The message of the book is straightforward and easy to apply: it derives from the interweaving of long years of field work with a solid theoretical background. The practice advocated presents children with the opportunity to confront contents and situations which are only too often considered inaccessible for them. The abundant examples presented show that when provided with an adequate toolkit composed of graphic texts, children are inherently motivated by the challenges surrounding them and can make the most out of them as valuable learning opportunities. Drawings, icons, photographs, maps and calendars are incorporated into the tool-kit while they are being used in circumstances in which they are required: children appropriate them while exposed to their use and experience their affordances. Children realize how the graphic texts empower their performance.

The fact that this toolkit is multimodal (involves several sensory modalities) implies that those for whom language is not the most readily available means of communication and processing are not discriminated against: on the one hand, it facilitates conceptualization and its expression by alternative means, and on the other it supports both the comprehension and production of verbal language.
Graphic Texts
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CHAPTER 1

INTRODUCTION

Notational instruments profoundly shape how we construct reality and help make us as smart and sophisticated as we are.¹

The use of graphic texts is a prominent characteristic of modern societies. Simple actions like driving and shopping at the grocery store are guided by signs, directions, maps and advertisements. More complex actions, such as scientific research and financial calculations, are supported by written texts, graphs and mathematical formulae. A wide variety of representational tools, such as photographs, illustrations, numerals and words, are cleverly combined to create many texts designed to serve those who make use of them.

Of this wide variety of tools, it is spoken and written language in particular that have drawn the attention of both the education system and the research community. On the other hand, despite the accumulation of a large body of research knowledge on the subject, to date non-verbal graphic texts have not attracted much attention from the education system (Kress, 2003).

The aim of this book is to attract the attention of educators, teacher trainers and policy makers to the potential contribution of non-verbal graphic texts to the enhancement of learning, thought, expression and communication processes in general and in young children in particular.

It is our intention to focus here on non-verbal graphic texts for children of pre-school age, but it should be noted that such texts can also be of considerable benefit to special needs populations, immigrants who are not proficient in the local language and adults who received no formal education. We believe that anyone who is interested in development, communication and learning will find something of interest and relevance in this book.

THE STRUCTURE OF THE BOOK

This introductory chapter presents in the first place the definition of graphic texts we have adopted as systems of external symbols found all around us. This will be followed by the examination of the unique aspects of non-verbal graphic texts. After explaining the contribution of such texts to individuals and society, we will address the way in which non-verbal graphic texts may be integrated into pre-school education.

Each of the chapters following the introduction can stand on its own and is devoted to a single non-verbal graphic text: illustrations, photographs, icons, maps and calendars. The chapters are organized from texts that are more familiar to
kindergarten age children to those more rarely used in kindergartens, and whose
formal instruction is usually postponed until elementary school.

The separate treatment of each type of text is a necessary outcome of the linear
structure of written text and it is this that makes for a focused and cohesive
discussion of each subject. It should be noted that in reality texts of different types
are usually integrated with one another, as required by context and by the
addressee’s goals, and this is equally true with regard to the use of graphic texts by
pre-school children. For instance, story books frequently also contain illustrations
and photographs; information leaflets include icons and maps. In each chapter we
have attempted to provide examples that combine texts presented in other chapters.

The different texts we examine embody a variety of representational principles
that in some cases are similar to one another and in other cases are unique to each
type of text. As mentioned above, in everyday life texts are intermingled. From our
point of view, combining the topics meant we needed to make decisions about
whether to include a topic in a particular chapter, although it might be equally
relevant in other chapters as well. One such example is spatial thinking, addressed
in the chapter on maps, whereas it is also relevant to the production and use of each
of the graphic texts. The result is that, wherever we considered it necessary, we
have recapped briefly on some items covered in previous chapters.

Each chapter begins with a theoretical overview describing the type of text
examined in that chapter. Coverage of theoretical subjects is minimal. We chose
to address only those aspects which are relevant to the use of graphic texts at pre-
school age, and which are not covered at length anywhere else. Later there is a
description of the development of understanding and use of the text in question by
children, as well as the potential educational contribution of use of that text to the
development of young children. Each chapter ends with ideas for tasks to enable
the acquisition of experience and familiarization with the text in question, and
information about the accessibility of the text and its functions.

Each chapter concludes with a section on activities. Its first part is devoted to
student teachers, and the second – to children. We assume that first hand
experience with the affordances of each graphic text will enhance student teachers’
practice when they introduce graphic texts to children.

Some of the activities suggested for kindergarten children could also serve as a
basis for students’ research and evaluation of children’s learning. Evaluation
activities are provided here with the idea of improving students’ insight into
literacy development of their pupils. These activities will enable students to
examine the extent to which their goals have been achieved. They are henceforth
marked: “Suggested Research”.

GRAPHIC TEXTS AS PERMANENT EXTERNAL SYMBOL SYSTEMS

Symbols

According to Peirce (1931), inherent in symbolic representation is a relationship
between three components: the sign itself (which he calls the representamen), the
object symbolized by the sign, and the interpretant, or how the sign is interpreted. For instance, a national flag is a sign, a piece of material representing a nation (the object). For some people (the interpretants), a flag represents a beloved – or conversely a despised – entity; others, who are unfamiliar with that particular flag, see it merely as a colourful piece of fabric. For them the flag is neither a sign nor a symbol. Peirce (1931) denotes three principal categories of signs: a) icon represents the object by virtue of a form common to both (e.g. an arrow designating direction of travel); b) index represents the object by virtue of some physical link between the two (e.g. a weather vane signalling wind direction); c) symbol represents the object by definition or rule (e.g. a word).

Piaget (1962) maintains that a symbol represents something that differs from itself. Hence, for Piaget, Peirce’s icons and symbols are both symbols, whereas an index is not a symbol at all. Thus, for instance, imitating the actions of another person when that person is not present, and even imitating the actions of a subject imitating himself (e.g. a child pretending to be asleep), are symbolic representations, whereas pointing to an object that is present does not constitute a symbolic representation of that object.

Nelson (2007) underlined that symbolic representation bears an intention on the part of the person producing it to deliberately create it. Symbolic representation is not a mere expression of implicit memory or an immediate perceptual experience. Furthermore, symbols are social, conventional and reciprocal: their meanings are not only personal and privately based in experience but rather enculturated, shared by the community of users. Nelson also views symbols as arbitrary and system dependent. These requirements lead to the conclusion that the referent-sign-concept relationship is not symbolic unless embedded in a system of arbitrary signs whose structure is the source of a certain level of its meaning (p. 145).

DeLoache’s (2004) position is that a “symbol” is anything intentionally created in order to represent something other than itself. She explicitly argues that “iconicity or physical resemblance is irrelevant to whether some entity serves a symbolic function”. She enumerates a variety of ubiquitous artefacts in everyday environments which she regards as symbolic in spite of their iconicity: pie charts illustrating how the budget is split among sectors, photographs, caricatures, engineering drawings, etc. This view is shared by other thinkers: Goodman (1976), Huttenlocher and Higgins (1978), and Ittelson (1996).

This book presents the outcome of our close observations of young children as they engaged in group activities which involved problem solving. We were struck by the vast range of representational tools children were able to manage thereby enhancing their problem solving abilities.

Given that we view the command of symbolic tools as one of the essential features of cognitive empowerment we attempted to consolidate a conceptual stance adequate for the description of children’s emergent symbolic competence as it had been revealed to us by our observations. Following Piaget (1962), Nelson (2007) and DeLoache (2004) we view a symbol as intentionally produced to represent something other than the symbol itself. We endorse Nelson’s view that symbolic meanings are shared by members of the community, and that this quality,
namely, **conventionality** is at the same time a requirement for and a consequence of interpersonal communication.

On the issue of iconicity, we have adopted DeLoache’s position considering it irrelevant as a criterion to determine whether an entity is a symbol or not. This is undoubtedly a most critical issue when coming to grips with the role of a group of graphic texts (with different but considerable degrees of iconicity) in children’s emergent symbolic competence. Our observations, as will be seen in the following chapters, have provided us with evidence that drawings, photographs, icons, maps and calendars serve as quite a formidable symbolic tool kit supporting, as is the case with symbolic tools, cognitive empowerment.

When the process of symbolization involves iconicity, it involves the selection of certain aspects of the represented entity, those that are relevant to the purposes for which the symbolization is created. This process requires ignoring other elements which are immaterial to that purpose; hence it results in the creation of a necessarily distorted sketch. The benefit is the **simplicity and clarity of the representation** thus achieved (Tversky, 2005). For instance, the schematic representation of a “dog” in Figure 1.1 is a simple image depicting the main characteristics of dogs, while omitting detailed features that characterize specific dogs. The result is an emphasis on a general outline common to all dogs, but devoid of any features that might identify any specific dog or indeed any features shared by dogs and other mammals.

