditory input on object categorization

Recent research suggests that the presence of object labels exert a powerful influence on infants' object categorization (Waxman & Markow, 1995). In support for the assumption that language may shape conceptual understanding, recent studies suggest that infants may take particular advantage from words they hear, connecting them to stimuli or events they are referring to (Baldwin & Markman, 1989). But these finding have raised another question: Is language the only way to influence object categorization or may other sources of auditory input also exert influence on object categorization tasks?

In this chapter I will explore a number of studies which have been developed in order to answer these intriguing questions.

6.1. How labelling objects may influence object categorization

Within their first years, infants develop capacities which are exclusively found in humans: they develop rich and flexible object categories, and they acquire language. In this context, the development of categories and the acquisition of language have separately been investigated over years (i.e. Fenson et al., 1994; Mandler & McDonough, 1993, 1998; Pauen, 2002a; Quinn, Eimas & Rosenkrantz, 1993; Rosch et al., 1976). Recent research, however, has suggested the existence of close links between the development of language and category formation (Waxman & Markow, 1995; Balaban & Waxman, 1997).

In an attempt to find out how naming may influence object categorization, a number of experimental paradigms have been developed lately (Gopnick & Meltzoff, 1986; Waxman & Markow, 1995; Balaban & Waxman, 1997; Pauen, 2000; Booth & Waxman, 2002; Waxman & Braun, 2005).

Interestingly, results of corresponding studies have showed that giving labels to objects during an experimental session promotes a general increase in attention to the target objects in 11-months-old infants (Pauen, 2000), as well as object categorization in 12-to-13-month-olds

(Waxman & Markow, 1995) and in 9-months-old infants (Balaban & Waxman, 1997). Booth and Waxman (2002) demonstrated that as object names, the demonstration of objects' function is also salient to infants facilitating categorization in 14-and 18-month olds.

Evidence provided by Waxman and Markow (1995) suggests that novel words can serve as an invitation to form categories. The use of novel words during an object examination task is assumed to help infants to look for the properties that the objects labelled with the same word may share with each other. The authors tested infants at the one-word stage with some version of object-examination task. The task was basically the following: Infants received a set of four exemplars from one category (e.g., different looking animals), one at a time, presented only once each. These exemplars were little toy-models of real world objects that infants could play with one after the other for a certain amount of time. Following the familiarization phase, infants received a perceptually new exemplar from the already familiar category (e.g., a new animal) and a new exemplar from a contrasting category (e.g., a fruit) simultaneously. At test, if they spent more time examining the out-of-category exemplar it was taken as evidence for category discrimination (Figure 8 shows the design used by Waxman & Markow, 1995)

In one of these studies, Waxman and Markow (1995) presented two higher-level contrasts: animals vs. vehicles and tools vs. animals, as well as two basic level contrasts: cars vs. airplanes, and cows vs. dinosaurs. Each infant was encouraged to complete all four tasks. In the *noun condition*, the experimenter labelled the object repeatedly only in trial 1, 2, and 4. For example, "[Infants name]. Look, a (n) X!" In the *no word condition*, the experimenter used the same short introductory phrase without labelling the object at the end. On familiarization trial 3, infants in both *noun condition* and no *word condition* were treated identically. The experimenter said, "[Infants name}. Look!" This design insured that all infants were exposed to the introductory phrase used in the subsequent test trials (described below).

At test, two objects were presented simultaneously (one object from the familiar category and another from a contrasting category). This time, no label was offered. After the test pair was introduced, the experimenter placed the objects within the infants´ reach for 45 seconds.

Infants participating in Experiment 1 ranged from 9 to 20 months (mean age: 13

months). Whereas performance in the basic-level task was at ceiling even in the no-labelling condition, infants in the label-condition showed improved categorization performance in the superordinate-level tasks. This finding supports the idea that words highlight commonalities among exemplars of the same category, facilitating category discrimination. Yet, in Experiment 2, when 12-months-old infants (range: 11; 9 to 13; 3 months) received objects that did not belong to the same category (neither basic-level nor superordinate-level), nouns did not influence infants' behaviour with these random sets of stimuli.

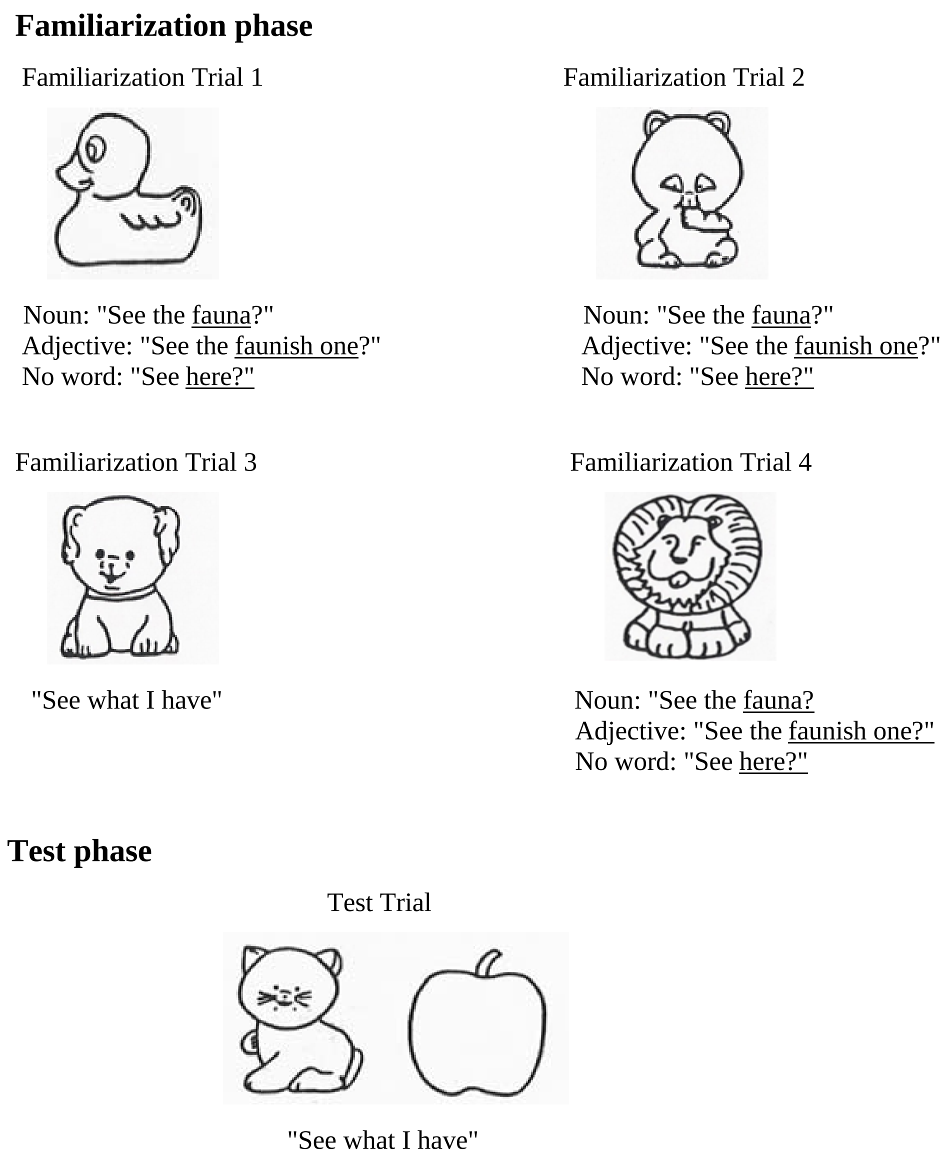


Figure 8: Design of experiment from Waxman and Markow (1995)

In a third Experiment, Waxman and Markow (1995) tested 12 month-olds (range: 11 months, 0 days to 13 months, 7 days), using again two superordinate-level contrasts (animals vs. fruits; tools vs. vehicles) and two basic-level contrasts (cars vs. planes; horses vs. cats). Methods and procedures followed the previous study. The authors included one more labelling condition in which the experimenter identified the objects by using an adjective rather than a noun, saying: "[Infant name]. See a (n) X-ish one." This time, parents were also asked to complete a language inventory while infants were accomplishing the object-examination tasks. Based on the questionnaire data, two vocabulary groups (high, low) were formed for word production. Whereas infants in the high vocabulary group profited from the labelling (noun, adjective) in the superordinate-level task, responses of infants in the low vocabulary group were less systematic. Kind of label (noun, adjective) did not have any effect on performance.

This set of findings suggests that infants who participate in an object-examination task can use words as an invitation to learn categories towards the end of the first year of life (especially if their language skills are well developed). However, it does not seem to be important if the verbal input is a noun or an adjective.

Extending these findings, Balaban and Waxman (1997) explored the effect of labelling on categorization performance in 9-months-old infants participating in a visual-preference task. In this study, infants were first familiarized with 9 single pictures of animals from the same basic-level category (rabbits or pigs) one after the other with a labelling phrase (e.g., "a rabbit") or a pure tone. In the word condition, six of the nine familiarization items were labelled during presentation. In a tone condition, a sound was presented instead of the word. During the test phase infants saw two pairs of pictures in succession. Each time, a new exemplar of the familiar category was presented together with a new object of a contrasting category.

Results revealed a general influence of auditory input in both conditions. Infants looked longer at pictures accompanied by auditory stimulation than at pictures without an auditory input, no matter if it was a word or a sound. However, effects on categorization performance were only found in the word condition. When dinosaurs (land animals) and birds (air animals) were contrasted in a follow-up study, these general findings were replicated. In a third study the authors presented pictures of dinosaurs and birds accompanied by words with degraded phonetic information. In this way infants were impeded to understand the meaning of the word although it could be recognized as verbal input. Infants´ performance at test was comparable to the word condition. Based on these results, Balaban and Waxman (1997) concluded that at the age of 9 months categorization performance in a visual basic-level task can be influenced by verbal input (this study will be recalled further in this chapter).

Taken together, the above described studies suggest that language can have an important effect on categorization in the one-word stage. Object names and adjectives do highlight commonalities among objects. These commonalities seem to help infants parsing objects into meaningful categories. For example, infants pay more attention to category relevant similarities when objects are labelled than if no label is provided (Waxman & Markow, 1995). It suggests a strong interaction between cognitive and linguistic development, supporting also the idea that language may shape conceptual understanding. Moreover, even before infants are able to speak, their ability to comprehend object names may support predictions about what objects will be found in the world when a specific name is heard. Labelling objects may also make infants look for non-obvious properties of category members which share the same name.