Vygotsky (1978) saw symbols as cultural tools whose use in the psychological and social fields is comparable to the use of work tools in the physical world. For instance, words enable speakers of the language to relate to objects that are distant in time and place. Thus, a word serves as a tool to bring a distant reality closer and make it more accessible and available for speakers to share (e.g. mention of the word “galaxy” makes that content accessible to addressees. In this case, galaxies may not be immediately perceived by the senses. Therefore, the word provides a basis for joint reference).

![Figure 1.1. Generic dog image.](image)
**Internal Representations and External Representations**

*Internal Representations* are private representations, in other words they are accessible only to those producing them. For instance: ideas and images present in our minds as we think, talk, dream, read and so forth.

*External Representations* are publicly accessible. They include a wide range of human expression: deliberate imitation of others, gestures, speech, play, music, singing, dancing, painting, video, computer imaging and more (see Table 1.1).

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Common wisdom takes external representations as direct expressions of pre-existent internal representations. However, dynamic processes of externalization and internalization account for both types of representations. Common external representations are constructed by the community by means of communications between its members; at the same time, shared external representations are vital to conceptualization (Vygotsky, 1978; Nelson, 2007). Thus these dynamic relations result in representations that enable both communication between members of society (communicative function) and support individual thought and memory processes (epistemic function).

*Relatively Permanent External Representations* are long lasting. Examples can be found in sculptures and texts (such as books), which used a system of recording (such as words, mathematical symbols or maps). Such representations constitute social tools to help the human mind overcome bio-mechanical limitations that influence possibilities of perception, memory and processing (Harris, 1986). Relatively permanent external representations reinforce human capabilities in three ways:
CHAPTER 1

– Mind extension. Expanding processing ability and enhancing mental function (Olson, 1994; Clark, 1997). Graphic representations enable people to overcome limitations of memory from the point of view of the amount of material retained, the length of time it remains available and the ability to retrieve it precisely and quickly. Easily accessible representations help individuals to perform mental tasks, such as editing, that would be much more difficult or impossible without them.

– Mind regulation. This refers to strengthening people’s ability to “manage” (or “organize”) themselves, or “enhance the ability to deal with oneself” (Donald, 1991; Clark, 1997). This could mean keeping a diary in order to keep track of tasks to be completed; differentiating between tasks already accomplished and those yet to be accomplished; reflection on or ways of coping emotionally and mentally with a complex reality (see: The Diary of Anne Frank).

– Mind sharing. Temporary and relatively permanent representations make it possible for different people to retrieve information, share it between them and communicate about it (Donald, 1991; Clark, 1997; Nelson, 2007). The passing on of information by means of permanent external representations is non-synchronic. A good example is how present-day archeologists are able to receive information from ancient texts.

This book addresses the ability to use relatively permanent external texts, both verbal and non-verbal, in ways connected to literacy. Until the 1980s the narrow definition of the word “literacy” referred to the ability to read and write (Pellegrini & Galda, 1993). Today the OECD (Organization for Economic Cooperation and Development) considers literacy to be “the ability to understand, use and reflect on written texts in order to achieve one’s goals, to develop one’s knowledge and potential, and to participate effectively in society” (UNESCO Institute for Statistics, 2003). The American Literacy Association expanded the definition of literacy to include the skilled use of various types of verbal and visual information. Literate persons are able to perform the following tasks: understand what kind of information they need; obtain information from different sources; understand the information received and evaluate it critically; integrate information obtained from different sources; retain information over a long period; share information with other people and use it towards decision making; resolve practical problems and raise questions and new directions of thought (ALA, 1989). These definitions of literacy emphasize what Snow and her colleagues (Snow, Burns, & Griffins, 1998) refer to as the “large problem space” of literacy, as opposed to the “small problem space” that consists in mastering decoding and basic writing skills. This book will use the term “literacy” to describe a person's ability to make use of verbal and non-verbal graphic texts for the purpose of effective interaction with the environment and/or themselves (Teubal & Goldman, 1998).
INTRODUCTION

Graphic Texts

The real properties of physical text transform the space of possible thoughts. (Clark, 1998, p. 176)

According to Halliday (1989), text is language that has meaning or function in a context of situation. A graphic text consists of relatively permanent external symbols, such as: written verbal language, written mathematical language, maps, charts, graphs, photographs, paintings, drawings and others (Olson, 1994). Information is presented to addressees in a visuospatial format, usually on a two-dimensional surface. All the information thus presented is available at once and can be observed at length and returned to at different times. The message transmitted by graphic texts is the product of a combination of the content presented and the representational means selected. This means that content represented by different means results in different messages to addressees (McLuhan, 1964).

Non-verbal graphic texts serve characteristic purposes by virtue of the “affordances” they offer, such as: photographs – as a record; icons – as a warning, etc. Combining uses of different types of texts can reinforce the ability of addressors to transmit complex messages. For example, both digits to denote dates and words to denote months on calendars; captions on photographs and caricatures; a combination of writing, numerals and icons on maps; and so forth. The ability of people (adults and children alike) to achieve their goals with the help of texts is linked to their ability to identify the affordances of different types of texts (Gibson, 1982; Donald, 1991). From the addressee’s point of view, a combination of different types of graphic texts can enhance the processing of the material represented (Donald, 1991; Schnozt & Bannert, 2003) and promote the use of preferred channels of processing the information. Certain people, for instance, may prefer verbal written representation, whereas others will prefer non-verbal graphic representations, such as illustrations.

THE DEVELOPMENT OF PERCEPTION AND UNDERSTANDING OF GRAPHIC TEXTS

As early as their first year, children create images of objects and events and begin to understand spoken words (Preissler & Carey, 2004). The first use of symbols is “rigid”, in the sense that it is connected to the context in which the symbol was learned. An example of such rigidity is a child who, in response to the question “Where is there light?” is able to point at a lamp in one particular room, but not in another.

The use of symbols is just one of the aspects involved in the ability to use graphic texts. Another essential pre-requisite is an understanding that a symbol has a dual existence: it exists both as an object in its own right and as an object representing the symbol. DeLoache (2004) calls this phenomenon representational “insight”. An example of the dual existence of symbols can be found in mathematics text books: in an exercise making a comparison between pairs of
numbers – the digits representing some of the larger numbers are printed in a smaller font than those representing the smaller numbers (e.g. 5 and 9). This is a printing device designed to encourage differentiation between the digit’s function as a symbol of a number and the digit as an object in its own right. In the example given here, the numeral 5 is printed in a larger font than the numeral 9, although the actual numerical value of 5 is smaller than 9.

Beyond a general understanding that a graphic text represents content (e.g. geographical maps representing places; calendars representing time, etc.), exposure to and experience with many texts of the same type contribute to the development of understanding the “rules of mapping” between the graphic system and what it represents (Liben, 1999): for instance, the connection between a color on a map and the height of that location above sea level. Such an understanding is no trivial matter (Tversky, 2005). Following Karmiloff-Smith (1992), we claim that when children are preoccupied with the components of graphic texts and the relationships between them, the texts become the object of discussion and research. This preoccupation is possible only when the children are already proficient and accomplished in use of the texts, at least in certain contexts (“behavioral mastery”). This process is repeated with every type of text, and the result each time is a new representation of the text at a higher cognitive level. At the higher level the user is able to generalize the properties of texts and assign them to other areas and other texts. For instance, familiarity with the feature on maps whereby a change of color indicates a change of height above sea level: this can lead to a generalization that “a change of color represents a quantitative change in a certain dimension”. That generalization may then be reassigned to other fields that are represented by other recording methods: for instance, a change of color representing a change in pollution levels created by different types of vehicles. According to Karmiloff-Smith (1992), the ability to turn representations into objects of research and new representation is unique to humans.

USE OF NON-VERBAL GRAPHIC TEXTS AT PRESCHOOL

Non-verbal graphic texts use the visual and spatial modalities which are crucial to learning in young children (Ramadas, 2009). Some graphic texts are particularly accessible to children due to their iconicity and their widespread use in social-cultural contexts in which children participate. Non-verbal graphic texts have the potential to transform pre-school age children from passive observers to active participants in a range of social and cultural activities; in the absence of those texts, such participation would not have been possible. For instance, by means of icons or drawings pre-school children can draw up lists of items that they need to take with them on a shopping trip with their parents; or they can make a photographic record of places or events relevant to them in order to share their experiences with others. Such activities allow children to realize the advantages to be obtained through the use of graphic texts, thus motivating them to appropriate these tools.

However, the acquisition of non-verbal graphic texts is not something that should be taken for granted; it needs to be learned. We should be wary of jumping
to the erroneous conclusion that initial usage of a text signifies full command of it. Photographs, for instance, are not necessarily transparent and may require expertise as a condition of use. To illustrate this concept, look at Figure 1.2 below. How long did it take you to identify the items in the photograph?

![Figure 1.2. What’s in the photograph?](image)

Non-verbal graphic texts can contribute to enhancing spoken language in a variety of ways: the presence of a non-verbal text (such as a photograph) contributes to the creation of a long and coherent spoken text more than might otherwise be possible in its absence. Oral discourse can be enhanced when children (and adults too) are able to “read” and interpret the information they need from a graphic text before them. Such a text frees them from a total reliance on memory, which often complicates the process involved in producing spoken texts. This is an especially important tool for children who either do not possess the necessary vocabulary or have difficulty retrieving it (Iverson & Goldin-Meadow, 1998). From the children’s point of view, the use of gestures enables them to continue expressing themselves. For educators, gestures provide an indication of children’s “zone of proximal development”. Educators may suggest appropriate labeling to replace children’s gestures and expand their range of verbal expression. Therefore, dealing with non-verbal texts may support the use and acquisition of vocabulary specific to the activity.

There are instances in which people’s cognitive and verbal abilities are higher than their command of written language. This is especially true of pre-school children. The use of non-verbal graphic texts enables them to express their insights and thoughts via relatively permanent external representations and thus overcome the gap between their linguistic and cognitive ability and their imperfect command of written language. Children who intend to convey a message may take advantage of the option of gradually integrating written and non-verbal texts according to their abilities and preferred cognitive mode. Written language may be integrated into non-verbal texts in a variety of ways, from individual letters (e.g. a single
initial letter denoting days of the week on a calendar) to complete verbal texts (such as a text produced in the footsteps of illustrations).

At the initial stages of written language acquisition, the inclusion of written words may be particularly valuable when they add information beyond that conveyed by the non-verbal representations. Such experiences expose children to the affordances specific to each type of text and alleviate writing difficulties. As their command of written language progresses, they become more competent at selecting the adequate mode of representation. The choice of written language as a means of representation is not “automatic”, but depends on the goals of the addressees. In certain contexts, such as spatial content representation, non-verbal texts like maps may be a more suitable form of representation than written texts.

Hence, the experience with graphic texts in contexts relevant to children serves two goals at the same time: 1) The texts can enhance children’s ability to achieve specific goals in any activity. These experiences prove the advantages of the use of permanent external representations. Such experiences are likely to motivate children to master the “world on paper” (Olson, 1994). 2) Children get acquainted with the affordances of the different texts. This is in line with the genre approach to teaching literacy (Cope & Kalantzis, 2000). Familiarity with the properties of different representational means provides a basis for the optimal use of texts, which takes into account the resources required for their production, the content represented in them, the characteristics of addressees and the objectives. This shows that children can be actively engaged in the diverse aspects of the “large problem space” of literacy (Snow et al., 1998) even before they acquire basic reading and writing skills. Nurturing literacy through the informed use of graphic texts is one of the main objectives that this book hopes to encourage.

Practical experience with symbolic representational systems promotes the ability to use additional symbolic systems. The broader the knowledge base about them, the easier the acquisition of new symbolic systems (Marzolf & DeLoache, 1994; Liben, 1999; Troseth & DeLoache, 1998). Enhancing familiarity with non-verbal graphic texts is therefore a step that facilitates children’s acquisition of new symbolic systems in the future.

The realization of the potential benefits of non-verbal graphic texts does not result automatically from the mere use of the texts, but rather depends on the conditions under which they are utilized within the education system. Just as language is misused in the case of “empty words” (saying nothing) (Piaget, 1995), non-verbal graphic texts also risk being misused, meaning that the external aspect of the texts might be adopted without any attention being paid to their affordances or specific contributions. The body of this book will therefore address both the texts themselves and the ways in which they may be incorporated into meaningful educational activity.

PEDAGOGICAL APPROACH

The pedagogical approach guiding this book is an ecological one, whereby learning and human knowledge develop within social, cultural and material
contexts and with cooperation between people of different backgrounds, abilities or attitudes (Vygotsky, 1978; Bronfenbrenner, 1979). Knowledge is disseminated among members of society and it is impossible to separate people, concepts, cultural tools and cultural outcomes (Clark, 1973). Pedagogical interaction with children must be based on recognition of the importance of the knowledge children bring with them, the utilization of cultural assets of the societies they live in and cooperation with the significant figures in their lives – parents and others (siblings, care-givers) – to whom they are most closely attached (Serpell, 2001).

Cognitive abilities come to the fore in situations of meaningful social-cultural activities in the lives of participants. Children’s activities when directed by laboratory researchers produce only an incomplete picture of their true ability and they often receive a lower assessment by comparison with situations where the children are active partners in seeking resolutions to problems (McGarrigle & Donaldson, 1974-1975).

Developmental processes are changes that take place over time and derive to a large extent from acquired experience. As a result, some of the differences revealed in studies comparing children and adults indicate differences between novices and experts, whereas in effect children’s typical coping mechanisms are, in many cases, quite similar to those of inexperienced adults (Chi, Feltovich & Glaser, 1980).

Learning occurs in an interpersonal space. The best contexts for learning are those where there is a three-way interaction between action, cognition and language: people act jointly to achieve a common goal, they are aware of the broad context in which they are acting as well as of the relevant characteristics of the environment, and they express themselves via language (Goodwin, 2000). An example is children’s assistance with routine domestic chores (Ochs & Izquierdo, 2009). By virtue of active participation and interaction between people of different levels of seniority and proficiency, joint activity improves the knowledge and skills of all participants: knowledge about the activity is enhanced, as is knowledge of the language used to effect the interaction; directional and attention skills are developed; the ability to distinguish between items or events of relatively greater or lesser importance is improved; and so forth.

The pedagogical approach endorsed in this book combines situated practice (implicit learning) with explicit teaching.

Situated Practice serves a goal that is significant for the participants in that action: For instance, making a list of items to pack in a suitcase before a trip; or a map of a public park marking seating areas for guests invited to a party due to be held in the park. The main advantages of situated practice are empowering those learning the information, increasing their motivation to learn, and the possibility of passing on the acquired knowledge from one particular situation to another (Dewey, 1902; Blank, Marquis & Klinovitch, 1995).

Explicit Teaching is the active intervention of an educator or tutor (a figure with superior familiarity with the subject being studied), who helps students and
clarifies for them the content or principles in question. The function of the educator is to serve as a model where necessary, and support the independent activity of those being taught (“guided participation”, Rogoff, 2003). Bruner (1978) likened such supportive activity to the use of scaffolding on a building: tutors offer students broad support during the initial stages of acquiring skills in the relevant area, and as their knowledge grows in strength the need for such support is lessened.

Another important source of learning is discourse among peers, whether in contexts of cooperation or confrontation. In a situation of cooperation, equal social standing enables peers to debate differences of opinion among themselves without the need to accept the opinion of a figure of authority even before any agreement or understanding is reached (Piaget, 1932). Arguments between peers make them aware of different points of view and thus contribute to broadening their understanding of the subject under discussion. To make themselves understood, peers must present their standpoint in clear and cohesive spoken texts (Blum-Kulka, 2004, Blum-Kulka & Snow, 2004; Blum-Kulka & Hamo, 2011; Zadunaisky Ehrlich, 2011; Pellegrini, 2009; Pontecorvo, 1987). In the course of this book we suggest dealing with any subject which arises for discussion among peers or between children and adults. The study of no such subject should be postponed until a later stage on the grounds of being “too difficult”. This requires a conscious effort to be as accurate as possible with the material being learned, through activities adequate to the child’s realm of interest.

As development progresses, the subjects being studied should be reiterated and abstraction. Looking anew at subjects already addressed in the past creates what Bruner (1960) called a “spiral curriculum”. Each new encounter with the subject enables a deeper internalization and understanding of knowledge. An effective way to implement this principle is to repeat a learning activity in additional appropriate contexts and record each activity for thoughtful reflection at a later date.

NOTES

1 After Boroditsky, L., “Lost in Translation”, Wall Street Journal: Life & Style (30.07.2010). We changed the original, which was: “The structures that exist in our languages profoundly shape how we construct reality, and help make us as smart and sophisticated as we are”.

2 The only exception is the chapter on drawings, where we considered it superfluous to explain what a drawing is, but later in the chapter we have defined illustrations as a kind of drawing.

3 These activities are not intended to be used as a standard measuring tool for summative evaluation of goal achievement; such use would contradict the pedagogical spirit of the entire book.

4 The activities suggested for children and students are examples of application of the theoretical principles presented throughout the book. They should not be considered as a binding or comprehensive list. The authors will be happy to receive readers’ reactions and comments on their practical experiences related to this book: Eva Teubal, teubalster@gmail.com; Ainat Guberman, ainatgub@gmail.com.

5 Peirce names the broadest category of symbolic representation a sign.

6 Drawings, photographs, icons, maps and calendars.
In the world of communications it is common to refer to those who create a communications message as “addressors” and those at whom the message is directed, or who attempt to interpret it, as “addressees”.

We recommend viewing and comparing Edvard Munch’s woodcut painting The Scream and its description as recorded by the artist in his diary. Photos of the painting may be seen on http://en.wikipedia.org/wiki/The_Scream (or enter the Search word “Scream” on Google Images). The artist’s description is translated on various websites (enter “Munch Scream diary”).

“Affordances” are best described as possible uses, or the uses “afforded” by an item. These depend on the properties of the item, the features of its users and the circumstances of its use. Thus, for instance, in one human context a book may be read; in another used as a paperweight; or in yet another serve as food for worms (Gibson, 1982).