6.2. Object categorization and auditory input: labels *versus* other sources of auditory stimulus

Given evidence that labelling can have powerful influence on category formation, an important question raised is whether this influence can be exclusively applied to object labels (and object functions) or also to other kinds of auditory input.

The question of whether labelling as well as other kinds of auditory input exert the same influence on infants' categorization has been examined by recent researches (Balaban & Waxman, 1997; Fulkerson & Haaf, 2003).

In attempt to answer this question, Balaban and Waxman (1997) tested 9-months-old infants with a visual-preference task. In this study the authors compared the effect of word phrases and tone sequences on infants' categorization.

During familiarization, infants were presented a series of nine pictures from the same basic-level category (e.g., rabbits or pigs). Three of the nine familiarization slides were presented in silence, while the remaining six familiarization slides were presented in conjunction with an auditory stimulus. Infants assigned to the *Word* condition viewed six familiarization slides accompanied by the corresponding word phrase (e.g. "a rabbit" or "a pig"). In the *Tone* condition, those six slides were presented in conjunction with a tone sequence. During test, infants were presented to two pairs of slides in succession: each time a new member from the familiar category (e.g. another rabbit) and a new member of the contrasting basic-level category (e.g. a pig) were presented together.

The results indicate a general influence of auditory stimulus on visual attention, and, more specifically, influence of words on infants' performance. During familiarization, infants revealed to pay more attention to the slides accompanied by auditory stimulus than on silent trials, no matter if it was a word phrase or a tone sequence. At test, the performance of infants assigned to the *Word* and *Tone* condition differed, however: effects on category discrimination were only found in infants assigned to the word condition. In a follow-up study, when dinosaurs were contrasted with birds, the same general pattern of results was found.

In a third study, the authors presented again the basic-level contrast dinosaurs and birds. This time they included a new condition where slides were accompanied by words with degraded phonetic information. Results of this study replicated the effects found in the earlier experiments for the *Word* as well as the *Tone* condition. The results for the *Content-Filtered Word* condition resembled the results for the *Word* condition in the sense that in the *Content-Filtered Word* demonstrated significantly greater attention to object in the novel category (at test).

This pattern of results suggests that word phrases influence object categorization in infants as young as 9-months of age. Importantly, the same kind of influence could not be found when a tone sequence was used. These results are consistent with previous studies (Waxman & Markow, 1995) which also document a facilitative effect of novel words on categorization at the superordinate-level in older infants.

Also attempting to find out whether different kinds of auditory input may influence object categorization, Fulkerson and Haaf (2003) developed a set of experiments with 9-and-15-months-old infants, using an object-examination task. In this study each infant was assigned to two tasks: one basic-level task (e.g., horses vs. giraffes or airplanes vs. trucks) and one global-level task (e.g., animals vs. vehicles), but only to one of three conditions: label, non-labelling sound, no sound condition.

During familiarization, infants were presented three objects from a specific category twice. Each trial lasted a total of 30 seconds. At test, two 30-sec trials immediately followed familiarization phase. On one test trial, a new member from the already familiar category was presented; on the other, a novel category exemplar was presented. The order of the test trials was crossed with age, sound condition, order of category level, order of auditory source, and pair of stimulus sets which infants received.

In the *label condition*, familiarization items were presented with the labelling phrase "Look at the bicket!" on one task, or " Look at the toma!" on the other. In the *non-labelling sound condition* familiarization items were introduced with repetitive mouth sounds on one task, or a five-note melody on the other. Auditory source was manipulated within subjects. For infants in the label and non-labelling sound conditions the auditory stimulus for one problem was presented orally by the experimenter, and played on a voice recorder for the other. In the *no sound condition*, familiarization items were introduced without any added sound. At test, the experimenter placed the object on the table in front of the infant without presenting any additional auditory stimulus.

Reported results demonstrate that labelling phrases helped infants categorize objects at the global but not at basic-level relative to non-labelling sounds and no sound condition. That is, infants at both ages only demonstrated global category discrimination when objects were introduced with a labelling phrase. In addition, results showed that the effect of labelling on infants' global categorization was also influenced by the sensitivity to the source of auditory input, which seems to become more restricted with age. This finding was particularly apparent on the global-level task. Nine-month-olds demonstrated global categorization when objects when presented with a labelling phrase, no matter whether auditory input was presented orally by the experimenter or played on a recorder. At the same time, 15-months-old infants only demonstrated global categorization when objects were labelled by the experimenter.

These studies replicate results from previous research in the sense that global categorization was particularly influenced by the presence of object labels. However, it differs from previous studies in the sense that the same facilitative effect of labels was not found at the basic-level. In the current study, 9-and 15-months-old infants categorized the stimuli at the basic-level regardless of sound or auditory source condition. To remind the reader, Balaban and Waxman (1997) found a facilitative effect of labelling in 9-month-olds object categorization when the basic-level categories pigs and rabbits were contrasted. An explanation for this discrepancy in results was offered by Fulkerson and Haaf (2003). According to these authors, the nature of the stimuli may provide a partial answer for this problem. While Balaban and Waxman used two-dimensional line-draw stimuli, the study conducted by Fulkerson and Haaf used three-dimensional objects. In this case, the greater perceptual details offered by 3D objects may facilitate category discrimination. It would at least partially explain why basic-level categorization may have been easier to detect in their study than it was in Balaban and Waxman's study.

In addition, an important issue raised by this study is what characteristics of labelling phrases underlie their facilitative effect. One possibility is that the observed influence of labels on infants' categorization is due to the presence of speech sounds, more specifically, infant-directed speech sounds. However, if the effect of labelling on categorization was due to the presence of speech sounds, non-labelling repetitive mouth sounds should lead to the same effects as the labelling phrases. It was not the case, however. Results on the global problem did not offer any evidence of categorization in the presence of non-labelling repetitive mouth sounds at 9 or 15 months. Therefore, the authors speculated that the effect of labelling phrases on 15-month-olds performance observed in this study might be attributed particularly to the presence of verbal label. The performance of 9-month-olds in this study does not make it possible to speculate on the relative roles of verbal labels or language in general in this age group. But at 15 months of age, the influence of linguistic input on categorization seems to become specific to the presence of verbal labels. Further studies would be important to clarify what characteristics of labelling phrases may account for their facilitative effect on categorization at different ages. Reported results demonstrate a general influence of auditory input on visual attention, if compared to control condition (no auditory stimulus). However, categorization pattern was only influenced by the presence of words, suggesting that words can serve as invitation to form categories.

Taken together, the reported findings suggest that language and cognition might go hand in hand in development. Moreover, this relation might be bidirectional, as suggested by Gopnick and Meltzoff (1986). Following their specificity hypothesis, the attainment of preverbal object concepts might motivate infants to acquire words by paying attention to the verbal input presented together with a given stimulus. At the same time, the use of particular words may direct infants' attention to different aspects of a given stimulus, therefore providing conceptual understanding. For example, the use of similar labels may direct infants' attention to commonalities which objects may share, whereas the use of different labels may highlight differences among objects.

It should be noted, however, that previous research using either the visual-preference technique or the object examination task suggested that global-level categorization is acquired at an earlier age than basic-level categorization (Mandler & McDonough, 1998; Pauen, 2002a; Quinn & Johnson, 2000). In contrast to this finding, the evidence reported above suggests that basic-level categorization is good even without the help of language input whereas global-level categorization can be enhanced when objects are being labelled. In the context of studies using the object examination technique (Waxman & Markow, 1995; Fulkerson & Haaf, 2003), this may have to do with the fact that the global categories were represented by a reduced number of familiarization items before the start of the test-phase: Fulkerson and Haaf presented three different looking exemplars twice, and Waxman and Markow presented four category members only once. Previous studies used at least four items presented twice. Without any instruction, it seems rather difficult to understand that this is a categorization game. This may explain why language had a facilitating effect under these circumstances.

Chapter 7

Experiment 1

Does labelling influence 7-month-olds object categorization?

A number of studies have demonstrated infants' ability for category discrimination at different ages (Mandler & McDonough, 1993, 1998; Quinn, Eimas & Rosenkrantz, 1993; Quinn & Eimas, 1996; Quinn & Johnson, 2000; Pauen, 2002a).

The current literature reveals that infants participating in a visual preference task typically show a global-to-basic level shift between 2 and 3 months of age (Quinn & Johnson, 2001). Infants participating in object examination tasks show the same kind of shift between the age of 7 and 12 months (Mandler & McDonough, 1993, 1998; Pauen, 2002a).

Using an Object Examination Task, Mandler and McDonough (1993) found that around the age of 7 months infants begin to discriminate animals from vehicles. At the age of 9-and-11-months this ability seems to be pretty robust. Although global categorization was successfully accomplished during the second half of the first year of life, performance in basic-level categorization tasks with each domain was less consistent. Infants demonstrated no category discrimination when presented with the basic-level contrast dogs versus rabbits or dogs versus fish that look rather different from each other. At the same time, birds and airplanes were treated as different even though the between-category similarity was high.

Further studies conducted by the same authors point to similar conclusions. Mandler and McDonough (1998) found that 7-to-11-months infants successfully accomplished the task when the global domains of animals, vehicles and furniture were contrasted. At the age of 11 months infants did not discriminate the subcategory tables and chairs. Within the animal domain, 9-and-11-month-olds responded to the life-form distinction between dogs and birds, but did not differentiate dogs from cats until the age of 11 months.

In support for the assumption that infants perform a global-to-basic level shift in early categorization, Pauen (2002a) demonstrated that both 8-and-12-month-olds succeed when the categories animals and furniture were contrasted. Moreover, only 12-month-olds showed basic-level category discrimination when dogs and birds or chairs and tables were contrasted.

Taken together, previous work suggests that infants undergo a global-to-basic-level shift. While global category discrimination (e.g., animals, vehicles, furniture) is about to begin at the age of 7 months, basic-level discrimination (e.g., dogs, cats) starts towards the end of the first year of life.