Karmiloff-Smith wrote about external representations in general, rather than specifically about texts.

“Zone of proximal development” is a term taken from Vygotsky’s theory. It denotes the distance between the actual developmental level as determined by independent problem solving, and the level of potential as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978).

Labeling should verbalize what the child expresses by means of non-verbal representation, i.e. provide a new way of representing the content of what he is expressing on a higher cognitive level. It is important to take care that such naming should not damage the flow of spoken text, but only advance it.
CHAPTER 2

DRAWINGS AND ILLUSTRATIONS

In the first years of their lives, most children enjoy drawing and are pleased with the results. Once they begin school the frequency of their drawing usually declines, and so does their sense of competence (Rose, Jolley, & Burkitt, 2006).

Children’s drawings have been examined from a variety of theoretical viewpoints: the psycho-dynamic approach looks at the emotional aspects (Koppitz, 1968; Machover, 1953; McNeish & Naglieri, 1993); the psychometric approach considers drawings to be indicative of children’s intelligence (Goodenough, 1926; Harris, 1963); the cognitive approach sees their drawings as an expression of cognitive development (DeLoache, 2004); and the semiotic approach studies the learning of signs and symbols and their meanings, as well as their use in various socio-cultural contexts (Chandler, 2005). This chapter will focus on the two latter approaches: we will look at drawing as a mode of communication whose use is based on a range of social contexts, and we will attempt to show that drawing – as well as language – can promote different cognitive functions, such as: developing acuity of observational skills, formulating concepts, recall ability, reflection, planning, questioning and more. It is our intention to clarify that such qualities qualify drawing as worthy of thoughtful and systematic nurturing within the education system, so as to maximize the many advantages inherent in such a valuable tool.

The subjects covered in this chapter are, in the following order: a discussion of the development of children’s ability to interpret and produce drawings; a presentation of drawing as a cognitive and communicative tool which promotes both the producers’ insights and the insights of the society to which they belong; a definition of two genres of drawings of special relevance to the fostering of literacy – narrative illustrations and scientific illustrations – including the examination of their different contributions to children; and children’s ability to distinguish between the two genres. Finally we offer some ideas for activities aimed at encouraging the use of drawing in general, and the two above-mentioned genres in particular, as well as ideas for research and evaluation of study in this field.

THE DEVELOPMENT OF THE ABILITY TO INTERPRET DRAWINGS AS SYMBOLS

According to Vygotsky (1978) there is a difference between first order symbols and second order symbols. First order symbols directly represent the signified objects (representatum). Second order symbol represent signs (representamen). Thus, for instance, writing is a second order symbol, since it is a representation of spoken language, which is itself a first order symbol. Second order symbols are of greater cognitive complexity: They require abstract thought and develop later than
first order symbols. Since figurative drawings are first order symbols, the ability to understand them usually develops earlier than the ability to understand writing.

The understanding that a drawing represents the object being depicted relies on the following insights: (1) there are similarities between the represented object and the drawing; (2) there are differences between them; (3) the drawing has dual reality: on the one hand it is itself a tangible object with its own structural characteristics (color, outline, size, etc.), and on the other hand it symbolizes an object, activity or idea (e.g. a generic drawing of a “cat”); (4) the drawing was created with the intention of sharing with addressees the meaning it represents, which is open to interpretation (Callaghan, 2005; Winner, 2006).

In the first months of their lives, babies are already able to see a similarity between objects and pictures of them (Jolley, 2010; Winner, 2006). It has been established that at nine months babies attempt to act towards pictures as they would towards objects. For instance, they might lick the nipple in a photograph of a bottle (DeLoache, Pierroutsakos, & Uttal, 2003). From the age of about 12 months, when children begin to pronounce their first words, they also label pictures of familiar objects, including basic, schematic black and white outline sketches of them.

The ability to differentiate between objects and their images also develops early: if a child is given an opportunity to choose between a picture and the object represented in that picture, from the age of three months the preference will be to reach out towards the actual object. DeLoache, Pierroutsakos and Uttal (2003) believe that children’s efforts at nine months old to act towards pictures as they would towards the objects they represent are not indicative of an “inability to distinguish” between the two, but rather indicate an attempt to investigate pictures and learn about their properties. DeLoache and her colleagues performed a comparison between middle class American babies and babies from the Ivory Coast, where pictures are rare. They found that the strength of this inclination (to investigate the picture) was proportionate to how realistic the pictorial representation was and the extent to which the children had experienced pictures. Studies have shown that at the age of eighteen months American babies no longer try to hold a picture, but rather point at it. On the other hand, the Ivory Coast babies tried to grasp pictorial representations of objects as if they were the actual objects, as would be the case with an American baby aged only nine months.

In the opinion of Preissler and Carey (2004), understanding of the representational nature of pictures develops as early as eighteen months of age. By labeling pictures, they taught children from this age to two years an unfamiliar word and found that the children used the newly learned word to name the object that appeared in the pictures, rather than the pictures themselves. At two years the children were even able to provide a verbal explanation that the picture is actually a picture of the object, and not the object itself.

Some researchers maintain that the understanding that pictures exist in their own right, separate from the objects represented by them develops after the age of four. They claim that between the ages of three and four children expect pictures to change in line with changes taking place in the object they represent, for example expecting a picture of a flower to change as the flower itself droops.
But other researchers disagree with that opinion, claiming that children are not surprised if they see a picture of themselves dressed in different clothes than those they are currently wearing (Jolley, 2010). Here too the disparity between researchers would appear to derive from the specific context of their experiments.\(^4\)

**The understanding of the communicative intention of the use of pictures** is the acknowledgement that people use pictures in social interaction in order to share their meaning with addressees. This underlies children’s ability to understand another person’s intention in contexts where pictures are used, and their ability to produce pictures with the aim of communicating (Callaghan, 2005). For instance, Bloom and Markson (1998) found that three year olds were more likely to label a picture when told that someone had drawn it than if they were told that the paint had just been spilt on the paper.

**THE DEVELOPMENT OF THE ABILITY TO PRODUCE REPRESENTATIONAL PICTURES**

One of the first researchers to record the development of children’s ability to draw representational pictures was Luquet (1927/2001), whose book about children’s drawings was translated from French into English only in 2001.

Luquet’s observations indicate that children in the second year of their lives like to leave signs: fingerprints, painted lines, holes made in the paper with a sharp pencil point, or something similar. There is an ongoing debate over the extent to which children intend to represent objects in “scribbles”. Thomas and Silk (1990) did not consider scribbling to be symbolic, whereas other researchers (Lee & Karmiloff-Smith, 1996; Yamagata, 2001) thought it was. Adi-Japha, Levin and Solomon (1998) analyzed scribbles and doodles made by children aged two to three years and found that they were produced by “free-flowing” hand movements and “intentionally angular” lines. As soon as they were finished, the children liked to assign some representational meaning (such as “airplane”) to the angular lines they had drawn, but not to those produced by “free flowing”, smooth movements. This difference – between the meanings assigned to broken lines as distinct from flowing ones – was not found in the way in which children interpreted other children’s sketches or even their own, if some time elapsed between the moment when they made the picture and the moment when they were asked what they had drawn. Furthermore, the children offered no such explanation for doodles made by the researchers in imitation of the children’s scribble movements. It can be claimed that the fact children assign representational meaning to doodles immediately after they were made does not prove their intention to produce a representation of an object at the outset. In this case, even though it did not initially set out to be a representational object, it later became one through the children’s verbal interpretation of their own product. This explanation was suggested by Tolchinsky (2007) in relation to drawing systems in general.
From about the age of two and a half, children frequently announce ahead of time their intention to draw a particular object and, almost always after completing their drawing, interpret it according to their prior intention (Lee & Karmiloff-Smith, 1996). Luquet (1927/2001) holds that the transition from doodling to intentional drawing is gradual: at first children are happy to doodle and find some resemblance between their doodling and a particular object; Luquet calls this stage “fortuitous realism”. Later, if satisfied with their doodle, children may announce their intention to produce another representation of the same object and repeat the same actions that made the first doodle successful. In this way they increase the chances that future scribbles will be similar to the first one that was seen as representative.

At the age of about three, children add details to their drawings to increase their resemblance to the object they consider similar. For instance, a three and a half year old girl produced a scribble and thought it looked like a bird. Afterwards, she added a beak and legs to the scribbled shape. According to Luquet, such enhancements are the start of intentional drawing. Hence, doodling is a convenient basis for the development of intentional drawing; it might be considered to be a “bootstrapping” mechanism. Children gradually produce more intentional drawings and fewer that are made merely with the intention of making marks on paper.

In many cases observers can identify the objects represented in children’s first intentional drawings, even though they are far removed from a realistic representation of the depicted object. Luquet calls such drawings “failed realism”, since in his opinion the children intend to produce a realistic picture, but do not succeed in doing so. The reasons for their “failure” are inadequate motor skills and limited attention span.

When children draw an object, they have to be in control of their motor skills while also making a comparison between their drawing on the page and the model it represents (whether that model is physically before them or drawn from memory). They begin by marking down the most prominent and important features and then progress to features they consider less important. The moment their attention is distracted from the drawing, they are likely to decide that the drawing is complete. If details that were omitted are pointed out to them, they may correct the drawing or explain retroactively why they left out those details. Another characteristic of such drawings is that each detail is drawn independently, without any overall view as to relative size and spatial relationships between them. For instance, in a drawing of a person the hands might be attached to the head, the mouth above the nose and the head larger than the legs. Corrections are added without first deleting the previous version.

At around the age of five, children’s drawings begin to look more realistic. Luquet (1927/2001) divides the period when children and adults produce realistic drawings into two phases, depending on the manner in which they attempt to resolve the problem of representing a three-dimensional reality by means of two-dimensional drawing. He calls the first phase “intellectual realism”, because the drawings characteristically produced during that period often represent the object as the artists conceive of it and not as it appears physically to their eyes at the
actual moment of drawing. Intellectual realism is achieved by a variety of techniques:

- **A separation of items that are actually connected and conceal one another:**
  For instance, the three hairs on the head of the boy in Figure 2.4 are separated.

- **Transparency:** drawings may depict toes inside shoes, roots of plants inside the soil and rooms visible through the walls of houses. In Figure 2.1 below, in the photograph the little girl climbing on the pitched roof blocks out the figure behind her and only the other child’s head is visible. In the drawing, however, the girl in the front is “transparent”, revealing a complete figure behind her.

- **Spreading the surface area of three-dimensional objects:** For instance, in Figure 2.2 below, the more distant margin of the tablecloth has clearly been spread upwards and the child is sitting on a chair that has been “spread” sideways.

- **A combination of different viewing angles:** This is a technique whereby every detail is shown from the angle of best visibility. For instance, in Figure 2.1 the head is drawn facing forwards and the body is depicted in profile. In Figure 2.2 the child is viewed from above and the table legs from the side.

As Luquet points out, in the adult world “intellectual realism” is intentionally applied in many circumstances in which it is particularly suited to serving the purposes of the production, such as scientific illustrations presenting items that are not visible to the eye, and architectural plans depicting the same building from different aspects, thus showing what is known rather than what is actually seen. Therefore intellectual realism is not a feature unique to children and cannot be considered a transient development phase.
Drawings representing reality as it appears to the producer at the moment of drawing begin to appear at about the age of eight. The name given by Luquet to the period when they are the most prevalent is “visual realism”. The first signs of visual realism are discernible in drawings of certain details by children aged four. For instance, depicting only one eye in a profile portrait, because the other eye cannot be seen from that angle (see Figure 2.3 below). Visual realism requires a relatively high level of technical skill, familiarity with the laws of perspective and with realistic depictions which serve as models for imitation. Figures 2.1 and 2.3 were drawn by kindergarten children. In both cases the contribution of their observation of the two-dimensional photograph to the degree of visual realism in reproducing the body in the drawings is noticeable.
In contrast to the view that the drawing of perspective represents the height of development, Cox (2005) claimed that the choice of drawing style is a deliberate choice dependent on the culture to which the producers belong, their skills and goals. Thus, for instance, adults draw caricatures in ways that are not realistic, because their purpose is criticism; certain expressive drawings or paintings integrate doodles as a way of expressing emotion; and in cubist art objects can be both “spread” and viewed from different angles, one alongside the other; a lack of depth typifies Byzantine art, whereas diagonal lines hinting at depth characterize traditional East Asian art.

THE COGNITIVE AND COMMUNICATIVE FUNCTIONS OF DRAWINGS

This section is devoted to presenting the cognitive and communicative values of the use of drawing in early childhood. Drawing can serve as a tool which empowers the ability to observe. Drawing based on observation is an intentional act. It requires planning and organization prior to and in the course of the act of drawing, as well as monitoring by means of repeated comparisons between the object depicted in the drawing and the actual outcome. As a result, the overall perception of the object depicted gradually becomes detailed and explicit, thus increasingly clarifying the details depicted and the connections between them. Hence, drawing is a tool for the creation of meaning by means of representational re-description which results in awareness of details that were previously unacknowledged (Tversky, 1999). In 2009 children in a pre-school in Jerusalem took part in an activity which involved the use of maps. They were asked to draw the route from the preschool to the grocery store or the library. They noted landmarks on the map: while doing so they noticed that on the sidewalks the covers of drainage pipes are round, while the covers of telecom cables are square. The highly detailed observation involved in drawing intended to record features of reality led to questions and observations relating to various infrastructures in the street and the need to note their existence and location.

Drawing can support the crystallization of emerging ideas (Tversky, 1999; Ramadas, 2009). Designers and architects begin their creative process with schematic sketches that gradually take shape as they are examined and compared with previous sketches. The advantage of sketching derives from the simultaneous and relatively enduring presence of multiple items of information. This enables an integrative grasp of the spatial relationships between them without overloading memory. The recorded details may yield new information which would not have been accessible to the planner without the sketches: for instance, how the addition of a particular detail will affect the overall appearance of the finished construction.

Drawings can also serve children as a planning device. Figure 2.4 below illustrates a kindergartner’s suggested plan for a bonfire party. The drawing shows that the party will take place next to a bonfire and that the following items will be needed: a tape recorder, potatoes, matches, skewers for roasting marshmallows, candies, and so forth. The little boy used the drawing to explain to
other children what he was planning (drawing as a communication tool). A number of children suggested similar plans which formed the basis for discussion and reaching a joint decision. The drawing that depicted the joint decision was kept by the educator in a folder accessible to the children as a record and a memory aid.

Figure 2.4 Planning a bonfire party.

ILLUSTRATIONS

Illustrations are drawings that represent, interpret and reinforce the meaning of texts by the use of pictures in a manner that makes the written and pictorial texts mutually complementary (Vernon Lord, 2007). The use of illustrations in combination with verbal texts can enhance understanding and recall processes with regard to the verbal texts, both when children produce the illustrations accompanying written texts themselves and when they look at those produced by others (Fang, 1996; Carney & Levin, 2002; Brookshire, Scharf, & Moses, 2002; Schnotz & Bannert, 2003; Peeck, 1993).

The dictionary is a context in which illustrations can aid text comprehension. They are helpful to anyone seeking a definition of unfamiliar words. Figure 2.5 below is an illustration for the expression “an eloquent man” (Exodus 4:10)
from a page of the kindergarten dictionary. At the top of the page is the definition of “an eloquent man”: a man who knows how to speak and conveys his words well, alongside which is an icon of a face with the mouth accentuated. At the foot of the page is an illustration representing Moses next to the burning bush, accompanied by a verbal description of the scene: Moses said to God that he is not an eloquent man. The preparation of the dictionary page required contributions of different genres: a dictionary definition, a Biblical quotation, an icon and an illustration.

Figure 2.5. A page from a kindergarten dictionary explaining “An eloquent man”.

In the example above, the illustrations complement the text. There are other cases where the illustration bears most of the burden of clarifying the meaning. See, for instance, Figure 2.6 below, in which the illustration is primarily responsible for explaining the meaning of the word “histager” meaning to “seclude oneself”.

“Adam hayode’a ledaber u’lenaseax et dvarav heitev”
A man who knows how to speak and express himself well in speech

“Moshe amar lashem she’lo ish dvarim hu”
Moses said to God that he is not an eloquent man
Figure 2.6. A page from the kindergarten dictionary for the term “seclude oneself”.

An examination of illustrated texts enables the verbalization of emotions and contributes to the understanding of words expressing emotion (Painter, 2003). For instance, one child reading the story of Snow White pointed to the dwarf named Grumpy and said: “He is grumpy. I’m not grumpy. I’m happy”.

The contribution of illustrations to understanding verbal texts is especially significant when it comes to conclusions that may be deduced from the text, as compared to recalling the information explicitly delivered by it (Gyselinck & Tardieu, 1999).

Rubman and Waters (2000) believe that a graphic representation of a story in the course of reading contributes to a deeper understanding of the text, more accurate monitoring of that understanding and a critical approach to it. Their study claims that children who created a graphic representation of a story they were reading had a better understanding of the story and were better able to detect ambiguities in the text (whether in previously provided information or in the readers’ overall general knowledge).

The positive impact of illustrations on understanding and memorizing texts has been explained in a number of studies and in a variety of ways which, rather than contradicting one another, increase and complement understanding of the subject. We will expand on this below:
For emergent readers and those with a limited vocabulary (such as immigrants with limited knowledge of the language, or children with language difficulties) illustrations can convey meanings they wouldn’t extract if only verbally expressed (Carney & Levin, 2002; Fang, 1996).

Illustrations, especially if colorful and interesting, may boost children’s motivation to approach and interpret the text (Brookshire, Scharf, & Moses, 2002; Fang, 1996).

Illustrations may summarize complex information and focus attention on the most important details (Carney & Levin, 2002).