In line with these findings, studies have demonstrated that naming objects during an experimental session promotes a general increase in attention to the target objects in 11-months-old infants (Pauen, 2000) and promotes categorization performance in 12-to-13-month-olds (Waxman & Markow, 1995). Particular effects of verbal input on category formation were also found by Balaban and Waxman (1997) in 9-months-old infants (see Chapter 6). Therefore, the use of verbal input seems to have powerful effects on categorization in the one-word stage.

Based on the findings described thus far, an interesting question can be raised: Does labeling at different levels of abstraction influence early category formation? Most studies investigating the effect of labelling on categorization tested infants at the one-word stage starting with 11 month olds (e.g., Waxman & Markow, 1995; Pauen, 2000). However, the current literature does not provide investigations about the effect of labels in object examination tasks at younger ages. To fill this gap, a set of studies was conducted testing the influence of language on 7-month-olds' categorization performance at the global level, using an object categorization task. It was chosen to test categorization at the global level because 7-month-olds already show some awareness of this ability, but are not fully stable. Hence it will be interesting to see whether or not the labelling of objects may improve performance. As a first step, infants were tested in two conditions: (a) receiving basic labels, and (b) receiving global labels.

Differing from the procedure used by Waxman and Markow (1995), in the current set of studies a series of ten different looking exemplars from the same global category was presented during the familiarization phase. At test, one new exemplar from the familiar category (Test1) and one perceptually new exemplar of the contrasting category (Test2) were presented in sequence. Categorization was inferred by a longer examining time to the contrasting category member.

Given that language is suggested to sustain infants' attention to objects (Gopmik & Meltzoff, 1986) and has important effects on object categorization in the one- word stage

(Waxman & Markow, 1995) we expect infants to respond in the following way:

Presenting 7-month-olds objects accompanied by basic-level labels (i.e., "turtle", "giraffe", "crocodile" "jeep", "oldtimer", "tractor") is a good way of drawing infants attention to differences among objects which belong to the same class. As suggested by Waxman (2003), applying unique names to unique individuals highlights their dissimilarities (perceptual or conceptual), thus providing means for tracing individual identity over time. Labeling each individual object differently should increase infants' interest in the stimuli and may thus keep a rather high level across all trials.

At the same time, presenting objects accompanied by a global-level label (i.e., "animal", "vehicle") is assumed to draw infants' attention to the similarities among the selection of familiarization stimuli and to the differences between both global domains. Waxman (2003) suggests that giving objects a common name, initiates a search for deeper and perhaps non obvious similarities among them, thus permitting rapid learning about categories.

Based on this line of thoughts, it was hypothesized that the use of basic-level labels will promote higher scores of examination time across all trials (i.e. familiarization and test trials). Consequently, infants may not respond with an increase in attention to the category change. At the same time, the use of global-level labels should promote a decrease in attention across the familiarization items because each familiarization exemplar will be labelled by the same name. As a consequence, higher scores in attention are expected in response to the novel category item presented at test because it will be accompanied by a new label.

In fact, naming objects at either the global or the basic level is expected to elicit different responses to the same set of stimuli depending on the level of abstraction of the labels: it should increase awareness of perceptual differences among exemplars in the basic-label condition whereas it should increase awareness of perceptual similarities among the familiarization stimuli and support category discrimination in the global-label condition. By comparing infants' performance in both experimental groups, we hope to learn more about how the kind of verbal input given influences 7-month-olds object categorization. To investigate this issue, experiments 1a and 1b were conducted.

Experiment 1a

The main purpose of Experiment 1a was to investigate the effect of basic-level labels on 7-month-olds object categorization pattern by using the object examination task. The categorical contrast was animals versus vehicles.

Method

Participants

Data collection took part in a medium-sized university town (Heidelberg) with a mixed socio-economic background. Infants' names were obtained from birth records, and their families were contacted by letter. Parents received a certificate with their child's photo for participation. A total of 35 infants took part in Experiment 1a (mean age = 7 months, 5 days; range: 7 months, 0 days to 7 months, 26 days). All the infants participating in this experiment came from a German speaking family. Sixteen additional infants were tested but excluded from the final sample due to the fact that did not meet criteria for participation (N= 14), due to fussiness (N= 1), or experimenter error (N= 1). The criteria for including subjects in the final sample were: 1) Infants participating in the labelling condition should necessarily have the German as the only spoken language; 2) Parents should not interact verbally or play with the infants during the experimental session; 3) During the habituation phase infants should necessarily be looking at the objects when they were labeled in at least 8 trials; 4) During the test phase infants should be looking at the objects (t1, t2) when they were labelled.

Stimuli

The stimuli consisted of 3-D realistic looking toy models representing the categories of animals and vehicles. They varied substantially in appearance within each given category. The animal category included a zebra, a rabbit, a hippo, a seal, a ladybird, a giraffe, a crocodile, an eagle, a fish, a fox, and a turtle. The category vehicle included an oldtimer, a motorcycle, a car, a motor home, an ambulance, a jeep, a scooter, a tractor, a deep loader truck, a fire truck, and a garbage truck. All objects were either made out of plastic or metal, and easily graspable by the infants (Figure 9 shows picture of the stimuli).

Figure 9: Stimuli – realistic toy models of animals and vehicles

Procedure

Infants were seated in a highchair at a table near their mothers or on the mothers' lap (only if necessary). The mother was asked to remain silent and did not interact with the child during the session. The experimenter presented each object within reach of the child for 20 seconds. Infants were allowed to play freely with the given material. Trial duration was indicated by a small lamp lighting up on the wall behind the child. If an object fell to the floor, the experimenter quickly picket it up and placed it back on the table.

The method of assessment used was a modified object examination task which differs slightly from the classical OET. In the classical version, infants are presented four different exemplars from the same category twice (familiarization phase). At test, a new member from the familiar category is presented followed by a contrasting category exemplar. In the modified OET version, which was used in the current experiments, infants were first presented ten different looking exemplars from a specific category (familiarization phase). At test, a new exemplar from the familiar category was presented, followed by a contrasting category exemplar. Category discrimination was inferred when a longer examining time at the contrasting category member was perceived. The order of presentation, as well as the familiarization category (animal or vehicle), were counterbalanced within each group.

In this study the experimenter labelled each object when it was placed in front of the child. Following the introductory phrase: "Schau mal, was ich here fur Dich habe! Ein X!" ("Look what I have here for you! An X!"), each object was labelled by its appropriate basic-level term (e.g., "Zebra", "Hase", "Nilpferd", "Robbe", "Kafer", "Giraffe", "Krokodil", "Adler", "Fisch", "Fuchs", "Schildkrote" in the case of animals, and, "Oldtimer", "Motorrad", "Auto", "Wohnmobil", "Tieflader", "Krankenwagen", "Jeep", "Feuerwehrwagen", "Mofa", "Traktor", "Müllwagen" in the case of vehicles). Each object presented was hence labelled differently.

Coding

Sessions were videotaped. The analysis of the video tape was carried out by two independent coders who had not been involved in the process of data collection. With the help of stop-watches they assessed the accumulated examination time for every trial. Examination is defined as a subset of looking time during which the infant focuses attention on the target and is involved in active information intake (Ruff, 1986; Oakes, Madole & Cohen, 1991). This state of attention is typically accompanied by a decrease in heart rate as compared to looking time (Elsner, Pauen & Jeschonek, 2006), thus indicating deep cognitive processing. If there was a difference of more than three seconds between the examination time measures of the two coders for a given trial, this trial was discussed and coded separately again. For further analyses the standardized results from both coders were used as raw data.

Results

Mean-coder reliability was high ($r = .98$), thus suggesting that examination duration was assessed with a high degree of objectivity.

To determine whether infants showed a familiarization response, the mean examination time for the first five trials (phase A) and the second five trials (phase B) were calculated and statistically compared, using a mixed-design analysis of variance with habituation category (animal, vehicle) as independent variable, and habituation phase (A, B) as dependent variable.

This analysis revealed a clear habituation effect $F(1, 33) = 4.85$, $p < .05$. Mean examination times decreased significantly from phase A to phase B. No significant interaction was revealed by this analysis.

When object examination during test phase (t1, t2) served as repeated measurement variable, infants showed a significant increase in examination duration from the last familiarization trial to the out of category item, $F(1, 33) = 60.05$, $p < .05$. The interaction between habituation condition and test trials was not significant. Table 2 reports the means and standard deviations for both habituation and test phase in any condition.

Table 2

Means (in seconds) and standard deviations for both habituation (A, B) and test phase (t1, t2), separated by experimental condition (basic label, global label, no label).

	Habituation Phase				Test Phase			
	Phase A		Phase B		Test 1		Test 2	
	M	SD	M	SD	M	SD	M	SD
Basic label	6.47	2.69	5.49	2.02	4.43	2.86	9.60	4.20
Global label	6.20	2.82	4.94	1.81	4.74	3.10	8.09	4.85
No label	5.22	2.30	5.04	3.35	5.16	4.22	7.01	4.70

Discussion

In a modified version of the object examination task contrasting toy models of animals and vehicles with the presence of basic-level labels, 7-month-olds showed both a significant habituation as well as significant categorization effect. For these infants, examination duration decreased significantly from familiarization phase A to phase B. Moreover, examination times also increased significantly across the test trials.

Habituation condition (animals, vehicles) did not have any impact on the results. Both: infants familiarized with animals as well vehicles showed a comparable decrease in attention from phase A to phase B. At test, the same general pattern of results was found. The increase in attention to the contrasting category item was comparable for infants habituated with animals as with vehicles.

Contrary to our expectations, infants did not keep attention at a high level throughout the entire session, but rather showed the same pattern of responding as one would expect in a no-labeling condition. Despite the fact that each item was labeled differently, they familiarized to the category and revealed category discrimination at test, thus suggesting that language input did not impede categorization performance. It should be noted, however, that a more elaborate discussion of the observed pattern of findings is only possible when the effect of basic-level labels can be compared to the effects of presenting each exemplar with its appropriate global-level term. Experiment 1b addresses this issue.

Experiment 1b

The main purpose of Experiment 1b was to investigate 7-month-olds performance in an object examination task using global-level labels. Results revealed by this task will allow a direct comparison of performance in both labeling conditions.