When an illustration repeats information provided in the written text, that information undergoes two distinct types of processing: visual-spatial and auditory-verbal. Such dual coding, in two different modalities, enhances memory of the text (Paivio, 1986).

Illustrations and verbal texts are appropriate to the presentation of different kinds of information: spatial content is better represented by illustrations, whereas serial content and/or content that includes movement is better represented by verbal texts (Gross & Teubal, 2001). For this reason a combination of the two can deliver a more complete and effective message than the use of each separately (Peeck, 1993).

There are individual differences between readers. Some are better able to process the information given to them via visual-spatial codes, and others are better at processing information delivered via verbal coding. Combining verbal and pictorial texts can increase the number of readers able to process the text in its entirety (Gyselnick & Tardieu, 1999; Peeck, 1993).

It must, however, be pointed out that alongside this sizable list of the advantages and contributions of illustrations to the understanding and recall of texts, another cumulative body of research suggests conditions whereby the use of illustrations may be detrimental to text processing and comprehension. These conditions are explained below:

Children may assign to an illustration an interpretation other than the conventional one. For instance, Ehrlén (2009) claims that exposing children to satellite photographs of Planet Earth and to scientific illustrations of the solar system can result in faulty conceptualization. Ehrlén reported that five year old children offered the following explanations of drawings of Planet Earth: one child claimed that people are on a plateau inside the planet; another thought that it was the mountains and curves in the roads that made the planet round; one little girl thought that every planet is a country, and only Sweden (her home country) is on Planet Earth. The children who took part in Ehrlén’s study recognized the illustrations because they had previously seen similar ones in their social environment, with no mediation. Thus Ehrlén’s work demonstrates that illustrations are not automatically understood and a certain visual literacy and mediation are needed to assist their understanding. We assume that would be the case not only for children: any person, regardless of his/her age might misinterpret an illustration representing totally unfamiliar objects.
Ivarsson, Schoultz, and Säljö (2002) claim that the choice of representational tool influences thought process and that use of a globe in familiarizing children with our planet would help them think and express their thoughts in a more “advanced” way. It therefore follows that congruence between the information presented and the affordances of the tool selected to present it is significant (Norman, 1993).

Where an illustration is not reproduced in close proximity to the relevant section in the verbal text, readers must transfer their attention from one place to another, with an adverse effect on processing efficiency (Mayer, 2002). We would not expect this to be different when textual references require from readers similar attention transfers.

If there is either no connection or a contradiction between the illustration and the verbal text, understanding and recall of the text may be impaired (Beck, 1984).

Some researchers are concerned that the addition of illustrations to texts results in a more superficial processing of the texts, since the apparent simplicity of an illustration could mislead the reader into believing that the text is clear and requires no further processing (Peeck, 1993; Weidenmann, 1989).

**DRAWINGS AND ILLUSTRATIONS AS A BRIDGE TO WRITING**

Drawings and illustrations can make a major contribution to the acquisition of writing. Drawings are an enduring form of text. They are available for discussion and editing. Figure 2.4 above demonstrates how kindergarten children made use of a drawing in order to plan a bonfire party, talk about the list they compiled, edit and reorganize it, keep it and include all those concerned in the preparations for the party. This was an effective introduction for those children to several of the many possible uses and benefits to be gained from texts, at a stage in which they were still not proficient in their use of the writing system.

A **drawing can serve as an organizational framework** into which written words can be incorporated. This will bring out the unique advantages of writing where it is especially needed, without the effort involved in writing longer portions of text – particularly in the early stages of acquisition – discouraging children from creating a whole text. All children can participate in making a drawing and most will be able to enhance it with symbols, letters and written words, each according to his or her own ability, and enjoy the joint creative process. Over time, as their ability to produce written language develops, the use of written words in texts created by children will gradually increase, until it replaces illustrations in places where the written word has an advantage (Teubal, 2008).

**Illustrations accompanying texts may form a bridge to interpreting the code of writing.** If a written word appears in conjunction with a suitable illustration (e.g. “a balloon”), children can show an interest in the connection between the spoken word used to label the illustration and the written word. Rhyming words appearing side by side (e.g. “balloon” and “moon”) can draw the children’s attention to the similarities and the differences between the written and
the spoken words respectively. The similarity between the rhyming written words can help them distinguish between writing as a system representing spoken language (a second order symbol) and the visual image representing the form of the item (a first order symbol).

NARRATIVE ILLUSTRATIONS

A narrative illustration is a graphic genre that incorporates pictures accompanied by narrative written text, with the goal of contributing to its understanding (Vernon Lord, 2007). Narrative illustrations also include caricatures, comic art and graphic love stories (Bell & Sinclair, 2005).

The use of narrative illustrations is especially widespread in children’s literature, and books for beginning readers. This is because narrative illustrations have special characteristics beyond those already described, whose purpose is to contribute to understanding the texts they accompany. We will expand on these characteristics below:

– **Framing the text and directing the reader’s expectations**: illustrations usually depict place, time and the actions of the story’s central character or characters. Thus they concentrate the descriptions in the story into a single frame and create a link between the story and the children’s already familiar world, as well as directing their expectations towards what follows (Carney & Levin, 2002; Fang, 1996; Peeck, 1993; Vernon Lord, 2007).

– **Interpretation and expansion**: illustrations can interpret the text and add information that is not expressly written or spoken. This means that the text may be brief in syntactical terms, without detracting from the complexity of the story’s messages (Carney & Levin, 2002; Peeck, 1993; Fang, 1996). A good example is found in a book entitled *Good night gorilla* (Rathmann, 1994), which tells a complete story, while the written text is limited to “Good night …” followed by the name of an animal. The text takes on different ironic meanings according to what is taking place in the illustrations.

– **Critical thinking**. The comparison between the pictorial and the verbal text may foster critical thinking. For example, during an activity carried out in a preschool after reading a book named *One Clear Morning* (Ayal, 1985), the children noticed that in one of the illustrations the grandmother welcomes the children whom she can’t see because they are hidden behind the door (see Figure 2.7). This resulted in a conversation in which alternatives were considered: they suggested changing either the direction in which the door opens or the location of the door bell. They accompanied their suggestion with a corrected illustration, which they created by altering a photocopied version of the original. Their correspondence with the illustrator led to the illustration being amended in later editions of the book. The interactions arising from the illustration offered the children an opportunity to deal with spatial issues and the comparison between the verbal and the pictorial text resulted in addressing the degree of correspondence between them. Through the manipulation of a
photocopied version of the illustration they also learned that texts may be edited and improved. This outcome was achieved with no writing.

– **Expansion of vocabulary and concepts**: illustrations, as first order symbols – i.e. symbols directly representing objects (Vygotsky, 1978) – are able to clarify the meanings of unfamiliar words for readers (Carney & Levin, 2002; Fang, 1996; Peeck, 1993).

Not all studies found narrative illustrations to be beneficial. Below we identify further preconditions for illustrations to be helpful to understanding and remembering the text.

– **Visual literacy** The understanding of narrative illustrations requires familiarity with the conventions of pictorial representation of narratives. Whereas in real life dynamic events occur in sequence, one after the other, so that at any given moment we see only a single event, narrative illustrations offer several static pictures at once, one alongside the other, each representing a single moment in the overall sequence of events. When looking at narrative illustrations, it is important to understand that the recurrent appearance of a figure refers to the same character who participates in the different events rather than a different figure each time. It is also necessary to understand the connection between the individual pictures: their location in the spatial sequence of presentation is indicative of the temporal order in which the events took place. For this reason the pictures have to be viewed in a fixed order which is appropriate to the conventional order of reading in the relevant culture (Borners, 1990).

– **Clarity** Illustrations should be clear and not overloaded with detail, so as to make it easy to pick out the most important aspects (Beck, 1984; Brookshire, Scharf, &d Moses, 2002).
– **Proximity** The location of the illustration must be close to the text it accompanies. The effect of disconnecting the verbal text from its attendant illustration can be especially serious where an understanding of the text depends on implications or allusions in the illustration. For instance: “Who is this? What is he doing?” (Elster & Simons, 1985).

– **Consistency** Major changes in the appearance of illustrated objects, which do not have their origins in the plot of the story, can impair understanding of the texts. For instance, a dramatic change in the size of illustrations or the angle from which they are drawn (Beck, 1984).

Even if all these conditions are present, some researchers are concerned about the possibility that illustrations might impair understanding of text, claiming that children may prefer to look at the pictures instead of making an effort to interpret the information provided in the text (Brookshire, Scharf, & Moses, 2002).

**SCIENTIFIC ILLUSTRATIONS**

Bruner (1986) makes a distinction between two modes of thought: paradigmatic and narrative.

**Paradigmatic thought** characterizes the natural sciences and is one of the crowning achievements of human cognition (Donald, 1991). Scientific activity in this field aspires to objectivity and the formation of a body of knowledge that will offer a description, explanation and overall prediction of observations by means of well-defined and formally interconnected concepts.