Method

Participants

As in Experiment 1a, data collection of infants participating in the global-label condition took part in Heidelberg. The procedure for contacting parents was the same as in the previous experiment. Parents received a certificate with their child's photo for participation. A total of 35 infants took part in Experiment 1b (mean age = 7 months, 8 days; range: 7 months, 0 days to 7 months, 25 days). All the infants participating in this experiment came from a German speaking family. Twenty-two additional infants were tested but excluded from the final sample for not meeting the final sample's criteria for participation (N= 16), fussiness (N= 3), or experimenter error (N= 1).

Stimuli, Procedure and Coding

As before, the stimuli consisted of 3-D realistic toy models representing the categories of animals and vehicles. The general procedure and coding were also the same, but in the global-label condition the experimenter referred to the objects using their appropriated superordinate-level label: "Tier" (animal) or "Fahrzeuge" (vehicle). Infants' interaction with the objects was video-taped and later analyzed off-line by two coders according to examination duration.

Results

Mean-coder reliability was again very high ($r = .97$). Means of both coders for each trial served as raw data for further analyses.

To determine whether infants showed a familiarization response, the mean examination time for the first five trials (phase A) and the second five trials (phase B) were calculated and statistically compared, using a mixed-design analysis of variance with habituation category (animal, vehicle) as independent variable and habituation phase (A, B) as dependent variable.

This analysis revealed a clear habituation effect $F(1, 33) = 11.16$, $p < .05$. Mean examination times decrease significantly from phase A to phase B. Results also revealed a main effect for habituation condition $F(1,33) = 10.07$ $p < .05$. Infants familiarized with vehicles showed higher mean examination times in both phases of the familiarization period (M_A= 7.49, SD_A= 2.97; M_B= 5.73, SD_B= 2.18), than infants familiarized with animals (M_A= 4.98, SD_A= 2.12; M_B= 4.20, SD_B= 1.16). No interaction was significant.

When object examination during test phase (t1, t2) served as repeated measurement variable, infants showed an increase in examination duration throughout the test phase $F(1, 33) = 15.21$, $p < .05$. No significant interaction between test trials and habituation condition were revealed by this analysis. See Table 2 for the mean examination times and standard deviation for both habituation and test phase.

Basic versus Global-level labels

To find out whether the kind of verbal input given had any impact on infants' responses, performance of each labelling condition for familiarization and test phase were statistically compared.

To determine whether infants showed a familiarization response, the mean examination time for the first five trials (phase A) and the second five trials (phase B) were calculated and statistically compared, using a mixed-design analysis of variance with habituation category (animal, vehicle) and labelling condition (basic, global) as independent variables and habituation phase (A, B) as dependent variable.

This analysis revealed a clear habituation effect, $F(1,66) = 14.78$, $p < .05$. Mean examination times decreased significantly from phase A (M= 6.34, SD= 2.75) to phase B (M= 5.22, SD= 1.95). Results also revealed a main effect for habituation condition, $F(1,66) = 7.86$, $p < .05$. Infants familiarized with vehicles showed higher mean examination times in both phases of familiarization (M_A=7.11, SD_A= 2.93; M_B= 5.79, SD_B= 2.10), than infants familiarized with animals (M_A= 5.61, SD_A= 2.37; M_B= 4.68, SD_B= 1.67). No interaction was significant.

When object examination during test phase (t1, t2) served as repeated measurement variable, infants showed an increase in examination duration throughout the test phase $F(1,66) = 61.55$, $p < .05$. No interaction was significant.

Integrative discussion of results from Experiment 1a and 1b

Seven-month-olds participating in a modified OET, contrasting animals with vehicles, showed highly similar performance when the stimuli presented were accompanied by either global- or basic-level labels. This pattern of findings suggests that the kind of verbal input did not influence 7-month-olds responses, thus raising the question whether language has any impact on young infants' categorization at all.

Interestingly, previous studies testing same aged infants with a global animal-vehicle contrast demonstrated infants' ability to categorize, but failed to show familiarization effects (Mandler & McDonough, 1993). This comes as a surprise because Mandler and McDonough provided infants with only four different exemplars which they presented twice each. Hence, it should have been more likely that infants showed a familiarization response. One may speculate that providing labels to objects (no matter at which level of abstraction) may increase the general attention towards the given objects, and paying more attention may support the process of forming (or activating) a category during the experimental session. This interpretation would at least partially explain why infants participating in the current experiments (basic and global-level label) showed significant habituation while those participating in Mandler and McDonough's studies did not. Alternatively, the reason for the presence of absence of habituation response may have to do with the specific selection of exemplars chosen to represent each category, or differences between German and American samples. To investigate which option seems more likely, one would have to compare performance in both labelling conditions with performance in a task that uses the same population and the same set of stimuli but presents each exemplar without any label. For this purpose, Experiment 1c was conducted.

Since the kind of language input (basic or global-label) did not influence the general pattern of results, both language groups were combined to form one "labelling condition".

Experiment 1c

Experiment 1c investigated 7-month-olds categorization performance in a global animal-vehicle object categorization task without the presence of any object labels. Comparing the results between Experiment 1a and 1b (combined) with Experiment 1c, it will be possible to directly test the impact of labelling on infants' general attention, familiarization and categorization responses.

Method

Participants

Infants participating in the no label condition were taken from a pool of more than 150 infants who took part in a larger project located in Berlin (Germany). The criteria of selection of infants taken from this pool were gender and habituation condition, which both matched infants participating in the basic- and global-level label condition of Experiment 1a and 1b. A total of 35 infants took part in Experiment 1c (mean age = 7 months, 8 days; range: 6 months, 25 days to 7 months, 29 days).

Stimuli, Procedure and Coding

In Experiment 1c, infants were presented the same toy models as in the previous experiments. The procedure as well as the coding was also the same as previously described. In the no-label condition the objects (familiarization and test trials) were accompanied by an introductory phrase such as "Schau mal here!" ("Look here!) or "Schau mal was ich hier für Dich habe" ("Look what I have here for you!"). Hence infants received verbal input, as before, but the experimenter provided no labels for the given exemplars. Infants' interaction with the objects was video-taped and later analyzed off-line by two coders according to examination duration. Hence, the procedure was highly comparable to that in Experiment 1a and 1b.

Results

As before, mean-coder reliability was high (r = .96). To determine whether infants showed a familiarization response, the mean examination time for the first five trials (phase

A) and the second five trials (phase B) were calculated and statistically compared, using a mixed-design analysis of variance with habituation category (animal, vehicle) as independent variable, and habituation phase (A, B) as dependent variable.

This analysis revealed no habituation effect F(1, 33) = .142, p. > .05. No interaction with habituation condition was significant, either.

When object examination at test (t1, t2) served as repeated measurement variable, infants showed a significant increase in examination time from the new same-category item to the out-of-category exemplar F(1, 33) = 5.00, p. < .05. The interaction between habituation condition and test trials was not significant, however. See Table 2 for the mean examination times and standard deviations for both habituation and test phase.

Discussion

Similar to previous results obtained with a different version of the object examination task without labelling (Mandler & McDonough, 1993), 7-month-olds participating in Experiment 1c showed no habituation, but a significant categorization response. This result differs from the pattern of findings obtained in Experiment 1a and 1b. A full evaluation of the corresponding findings requires a direct statistical comparison between performance in the labelling and the non-labelling condition, however.

Label versus No label condition

In order to find out whether labelling influences 7-month-olds categorization in any way, a comparison of infants' performance in the two conditions (no label, label) was conducted.

An analysis with mean examination duration during the habituation phase as dependent variable revealed an habituation effect F(1, 101) = 6,14, p < .05, as well as a significant effect for habituation condition F(1, 101) = 5,59, p < .05. Mean examination times decrease from phase A (M= 5.97, SD= 2.65) to phase B (M= 5.16, SD= 2.49). Higher scores were reached in both phases when infants were familiarized with vehicles (M_A= 6.55, SD_A= 2.96; M_B= 5.75, SD_B= 3.03) than when they were familiarized with animal items (M_A= 5.41, SD_A= 2.20; M_B= 4.60, SD_B= 1.69). A marginally significant interaction between habituation phase and labelling condition was also observed, F(1, 101) = 3,29, p = .072, resulting from the fact that infants tended to examine the objects longer in the labelling condition (M_A= 6.34, SD_A= 2.75; M_B= 5.22, SD_B= 1.95), than in the non-labelling condition (M_A= 5.22, SD_A= 2.30; M_B= 5.04, SD_B= 3.35).

When object examination during test phase served as repeated measurement variable, the following results were observed: Infants showed a significant increase in attention across test trials $F(1, 101) = 39{,}85$, $p < .05$, thus indicating that both categories were discriminated. Furthermore, we found a significant interaction between test trial and labelling condition $F(1,101) = 6{,}46$, $p < .05$. This interaction can be explained by the fact that infants participating in both conditions did not differ significantly in the first test trial, $t(103) = .816$, $p > .05$, but those in the labelling condition showed a stronger categorization effect than infants in the non-labelling condition, $t(103) = -1.93$, $p < .05$. In addition, we also observed a two-way interaction between test-trial and familiarization condition, $F(1, 101) = 4{,}11$, $p < .05$. Infants familiarized with animals showed stronger increase in attention from the first to the second test trial (M_{t1}= 4.33, SD_{t1}= 2,74; M_{t2}= 8.64, SD_{t2}= 4.52), than infants familiarized with vehicles (M_{t1}= 5.24, SD_{t1}= 4.00; M_{t2}= 7.82, SD_{t2}= 4.83).

Figure 10 shows the infants' general pattern of results during both habituation phase (A, B) and test phase (t1, t2), separated by the experimental condition (labelling, non-labelling).