**Narrative thought** on the other hand, is subjective and based on prior experience. Thought processes are associative. Analogies, metaphors and narratives are tools used in everyday life to describe, explain and predict reality. Concepts in natural language are not defined, but rely on some similarity to “typical” items (Klein, 2006).

How, then, did scientific literacy evolve from everyday thought? The development of science is a communal achievement and scientific knowledge is not the same as that of individuals (e.g. see Donald, 1991; Klein, 2006). Factors that have contributed to the development of natural sciences in the western world include writing, which has made it possible to make lasting records of and preserve observations, compare different findings, examine theories in light of the findings, plan long-term research and peruse previous documents. The exposure of the general public to existing knowledge, the ongoing re-examination and critical approach to previous theories and findings, lie at the heart of scientific activity and constitute the difference between inflexible dogma and development and renewal.

One of the main functions of the science curriculum for pre-schoolers and the early elementary school classes is to act as a bridge between the world of the child and scientific activity. By investigating subjects relevant to them, children undergo a process of socialization that introduces them to activities “in the spirit of science” (Teubal, 2003); they learn to perform precise observations and focus upon details; control variables and work in a manner that enables them to replicate both methods
and findings; make clear and systematic record of what they see and use that record for comparison, hypotheses testing and learning.

When children are encouraged to engage in “research” with the goal of exploring their conjectures the atmosphere around them is one of “team work”. They collaborate in order to find out the answers to intriguing questions, by incorporating in their conclusions both positive and negative results rather than compete to win in a guessing game. We expect this approach to result in children gradually adopting an objective attitude to hypotheses testing (Teubal, 2003).

One of the most important tools in this process of enhancing the abilities of “children as scientists” is language in its broadest sense, both spoken and written and including both verbal texts and non-verbal graphic texts (Lemke, 1998). Researchers in the field of scientific education warn that scientific education in schools “misses the point” in failing to make adequate use of the visual-spatial channel: introducing graphic texts such as scientific illustrations, photographs, maps and graphs that could help learners (Ramadas, 2009; Trumbo, 2006).

Scientific illustration is one of the main genres of non-verbal graphic texts supporting the understanding and production of scientific content. In this chapter we will look at two types of scientific illustrations: those recorded during the course of observations or immediately thereafter (see Figures 2.8a and 2.8b), and those that represent the illustrators’ insights and hypotheses on processes and structures, henceforth to be called “models” (see Figures 2.9-2.11). Models may make use of symbols with no iconic similarity between the symbol and the object presented (e.g. the action of inhalation is represented as wavy lines in Figure 2.11).

Because of the difference between activities that are “natural” to children and those of a scientific nature (Vygotsky, 1978), it is critical to draw children closer to science without making the activities tiresome and laborious. The aim is that children be inspired by a sense of wonder: while often investigating something supposedly “familiar”, they discover a whole new world that was hitherto concealed “right under their noses” (Teubal, 2003). Scientific illustrations are a valuable tool only when incorporated in the context of meaningful “scientific activities”.

**Scientific Illustrations Recording Observations**

The purpose of scientific illustration is to depict as accurately and objectively as possible the typical characteristics of a recorded phenomenon and focus on its most essential aspects (Mikel, 2007). The history of science indicates that illustrations recording observations play a central role in the formulation of theories. Olson (1994, 2004) claims that the huge body of 16th century plant illustrations contributed to the development of systematic botanical knowledge of the structure and differentiation of plant species. Illustrations of specific plants were used as the basis for descriptions of “ideal” plant genera. Observations of the similarities and differences between different plant varieties led to the introduction of the taxonomy and morphology of plant species.
The link in Note 9 shows a video recording named “The Diversitv of Life” in which the biologist Edward Wilson is seen producing illustrations to record his observations of an ant. While looking at it through a microscope, he illustrated from different viewpoints a number of prominent characteristics that he considered important. He explained that a combination of several unique features would enable him to determine whether the newly discovered ant belongs to a separate biological species. Thus, illustration is as important a “working tool” to Wilson as his tweezers, camera and microscope – all tools which together constitute an integral part of his regular daily business and a means of achieving the goal of his scientific work.

Biology is no different than other sciences. In geology, illustrations of different ground formations have been used as the basis for models of calculation describing the processes that formed the earth’s surface (Ramadas, 2009).

Illustrations used to record observations may contribute also to children’s learning. Brooks (2003) described how a drawing of a butterfly chrysalis caused the young illustrator to look closely at the chrysalis and notice many details. Her observation formed the basis for questioning and the creation of new knowledge about larval development. A conversation about illustrations enables children to acquire new vocabulary to express verbally the knowledge acquired visually and kinesthetically, as active participants in the preschool enterprise. The activity of drawing the butterfly, taught the children the words larva and shed (as the butterfly larva shed its skin). A precise list of what the larva ate allowed them to perform systematic examination of their hypotheses: the larva was given a different type of food each time and the children discovered that it ate only mulberry leaves.

Below is an example taken from an ant observation exercise conducted by a student teacher during her practice at a Jerusalem preschool:

Several children are sitting around a table. Each child has a white Petri dish containing an ant, a magnifying glass, a pencil, pencil sharpener and eraser. They were instructed to look at the ant from above through the magnifying glass and try to get a good look at the parts of its body.

Student: We will start our drawings only after we have looked at the ant and made up our minds about how we want to go about drawing it.

Debbie, Child1: It has no hair. Its head is bald. Apart from its antennae … two legs and two antennae on its head!

Michelle, Child2: No, six!

Debbie: Wait a minute, I’ll count them … oh, right. Three on each side … shall we do the eyes?
Student: Draw whatever you see.

Debbie: But I didn’t see its eyes, only the ears. You can hardly see the neck…

Student: Does it have a neck?

Michelle: Here you are, I’ve finished. My ant is called “Tiko”. Look, it has three little circles, six legs and two antennae.

Student: What do you think? What are those circles?

Michelle: The middle circle is the stomach, the lower circle is its bottom and the circle at the top is the head …

Student names the ant’s body parts: head, thorax, stomach.

Debbie shows her drawing and adds that the ant also has eyes in its head.

Michelle: I didn’t see eyes, so I didn’t draw any.

Debbie: Of course it has eyes in its head, otherwise how will it see how to get home to its nest?

Figure 2.8a. Michelle’s ant
Figure 2.8b. Debbie’s ant
Both figures were drawn after close observation.

In the example of ant observation, illustration led to enriching vocabulary and knowledge of the ant’s body structure. The observation formed the basis for questions about how the ant sees and finds its way.

In a study by Gross and Teubal (2001), kindergarten children looked through a microscope at water seeping through grains of two different kinds of soil: sand and loam soil. They were asked to explain the two different outcomes of the water
seepage: water disappeared almost immediately after it was spilt on the sand, whereas it formed a small puddle on the loam soil. The very act of producing the illustrations focused their observations on the grains and allowed them to maintain their observations even after the microscope was no longer available. The illustrations made it easier to report the findings. For example, one little girl explained that “the sand has bigger holes” (as compared to loam soil). Her sand illustration represents sand particles by means of relatively large circles, representing granules of considerable size, through which water seeped, whereas the loam soil is represented as a large lump in which the additional small dots hint that the lump consists of very small particles to which the water adhered, making it less permeable (see Figure 2.9).

![Loam Soil and Sand Illustrations](image)

Figure 2.9. The “pictorial answers” of a preschool girl to the question: “Why does water disappear faster when it spills on sand than when it spills on loam soil?” (The illustrations were produced following observation through a microscope with magnification of x40.)

It is evident that the two explanations, each of them in a different modality, verbal and pictorial, complement each other. The gap, or mismatch (Goldin-Meadow, 2003) between these two explanations may be taken advantage of by educators as it points at the “zone of proximal development” (Vygotsky, 1978), inviting mediation: providing children with the adequate vocabulary (which enhances conceptualization) in order to verbally formulate their understanding.

**Scientific Illustrations as a Model for Processes and Structures**

Illustrations representing processes and structures appear in scientific texts as support for the informational content. By presenting concisely all elements of phenomena described in the text and their inter-relationships, illustrations can actually be more effective than verbal text. They are especially valuable when spatial information is conveyed.
The purpose of illustrations is better achieved if accompanied by a brief explanation and caption, designed to direct the reader to their meaning and draw attention to certain main components. Symbols directing attention, such as arrows, can likewise contribute to the reader’s understanding (Peeck, 1993). None of the illustration subgenres is transparent. They all require a certain degree of literacy. This is particularly the case regarding scientific illustrations. It is equally true for children, when viewing an illustration of the solar system (Ehrlén, 2009), for example; and for university students learning how to produce a graphic representation of chemical compounds (Pozo & Lorenzo, 2009).