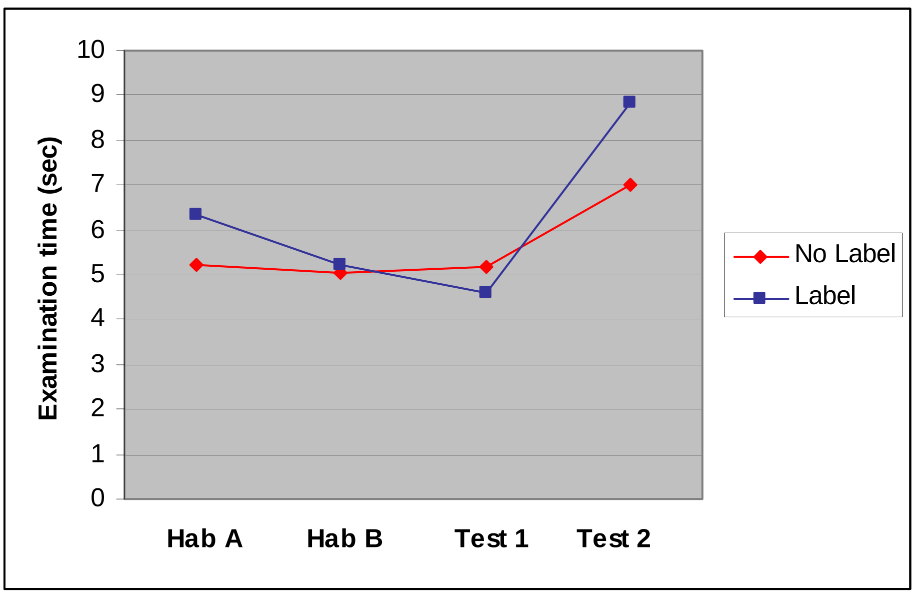


Figure 10: Infants performance during the habituation (A, B) and test phase (t1, t2) according to the experimental condition (label, no label).

Integrative discussion of results from Experiments 1a, 1b and 1c

The reported set of experiments shows an interesting pattern of results that allows some tentative conclusions about how labelling influences 7-month-olds categorization in an object examination task: Infants participating in all three conditions (basic label, global label, no label) showed significant categorization when animals were contrasted with vehicles. The current literature has demonstrated that the ability for global level distinction starts at the age of 7 months (Mandler & McDonough, 1993, 1998).

Labelling had some effect on infants' habituation performance, as indicated by the fact that a familiarization response was only observed for those who received labels but not under control conditions (i.e. without labelling). Similar findings were obtained by Mandler and McDonough (1993), testing 7-month-olds without the presence of object labels. Hence, labelling may support the process of online-category formation even in young infants, as suggested by Balaban and Waxman (1995).

Labelling also influenced categorization performance. At test, the presence of object labels promoted a sharp increase in attention from test item 1 to test item 2 (see Figure 8). Despite the fact that this increase was also observed in the non-labelling condition, it was much weaker, as indicated by a significant interaction of test-trial and labelling condition.

Taken together, the reported set of findings is well in accord with the current literature in terms of showing infants' early emerging ability to categorize animals and vehicles in an object examination task. Furthermore, we have shown that labelling supports both, the process of familiarization as well as categorization at 7-months of age. Previous studies exploring the role of labelling for categorization performance tested slightly older infants (i.e. 9-month-olds; see Balaban & Markow, 1997). Hence, the present series of experiments extends this conclusion to even younger infants.

Contrary to our original expectations, we did not find any impact of kind of label on 7-month-olds' performance. More specifically, we had expected to find reduction of categorization response in the basic-label condition as compared to the global-label condition. The lack of corresponding findings may indicate that 7-month-olds do not yet understand that labels highlight either similarities or dissimilarities between exemplars of the same domain. Rather, they seem to look out for similarities among a given set of familiarization stimuli anyway. Language seems to support this process in a more general sense. This could change with age, however. For example, it could be that infants show different responding in both language conditions as soon as they enter the stage of word learning (i.e. 10-12 months of age). To explore this possibility Experiment 2 was conducted.

Chapter 8

Experiment 2

Does labelling influence 11-month-olds object categorization?

Experiment 1 has demonstrated that labeling objects at different levels of abstraction does not influence the general pattern of categorization among 7-month-olds. To explore whether this pattern of findings changes with age, a new set of experiments will test the influence of labeling objects during an object examination task at the age of 11 months. Following up on the theoretical introduction to Experiment 1, we expect that the use of basic labels highlight dissimilarities among the familiarization stimuli, thus leading infants to show less strong familiarization effects and categorization responses. When global labels are being used, this should support the "natural" tendency of infants to look out for similarities among the given habituation stimuli and to detect category boundaries more easily.

Since infants are known to start learning basic-level categories as well as basic-level terms towards the end of the first year of life, we expect 11-month-olds to show a pattern of findings that varies systematically with the kind of labeling input (i.e. basic vs. global).

As before, we first report separate analyses for each labeling condition, before both sets of data will be analyzed together.

Experiment 2a

The main purpose of Experiment 2a was to investigate the effect of basic-level labels on 11-month-olds object categorization pattern by using the modified object examination task.

Method

Participants

Data collection took part in a medium-sized university town (Heidelberg) with a mixed socio-economic background. Infants' names were obtained from birth records, and their families were contacted by letter. Parents received a certificate with their child's photo for participation. A total of 26 infants took part in Experiment 2a (mean age = 11 months, 12 days; range: 11 months, 0 days to 11 months, 29 days). All the infants participating in this experiment came from a German speaking family. Seven additional infants were tested but excluded from the final sample for not meeting the final sample's criteria for participation (N= 5), fussiness (N= 1), or experimenter error (N= 1).

Stimuli, Procedure and Coding

In this set of experiments, we used the same toy models as in the experiments conducted with 7-months-old infants. Procedure and coding was also the same as in the previous set of experiments. In the basic-label condition, the experimenter named the objects using their appropriated basic-level label. For example, after the introductory phrase: "Schau mal was ich hier für Dich habe!" ("Look what I have here for you!"), each object was labelled by its individual name (e.g., "Zebra", "Hase", "Nilpferd", "Robbe", "Kafer", "Giraffe", "Krokodil", "Adler", "Fisch", "Fuchs", "Schildkrote" in the case of animals, and, "Oldtimer", "Motorrad", "Auto", "Wohnmobil", "Tieflader", "Krankenwagen", "Jeep", "Feuerwehrwagen", "Mofa", "Traktor", "Müllwagen" in the case of vehicles). Infants' interaction with the objects was video-taped and later analyzed off-line by two coders according to examination duration.

Results

Mean-coder reliability was high (r = .97). Means of the measures obtained by both coders for each given trial were taken for further analysis.

To determine whether infants showed a familiarization response, the mean examination time for the first five trials (phase A) and the second five trials (phase B) were calculated and statistically compared, using a mixed-design analysis of variance with habituation category (animal, vehicle) as independent variable, and habituation phase (A, B) as dependent variable.

This analysis revealed no significant decrease in examination duration across the habituation trials, $F(1, 24) = .022$, $p > .05$. No interaction was significant either.

When object examination during test phase (t1, t2) served as repeated measurement variable, infants showed a significant increase in examination duration throughout the test phase, $F(1, 24) = 6.80$, $p < .05$. No interaction between habituation condition and test trials was significant, however. Table 3 reports the mean examination times and standard deviations for both habituation and test phase in any condition.

Table 3

Means (in seconds) and standard deviations for both habituation (A, B) and test phase (t1, t2), separated by experimental condition (basic label, global label, no label).

	Habituation Phase				Test Phase			
	Phase A		Phase B		Test 1		Test 2	
	M	SD	M	SD	M	SD	M	SD
Basic label	6.23	3.23	6.17	2.87	6.72	4.68	9.34	3.79
Global label	5.43	2.76	5.60	2.70	6.56	3.90	8.84	3.87
No label	4.48	2.32	4.52	2.69	3.56	3.15	6.41	5.14

Experiment 2b

Experiment 2b was conducted to investigate the effect of global-level labels on 11-month-olds object categorization pattern. Results obtained by this task will allow a direct comparison of infants' performance in a modified OET with the presence of basic and global-labels conditions.

Method

Participants

As in Experiment 2a, data collection of infants participating in the global-label condition took part in Heidelberg. Infants' names were also obtained from birth records, and their families were contacted by letter. Parents received a certificate with their child's photo for participation. A total of 25 infants took part in Experiment 2b (mean age = 11 months, 11 days; range: 11 months, 2 days to 11 months, 28 days). All the infants participating in this experiment came from a German speaking family. Five additional infants were tested but excluded from the final sample for not meeting the final sample's criteria for participation (N= 4), or fussiness (N= 1).

Stimuli, Procedure and Coding

In the current experiment infants were presented the same stimuli as previously. The general procedure as well as coding was also the same as before. In the global-label condition, the experimenter referred to the objects using their appropriated category label: "Tier" (animal) or "Fahrzeug" (vehicle). For example, after the introductory phrase: "Schau mal was ich hier fur Dich habe!" ("Look what I have here for you!"), each object was labelled by its appropriate global-level label (e.g., animal or vehicle). Infants' interaction with the objects was video-taped and later analyzed off-line by two coders according to examination duration.

Results

Mean-coder reliability was equally high as before (r = .97). Means of both coders for each trial served as raw data for further analyses.

To determine whether infants showed a familiarization response, the mean examination time for the first five trials (phase A) and the second five trials (phase B) were calculated and statistically compared, using a mixed-design analysis of variance with habituation category (animal, vehicle) as independent variable, and habituation phase (A, B) as dependent variable.

This analysis revealed no significant habituation effect $F(1, 23) = .067$ $p > .05$, and no significant interaction.

When object examination during test phase (t1, t2) served as repeated measurement variable infants showed a significant increase in examination duration throughout the test phase $F(1, 23) = 4.45$, $p < .05$. Again, no interaction between habituation condition and test trials was revealed. See Table 3 for the means and standard deviations for both habituation and test phase.

Basic versus Global-level labels

To test whether the general pattern of results from the two language groups was really comparable, we conducted two separate analyses of variance with labelling condition (global, basic) as independent variables and either familiarization phase (A, B), or test-exemplar (same category, different category) as repeated measurement variable.

This analysis revealed no significant habituation effect, $F(1,47) = .003$, $p > .05$. No interaction was significant, either.

When object examination during test phase (t1, t2) served as repeated measurement variable, infants showed a clear increase in examination duration throughout the test phase, $F(1,47) = 10.60$, $p < .05$. Results also revealed a marginally significant main effect for habituation condition, $F(1,47) = 3.15$, $p = .082$. Examination duration was slightly higher for infants familiarized with animals ($M_{t1}= 7.12$, $SD_{t1} = 4.04$; $Mt2= 10.14$, $SDt2= 3.96$) than for infants familiarized with vehicles ($M_{t1}=6.14$, $SD_{t1}= 4.53$; $M_{t2}= 8.01$, $SD_{t2}= 3.36$). No interaction was significant.

This analysis show that the kind of verbal input (basic or global label) did not influence the infants' general pattern of results..

Integrative discussion of results from Experiment 2a and 2b

The findings reported for Experiment 2 are largely comparable to those of Experiment 1 testing younger infants. More specifically we found that kind of labelling (global or basic) did not have any effect on infants' familiarization or categorization responses. Differing from

Experiment 1, no indication of a habituation response was found in 11-month-olds. It seems unlikely that infants suddenly "loose" their ability to look out for similarities among familiarization exemplars altogether. Rather, it may be the case that 11-month-olds have already started to pay special attention to perceptual differences between various basic-level exemplars, thus keeping attention at a high level throughout the habituation phase. Interestingly, this tendency to analyse exemplars at the perceptual level is not influenced by kind of labelling.

To further explore whether language has any impact on 11-month-olds' performance, both labelling groups will again be combined, and compared to a group of same-aged infants who did not receive any labels.

Experiment 2c

Experiment 2c was conducted to investigate 11-month-olds categorization performance when animals and vehicles are contrasted without the presence of object labels. Results obtained in this study will provide the opportunity to verify in what extend labelling objects at different levels of abstraction influence object categorization.

Method

Participants

As in the set of experiments conducted with 7-month-olds, infants participating in the no label condition were taken from a pool of more than 150 infants which took part in a larger project located in Berlin (Germany). The criteria of selection of infants taken from this pool were again gender and habituation condition, which necessarily matched infants participating in the basic and global-label condition. A total of 25 infants took part in Experiment 2c (mean age = 11 months, 6 days; range: 11 months, 0 days to 11 months, 29 days).

Stimuli, Procedure and Coding

In Experiment 2c, stimuli as well as procedure and coding were the same as in Experiment 1c. In the no-label condition the objects (familiarization and test trials) were accompanied by an introductory phrase (as described before) but no label was provided at the end. Infants' interaction with the objects was video-taped and analyzed off-line by two independent coders.

Results

As previously, mean-coder reliability was high ($r = .96$).

To determine whether infants showed a familiarization response, the mean examination time for the first five trials (phase A) and the second five trials (phase B) were calculated and statistically compared, using a mixed-design analysis of variance with habituation category (animal, vehicle) as independent variable and habituation phase (A, B) as dependent variable.

Similar to infants participating in the basic and global-label conditions, infants participating in the current experiment revealed no habituation effect $F(1, 23) = 0.19$, $p > .05$.

Habituation condition did not have any impact on the results.

When object examination during test phase (t1, t2) served as repeated measurement variable infants showed an increase in examination duration throughout the test trials $F(1, 23) = 8.29$, $p < 0.5$, as well as a marginally significant main effect for habituation condition, $F(1, 23) = 3.93$, $p = .059$. Higher scores were reached by infants familiarized with animals ($M_{t1} = 4.36$, $SD_{t1} = 2.95$; $M_{t2} = 8.31$, $SD_{t2} = 5.88$) than by infants familiarized with vehicles ($M_{t1} = 2.82$, $SD_{t1} = 3.26$; $M_{t2} = 4.67$, $SD_{t2} = 3.79$). See Table 3 for the means and standard deviations for both habituation and test phase.

Label versus No Label condition

To investigate whether labelling influences 11-month-olds categorization in any way, infants' performance in the two conditions (label, no label) was compared. An analysis with mean examination duration during both habituation phases as dependent variable, and labelling condition as well as habituation condition (animals, vehicles) as independent variable, revealed no habituation effect $F(1, 72) = 0{,}30$, $p > .05$, and a significant effect of labelling condition $F(1, 72) = 5{,}09$, $p < .05$. Higher scores in examination duration were reached in both phases by infants participating in the label condition ($M_A = 5.84$, $SD_A = 3.01$; $M_B = 5.89$, $SD_B = 2.77$), than by infants participating in the no label condition ($M_A = 4.48$, $SD_A = 2.32$; $M_B = 4.52$, $SD_B = 2.59$). No other main effect or interaction was significant.

When object examination during test phase served as repeated measurement variable in the same kind of analysis, infants showed a significant increase in attention across the test trials, $F(1, 72) = 18{,}04$, $p < .05$. This analysis also revealed a significant effect for the labelling condition, $F(1, 72) = 13{,}69$, $p. < .05$, as well as for habituation condition, $F(1,72) = 7{,}41$, $p. < .05$. Higher scores in examination duration were reached by infants participating in the labelling condition ($M_{t1} = 6.64$, $SD = 4.27$; $M_{t2} = 9.09$, $SD = 3.80$) than by infants participating in the no label condition ($M_{t1} = 3.56$, $SD = 3.15$; $M_{t2} = 6.41$, $SD = 5.14$). In addition, infants familiarized with animals examined the objects longer ($M_{t1} = 6.25$, $SD = 3.91$; $M_{t2} = 9.56$, $SD = 4.65$) than those familiarized with vehicles ($M_{t1} = 5.01$, $SD = 4.39$; $M_{t2} = 6.86$, $SD = 3.82$). Figure 11 shows the means for both habituation and test phase according to experimental condition (label, no label).

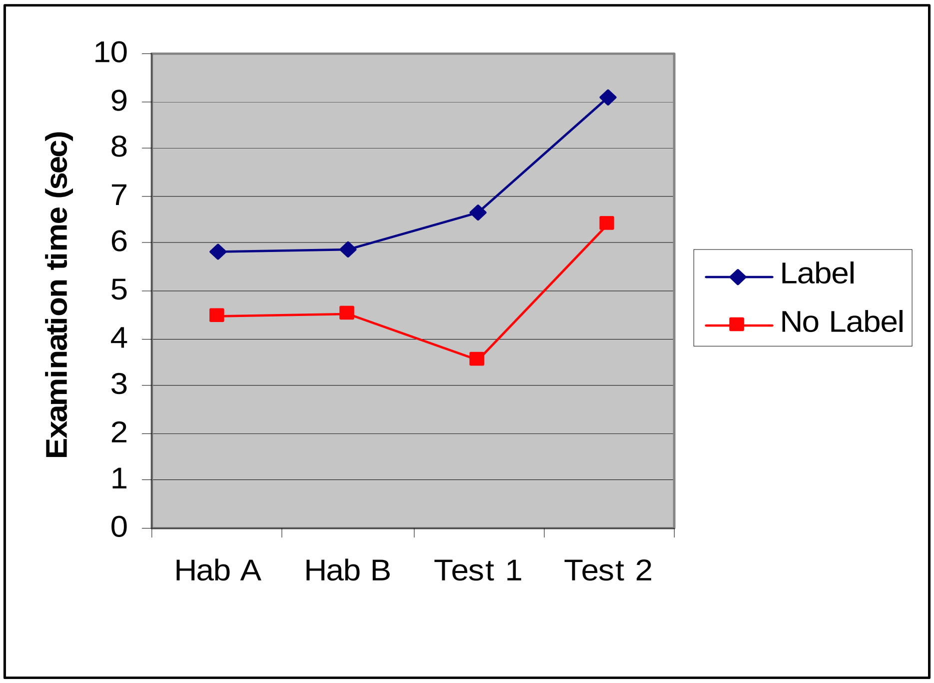


Figure 11: Infants performance during the habituation (A, B) and test phase (t1, t2) according to the experimental condition (label, no label).

Discussion

Consistent with previous studies on category formation (Mandler & McDonough, 1993), 11-month-olds participating in an object categorization task using no labels successfully discriminated animals from vehicles. Yet, during the familiarization phase no decrease in examination duration was observed.

During the test phase, we found a marginally significant effect for the habituation condition: higher scores on examination duration were reached by infants familiarized with animals than by infants familiarized with vehicles. Since this preference for animals was not observed during familiarization, it can not be argued that infants of the tested age-range show any general preference for either animals or vehicles.

Integrative discussion of results from Experiments 2a, 2b and 2c

As younger infants participating in Experiment 1, 11-month-olds participating in a modified OET, contrasting animals and vehicles, showed no systematic difference depending on labels: Infants showed highly similar performance when the stimuli presented were accompanied by basic- or global labels. More specifically, basic-level labels did not impede categorization performance. This pattern of findings suggests that global-level categorization appears to be stable across age and not to be influenced strongly by language input.

Interestingly, previous studies testing same age-group infants with the global contrast animals vs. vehicles without the presence of language input, has demonstrated infants' ability for both, familiarization and categorization effect (Mandler & McDonough, 1993). Alternatively, the reason why infants participating in Mandler and McDonough's study showed a significant familiarization effect, and infants participating in our studies did not, may have to do with the kind of task: In our studies infants were provided with ten different category exemplars during familiarization, whereas Mandler and McDonough provided infants with only four different exemplars which were presented twice each. Therefore, it is more likely that infants show a significant familiarization effect.

The results obtained in our experiments may reflect a general developmental trend in terms of perceptual and conceptual fine-tuning with age: While older infants threat different familiarization exemplars as distinct, younger infants detect commonalities more easily. This developmental trend appears to explain why 11-month-olds did not show habituation effects in any condition. The presence of object labels did not have any significant impact of the results. It should be noted, however, that categorization performance was not impeded by the absence of a habituation effect. This suggests that categorization responses may occur in the presence or absence of a habituation response, thus suggesting that category discrimination does not depend exclusively upon the process of abstracting similarities among the given familiarization stimuli online.

Chapter 9

Experiment 3

How about a basic-level task? Does labelling make the difference?

Experiment 1 and 2 have demonstrated that the presence of object labels did not influence 7-and-11-month-olds' general pattern of results when the global categories of animals and vehicles were contrasted.

Based on the results described so far, one may speculate that the presence of language input cannot influence the level of abstraction at which infants think about objects: Using an object examination task without the presence of object labels, infants of both age groups (7 and 11 months) show the ability for global-category discrimination (Mandler & McDonough, 1993, 1998). Our experiments replicated this finding, regardless of whether global-level or basic-level nouns accompanied the presentation of a given set of stimuli. Thus, given objects labels during the experimental session did not influence infants' general categorization performance in a global-level task.

These results lead us to raise an interesting question: Does labelling objects influence categorization when category performance is not yet at ceiling? Would basic-level terms facilitate basic-level categorization at an age when infants have not yet finished the global-to-basic-level shift? To answer this question, we chose to test 11-month-olds' basic-level categorization performance when cars and trucks are contrasted without the presence of verbal input. In case no significant categorization pattern will be found, it will be interesting to see whether or not labelling objects may improve basic-level categorization performance at the one-word stage.

To begin, a "no labelling" condition was conducted. As in Experiment 1 and 2, we used a modified object categorization task. Experiment 3a addresses this issue.

Experiment 3a

The main purpose of Experiment 3a was to investigate infants' categorization performance when the basic-level categories cars and trucks are contrasted without the presence of object labels.

Method

Participants

The data for this experiment was also collected in Heidelberg. A total of 22 infants took part in Experiment 3a (mean age = 11 months, 9 days; range: 11 months, 0 days to 11 months, 23 days). Seven additional infants were tested but excluded from the final sample for not meeting the final sample's criteria for participation (N= 3), fussiness (N= 3), or experimenter error (N= 1).

Stimuli

The stimuli consisted of 3-D realistic looking toy models representing the basic-level categories "cars" and "trucks". They varied substantially in appearance within each given category. The car category included eleven different looking cars. The category truck included eleven different looking trucks (Figure 12 shows picture of the stimuli).

Figure 12: Stimuli – realistic toy models of cars and trucks

Procedure and coding

Procedure and coding was the same as in Experiment 1 and Experiment 2. As before, in the no label condition the experimenter used an introductory phrase such as "Schau mal was ich hier fur Dich habe!" ("Look what I have here for you!"), when the objects were placed in front of the child, but no object label was given at the end.

Results

Mean-coder reliability was high ($r = .96$).

To determine whether infants showed a familiarization response, the mean examination time for the first five trials (phase A) and the second five trials (phase B) were calculated and statistically compared, using a mixed-design analysis of variance with habituation category (cars, trucks) as independent variable and habituation phase (A, B) as dependent variable.

Infants participating in Experiment 3a revealed no habituation effect $F(1, 20) = .007$, $p > .05$. However, a main effect for habituation condition was observed, $F(1, 20) = 5.19$, $p < .05$. Higher scores in examination duration were reached for infants familiarized with trucks ($M_A = 8.59$, $SD_A = 3.56$; $M_B = 8.59$, $SD_B = 3.45$), than for infants familiarized with cars ($M_A = 5.41$, $SD_A = 2.94$; $M_B = 5.51$, $SD_B = 3.90$). No interaction was significant.

When object examination during test phase (t1, t2) served as repeated measurement variable, infants showed no significant increase in examination duration from the first to the second test item $F(1, 20) = .003$, $p > .05$. The interaction between habituation condition and test trial was also not significant. Table 4 reports the mean examination duration and standard deviations during both habituation and test phase in any condition.

Table 4

Means (in seconds) and standard deviations for both habituation (A, B) and test phase (t1, t2), separated by experimental condition (no label, label).

	Habituation Phase				Test Phase			
	Phase A		Phase B		Test 1		Test 2	
	M	SD	M	SD	M	SD	M	SD
No label	7,00	3,58	7,05	3,92	7,82	6,69	7,71	4,81
Label	7,76	3,28	6,38	3,01	4,78	4,20	6,89	4,58

Discussion

In a modified version of the object categorization task contrasting toy models of cars and trucks without the presence of object labels, 11-months-old infants showed no significant habituation or a significant categorization effect. This set of findings is consistent with literature which has demonstrated that 11-month-olds' basic-level categorization is not yet fully stable (Mandler & McDonough, 1998).

During the familiarization phase, a significant effect for habituation condition was found: higher scores on examination duration were reached by infants habituated with trucks, than by infants habituated with cars. At test, no such preference was observed, however.

To find out whether labelling objects during the experimental session influences 11-month-olds' performance in a basic-level task, Experiment 3b was conducted.

Experiment 3b

The purpose of Experiment 3b was to explore the effect of objects labels when the basic-level categories cars and trucks are contrasted. Results obtained by this experiment will allow a direct comparison between infants' performance in the two conditions (no labelling, labelling). These results are expected to tell us whether the presence of object labels influence 11-month-olds' categorization performance in a basic-level task.

Method

Participants

A total of 22 infants from the same population as in Experiment 3a took part in Experiment 3b (mean age = 11 months, 12 days; range: 11 months, 0 days to 11 months, 27 days). All the infants participating in the label condition came from a German speaking family. Four additional infants were tested but excluded from the final sample because they did not meet the final sample's criteria for participation (N= 3), or fussiness (N= 1).

Stimuli, Procedure and Coding

Stimuli, procedure and coding were the same as before. In the labelling condition, the experimenter named each object when it was placed in front of the infant, using the German phrase: “Schau mal was ich hier für Dich habe: Ein X!” (“Look, what I have for you, an X!”). Familiarization trials and test trial 1 (new exemplar from the familiar category) were accompanied by the same global-level label: "Auto" (car) or "Laster" (truck) which represented the basic-level category that the infant had been familiarized with. Test trial 2 (new exemplar from the contrasting category) was accompanied by the global-level label which represented the contrasting category class.

Results

Mean-coder reliability was again high (r = .98). As in the previous experiments, means of both coders served as raw data for further analysis.

To determine whether infants showed a familiarization response, the mean examination time for the first five trials (phase A) and the second five trials (phase B) were calculated and statistically compared, using a mixed-design analysis of variance with habituation condition (cars, trucks) as independent variable and habituation phase (A, B) as dependent variable.

Corresponding analysis revealed a clear habituation effect, $F(1, 20) = 5.81$, $p < .05$, as well as a significant interaction between habituation phase and familiarization condition $F(1, 20) = 5.77$, $p < .05$. While examination times clearly decrease for infants familiarized with trucks ($M_A = 8.70$, $SD_A = 3.25$; $M_B = 5.95$, $SD_B = 3.05$), no decrease in examination duration was revealed by infants familiarized with cars ($M_A = 6.82$, $SD_A = 3.18$; $M_B = 6.82$, $SD_B = 3.06$) .

This analysis also showed a clear increase in examination times from test trial 1 (new object from the familiar category), to test trial 2 (novel category exemplar), $F(1, 20) = 6.19$, $p < .05$. A marginally significant interaction between test trial and habituation condition was also observed, $F(1, 20) = 3.52$, $p = .075$. While for infants familiarized with cars examination duration clearly increased across the test trials ($M_{t1} = 4.33$, $SD_{t1} = 3.52$; $M_{t2} = 8.04$, $SD_{t2} = 4.64$), for infants familiarized with trucks only a slightly increase was observed ($M_{t1} = 5.22$, $SD_{t1} = 4.92$; $M_{t2} = 5.74$, $SD_{t2} = 4.42$). See table 4 for the mean examination times and standard deviation during both habituation and test phase.

Discussion

In Experiment 3b we found that 11-month-olds' participating in a basic-level task contrasting cars and trucks show a clear habituation, as well as significant categorization effect.

The reported results also revealed a significant interaction between habituation phase and familiarization condition: while infants familiarized with trucks showed a clear decrease in examination duration from phase A to phase B, infants familiarized with cars showed comparable examination times in both habituation phases. At test, we found a marginally significant interaction between test trial and familiarization condition: while examination duration across test trials clearly increased for infants familiarized with cars, such increase was less salient for infants familiarized with trucks.

Given that infants participating in a similar task without the presence of labels failed to show habituation as well as categorization effect, one may conclude that labelling objects supports basic-level categorization at the age of 11 months when cars and trucks are contrasted. Figure 13 shows infants' performance during the habituation phases (A, B) as well as during test phases (t1, t2), separated by experimental condition (labelling, no labelling).

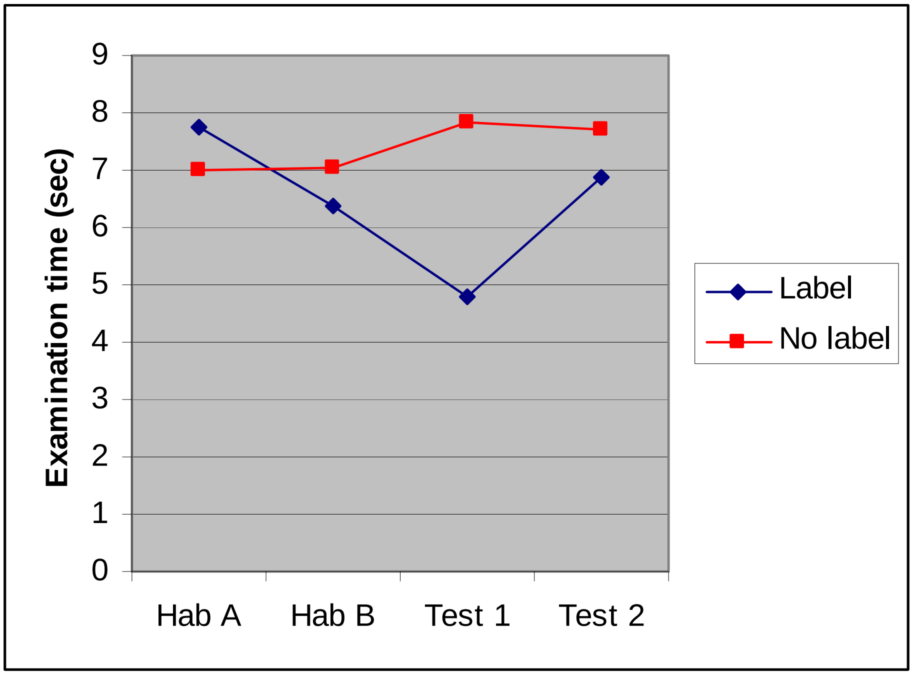


Figure 13: Infants' performance during habituation (A, B) and test phase (t1, t2) according to the experimental condition (label, no label)

Label versus No Label condition

In order to find out whether labelling influences 11-month-olds' object categorization in a basic level task, infants' performance in the two experimental conditions (no label, label) were statistically compared.

An analysis of variance with mean examination duration during both habituation phases as dependent variable, and experimental condition (no label, label) as well as habituation condition (cars, trucks) as independent variable, revealed no habituation effect $F(1, 40) = 2{,}27$, $p > .05$, as well as marginally significant effect for habituation condition $F(1, 40) = 3{,}96$, $p = 0.53$. Higher scores in examination duration were reached for infants familiarized with trucks (M_A= 8.65, SD_A= 3.32; M_B= 7.27, SD_B= 3.45), than in infants familiarized with vehicles (M_B= 6.12, SD_B= 3.07; M_B= 6.16, SD_B= 3.48). Results also revealed a marginally significant interaction between habituation phase and familiarization condition $F(1, 40) = 3.14$, $p = 0.84$. While for infants familiarized with trucks examination duration slightly decreased from phase A ($M= 8.65$, $SD= 3.32$), to phase B ($M= 7.27$, $SD= 3.45$), no decrease in examination times were observed for infants familiarized with cars ($M_A= 6.12$, $SD_A= 3.07$; $M_B= 6.16$, $SD_B= 3.48$). In addition, a marginally significant interaction was observed between habituation phase and labelling condition $F(1, 40) = 3.15$, $p = 0.84$. While infants participating in the non-labelling condition revealed no decrease in examination duration from phase A ($M= 7.00$, $SD= 3.58$) to phase B ($M= 7.05$, $SD= 3.92$), infants participating in the labelling condition showed a slightly decrease in examination from habituation phase A ($M= 7.76$, $SD= 3.28$) to habituation phase B ($M= 6.38$, $SD= 3.01$).

This analysis also showed no increase in examination times from test trial 1 (new object from the familiar category), to test trial 2 (novel category exemplar), $F(1, 40) = p > .05$. No interaction was significant. See session General Discussion for a discussion on these results.

Integrative discussion of results from Experiment 3a and 3b

Experiment 3a and 3b revealed that 11-month-olds' performance in an object examination task contrasting cars and trucks varied systematically with the presence of language input: While infants participating in a basic-level task without the presence of labels failed to show habituation and categorization effect, infants participating in the labelling condition successfully accomplished the task.

The reported results suggest that presenting objects the same label during the familiarization period might have drawn infants attention to the similarities among objects which belong to the same class, thus promoting a habituation effect. As a consequence, a significant increase in attention was observed when the contrasting category exemplar was presented accompanied by a new label.

This pattern of findings suggests that the presence of labels can support object categorization when infants do not yet make a corresponding distinction spontaneously. This result is in accord with the literature suggesting that the use of certain words may direct infants' attention to specific aspects of given stimulus, providing the opportunity to increase conceptual understanding (Waxman & Markow, 1995). According to Waxman and Markow, words can serve as invitations to form categories because it may help infants to look for the similarities that the objects labelled with the same word may share.

Chapter 10

General Discussion

The current set of experiments explored whether the presence of object labels at different levels of abstraction influence infants' categorical thinking in preverbal age through an object examination task.

As discussed earlier (see Chapter 6), previous studies have suggested that words have a facilitative effect in 12-to-13-month olds' object categorization (Waxman & Markow, 1995) and also in 9-month-olds (Balaban & Waxman, 1997). Importantly, these studies were mostly concerned to show the influence of verbal input (i.e. words) in infants' object categorization, but failed to clarify what kind of verbal input is important for categorization. The current set of experiments goes a step further, investigating what kind of object labels have an effect on object categorization at particular age groups.

Interestingly, results revealed that when the categorization performance is already at ceiling, the presence of object labels (no matter at what level of abstraction) does not change infants' categorization abilities. In addition, labels seem to be most effective if infants are about to learn the given category, suggesting that it is important to present infants the correct level of categorical contrast with the language input. The following paragraphs will discuss these general results in detail.

Contrary to our initial hypothesis, the reported findings suggest that the kind of label used during the experimental session (basic-level label, global-level label) does not influence 7-and-11-month olds' categorization ability when the global categories vehicles and animals are contrasted. Previous research has demonstrated infants' ability to discriminate animals and vehicles as different domains when the stimuli were presented without the presence of object labels (Mandler & McDonough, 1993, 1998). Our experiments replicated these findings. The presence of basic or global labels did not influence this general ability, however. This set of results shows that categorization is not influenced by the presence of object labels (no matter at what level of abstraction) when infants have the ability to categorize spontaneously (i.e. without the presence of object labels). This replicates earlier findings by Balaban and Waxman (1997).

Interestingly, the effect of language input could be observed when the basic-level categories cars and trucks were contrasted: eleven-month olds participating in the no labelling condition failed to show a significant habituation as well as categorization effect, whereas infants who took part in the labelling condition successfully accomplished the task. This general pattern of findings suggest that the presence of object labels influence categorization at preverbal age specially when the concepts are not yet at ceiling (a discussion on these results will be carried on further in this session).

In the studies conducted with 7-month olds (Experiment 1), labelling had some effect on infants' habituation as well as categorization responses: A significant habituation was only found in the presence of object labels (no matter if basic-or global level labels), suggesting that the presence of verbal input may increase infants' general attention towards the given objects, thus promoting habituation. Despite of that, infants' performance on the basic and global label condition were statistically comparable. In addition, labelling also had some effect on infants' categorization performance: although both groups (labelling, no labelling) showed a significant categorization pattern, a sharp increase in attention across the test trials was observed in the labelling condition only, suggesting that the presence of object labels support 7-month-olds' object categorization.

The results observed in the 11-month-olds (Experiment 2), are largely comparable to the ones from 7-month-olds (Experiment 1). More specifically, the kind of labelling (basic label, global label) did not have any impact on categorization results. Contrasting the results revealed by the younger infants, no habituation response was found in 11-month olds in any condition. As discussed earlier, one possible interpretation is that 11-month olds might be particularly interested in the perceptual differences between members of a given category. As a result, a high level of focused attention is kept throughout the habituation phase. Interestingly, this general tendency seems not to be influenced by the presence of language input. Whereas the presence of basic-or global labels did not influence infants' categorization or habituation performance, responses clearly differed between labelling and no labelling condition. Objects presented were examined longer when labeled verbally, no matter if the labels were at the basic-or global level of abstraction. Previous studies report similar findings (Pauen, 2000). In the set of studies conducted by Pauen, same age-group infants were presented the global categories of animals and furniture in three conditions: (1) with basic-level labels, (2) with global-level labels, and (3) no labelling. Whereas objects were examined longer in the presence of labels, the kind of verbal input did not influence results. Taken together, these findings suggest that language increases general attention for objects at the age of 11 months.

The results from Experiment 3, indicating a facilitative effect of words on categorization are consistent with previous work suggesting that words can serve as invitation to learn categories (Waxman & Markow, 1995). Like in the current studies, Waxman and Markow argue for a facilitative effect of labels on infants' categorization. According to the authors, the presence of object labels may help infants to look for the properties that objects labelled with the same word may share with each other. The fact that the interaction does not get significant when results of the two experimental conditions (no label, label) are compared should not be evaluated too high. First of all, because of the size of the sample which is quit small (11 infants in each familiarization condition), and therefore the variance may be too high and the values not strong enough to find significant results. Another factor is that there is lots of variance due to the habituation condition. For example, the means that are seen in the graphs (see Figure 13), mostly reflect what infants in the truck condition do, so it could be also that it indicates that infants at this age are really busy with understanding this category, and therefore pick up the label. Anyway, more studies are needed to clarify this issue. Importantly, this set of data suggests that many aspects may influence the effects of language in infants' categorization and it is very important to take into consideration which exemplars and what categorical contrast is used being difficult to make generalizations overall.

One interesting difference between the reported results and those of previous studies conducted by Waxman & Markow (1995) concerns the level of abstraction at which labelling exerts some effect. In the present case, the presence of object labels influenced 11-month-olds object categorization at the basic-level. To remind the reader, the present experiments did not find habituation and categorization patterns at the basic-level in the no labelling condition, but did indeed find it in the presence of object labels. The pattern of findings from the no labelling condition is supported by the literature that shows that basic-level categorization starts at about the age of 11-months although not yet fully stable (Mandler & McDonough, 1993, 1998). In previous studies, labelling influenced 12-to-13-month olds global-level categorization. As global-level categorization is demonstrated to be stable in this age-group

(Pauen, 2002a), the fact that 12-to-13-month olds did not show categorizationin the control condition (i.e. no labelling) but did in the experimental condition (i.e. superordinate-level label) may have to do with methodological issues. While the current studies presented ten different looking exemplars during the familiarization phase, providing infants the opportunity to habituate to the referred category, previous studies conducted by Waxman and Markow only used four items presented once. Thus, it seems quite likely that the reduced number of familiarization items presented only once and without any instruction (i.e. control condition), did not provide infants the opportunity to build the referred category in mind and understand that this is a categorization game. Therefore, the use of object labels at the superordinate-level may have helped infants to search for the commonalities among the set of stimuli, promoting a categorization response. In fact, the reason why basic-level categorization was observed in Waxman and Markow's studies in any condition, might be explained by the fact that perceptual similarities are quite high among a set of basic- level stimuli, making it easier for infants to recognize the out-of-category item. Like in our studies, the presence of object labels did not influence results when categorization was already at ceiling.

Altogether one can see that the findings described in this dissertation seems to vote for the *specificity hypothesis* (Gopnick & Meltzoff, 1986, 1998) and provide an important piece of the puzzle of how infants come to understand that words map onto concepts. As previously postulated by Gopnick and Meltzoff, the interaction between labelling and categorization seems to be bidirectional: at the same time that the presence of object labels may influence categorization, the attainment of object concepts (categories) is suggested to influence infants' ability to understand words and to pick up on words.

Taken together, the closing point seems quite simple: words can serve as invitations for infants to form categories, suggesting that labels can increase conceptual understanding especially when the conceptual understanding is not yet at ceiling. On the other hand, a more conclusive statement about the influence labelling exerted in the performance of infants participating in Experiment 3 seems to require further investigations. It seems quite obvious that the presence of object labels in Experiment 3 made infants respond to the task in a different way than they otherwise do (i.e. no labelling condition). A question that remains open is the following: Was infants' categorization performance influenced by the simple fact that a verbal label accompanied the objects, making infants pay more attention to the perceptual similarities and dissimilarities of objects, or the source of the verbal input (at the global level) played a crucial role? In order to clarify this issue, it would be necessary to conduct an additional study using the same stimuli and procedure as Experiment 3, but a basic-level label condition. By comparing infants' performance in both conditions, one could draw a more conclusive statement about the influence of object labels in this task.

List of Tables and Figures

Tables

Figures

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