Scientific illustration is not a depiction of reality, but a representation of the illustrator’s conceptualization of that reality. This means that the same reality can be represented in a variety of ways. The manner of presenting information can facilitate the execution of certain tasks or, conversely, make others more difficult. Schnotz and Bannert (2003) conducted a study in which they showed adult respondents’ illustrations representing the earth’s lines of latitude (and time zones). One group of respondents saw an illustration showing the planet shaped as a circle, as seen from the North Pole, while another group was shown an illustration outlining the planet’s continents across a rectangular table. The findings showed that, by comparison to reading a text with no illustrations, the first illustration (the circular representation) helped respondents answer a question relating to crossing through time zones, but made it harder for them to calculate the time at a specific point on the planet, after first being told the time at another point. The results with the second illustration (the rectangular table) were the exact opposite. However, as people acquire and retain more information on a subject, the impact of each individual model on the understanding and utilization of that knowledge is reduced (Schnotz & Kürschner, 2007).

Many studies have required participants to draw in order to reveal their conceptualizations of the depicted subjects (Best, Dockrell, & Braisby, 2006; Ehrlén, 2009; McGregor, Friedman, Reilly, & Newman, 2002; Vosniadou, 1994). When students are asked to produce their own scientific illustrations in the course of their studies, the information is processed in greater depth, but there is a risk of the illustration perpetuating erroneous conclusions (Peeck, 1993). In a teaching method known as “Talking Drawings” (McConnell, 1993), children are asked what they know about a particular subject before they learn it. The drawings and discussions about them reveal the children’s prior knowledge, based on the ideas and vocabulary they start out with (e.g. see Figure 2.10). Discussion of the drawings then opens a window onto the children’s thoughts and insights and allows educators to plan effective and appropriate instruction of the subject. As they learn, children are asked to talk among themselves about the various drawings, make observations, record them, write them down or make a new drawing of them. The process of recording or producing new drawings enables the children to combine their newly acquired knowledge with what they knew on the subject to begin with (for instance, settling the question of whether Planet Earth is round or flat). The drawings are open to discussion and rearrangement and serve as a tool in the shared social experience of fostering knowledge. The use of drawings increases
children’s motivation to study and helps even those who have difficulty writing to succeed. Thus, a mixture of debate, writing and drawing boosts use of the knowledge and vocabulary acquired during the study session and prevents them from merely turning into empty, automatic slogans (Acher & Arca, 2009; Brooks, 2003; Paquette, Fello, & Renck Jalongo, 2007).

Figure 2.10 shows a drawing by a five and a half year old girl prior to learning about the digestive system. The drawing shows that the child is aware of the existence of the body’s digestive tracts. However, according to the drawing liquids are separate from solids. It does not explain how the chocolate is digested inside the body and transformed into nourishing substances.

Figure 2.10. The passage of a cube of chocolate through the digestive system. (Illustration courtesy of Dr. Elvira Bar.)
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Figure 2.11 is a sketch that shows naphthalene smell being inhaled from a tube. The tube (on the left of the sketch) is emitting drop particles of odor (in the center), which reach the nose of the person smelling them (on the right). The wavy lines beneath the nose depict the inhalation process from the air. The nose is drawn in isolation, without the rest of the face. This omission is a product of the selective process: it gives up the realism of the drawing, but highlights the main subject.

CHILDREN’S ABILITY TO DISTINGUISH BETWEEN NARRATIVE ILLUSTRATIONS AND SCIENTIFIC ILLUSTRATIONS

A genre is a category of texts which serve a common social goal and have a characteristic structure which serves that goal (such as instruction manuals, argumentative or descriptive texts, etc.) (Halliday, 1994). The distinction between genres is a mainstay of the development of literacy, since genres are tools that facilitate the addressor’s goals. Identification of the genre to which a text belongs enhances interpretation. Yet the development of children’s ability to differentiate between genres and use them in a variety of contexts has not been studied very extensively (Blum-Kulka, Huck-Taglicht, & Avni, 2004). In order to ascertain the extent to which pre-school children are able to produce distinct narrative or scientific illustrations, Teubal and Guberman (2011) conducted a study in which children were asked to make two separate drawings:

(1) An illustration depicting as precisely as possible an ant placed in front of them for examination, so that the drawing could be used in the future to recall what the ant looked like. The process of making the drawing was mediated by the educator: the first step was making the purpose of the drawing clear to the children; next their attention was focused on the ant’s body parts – their number, size relative to each other, color, location. As a result of the educator’s mediation, the children paid closer and more prolonged attention than if they had worked on their own. However, they found the assignment demanding because it did not allow them to draw freely, as they were used to doing.

(2) An illustration of the ant in Aesop’s fable “The Ant and the Grasshopper.” Children were individually interviewed by one of the researchers in a quiet corner of the kindergarten two weeks after they had been told the story by the class educator. They were asked to retell the story. The interviewer wrote down their retold story and then asked them to tell what they particularly liked or disliked about the ant’s “personality” (e.g. stingy, energetic, cruel). After this, they were invited to illustrate their version of the story and were encouraged to try to show in their drawing the ant’s features deemed important by them.

The research questions were: Would preschoolers’ productions distinctly reflect the difference between the goals of the two tasks: portraying the ant’s protagonistic role vs. displaying the ant’s essential physical characteristics as an object of study? If so, was the distinction between the two genres, as the children sought to show, clear to adult observers only, or were other children also able to distinguish
between them when looking at drawings produced by their peers? Finally, what were the characteristics of those illustrations in which the distinction was evident?

The findings showed that both adults and four to six year old children were able to identify the different genres of illustrations (see Figures 2.12a and 2.12b). Scientific illustrations were more realistic than narrative ones. Narrative illustrations were larger and more colorful than scientific ones and contained more facial expressions and imaginary body parts for the ant (e.g. fingers and a nose), as well as a depiction of context (e.g. a house, fence or plants).

Each of the illustrations made by the children appeared to be the outcome of many complex considerations and choices that were influenced by the purpose of the illustration, the characteristics of each genre, esthetic considerations, conventions and other factors (e.g. see the design of the house in Figure 2.12b). The children, both in their role as producers and in their role as judges, differentiated between the two genres and the characteristic features of each. This was clear from both their illustrations and their judgements. The research findings indicate that different graphic genres can co-exist in the “toolbox” of children as young as four, without one canceling out the other. Introducing children to different genres enables them to see the same object from more than one viewpoint and be aware of the constraints defining each genre and its role for different socio-cultural purposes (meta-literate awareness). The findings indicate that introducing these two graphic genres, and perhaps even more, in a preschool setting, is a highly valuable and enriching experience.

Children have the ability to distinguish between scientific and narrative genres. This distinction serves to support both conceptualization and vocabulary enrichment processes. Below, several examples from kindergarten life illustrate the children’s ability and show how the educator substitutes deictic expressions used by the child with adequate content words. The examples are presented in the educator’s voice:
We went out into the garden to look at two eggplant seedlings that had leaves, buds, flowers and an actual fruit growing on them. We looked at the plant and all its different parts and I told the children we should try to remember the way the plant looks now, because it is constantly changing and growing, and we would follow its progress and come back again to see how it will grow and what will be different. I asked Raphael if he could see anything on the plant and he said “Eggplant”. I asked him to show where the eggplants come from and Raphael pointed to the stem and said “from here”. I replied, “That’s the stem, the eggplant grows from the stem.” Then I said, “Let’s see what other parts the plant has.” Raphael pointed to different parts and said, “Flower, leaf … and that.” I said, “Buds. The plant has flowers, leaves and buds.”

I started to draw the plant and asked Raphael: “Where do you want to start your drawing from?” He said: “From here,” pointing to the base of the stalk. He drew the stalk, then added a bud, saying: “I’m drawing the bud” (a word he had not known at the start of our conversation). I repeated after him: “You are drawing the bud. It is very important to draw the bud, because when we look at it again we will be able to see how that bud has developed.” Raphael then drew a leaf that was attached directly to the stalk and commented: “I’m drawing the leaf.” I reaffirmed: “Yes, it is important to draw the leaf. Let’s choose another leaf and see how it is attached to the stalk.” Raphael said: “It’s attached with a stalk.” I replied: “It is attached to the stalk by a small stem, the leafstalk.” We looked and saw that all the leaves were attached by a leafstalk. Raphael chose one from the top and another from the bottom. I asked him to draw the stalk, but he said “I don’t know how to.” I told him: “Look, the leaf is jagged, like teeth.” “Like this?” he asked, drawing a jagged line. I said: “You see, you are doing it.”

Next Raphael drew the elongated eggplant. I said: “Now you are drawing the elongated eggplant.” We looked at the sepals of the eggplant. I said: “Look at the size of the sepals,” and Raphael said: “They are bigger than those”, indicating the bud. I said: “Yes, they are. The sepals on the bud are smaller.”

Then he chose to draw the second plant too, with the more rounded eggplant. We talked about the differences between the two eggplants. Raphael said: “This one’s small and that one is big.” I said: “There are two different species of eggplant here: this species has an elongated shape, and this one is oval.” Raphael noticed the color of the eggplant and mentioned that it was shiny and smooth. He wanted to draw more leaves and I said we should draw other parts of the plant so that we will be able to remember and see how it would develop. The flower, for example: I pointed out the petals, the sepals and the stamens. He counted the petals and the stamens and said: “Its stamens are thick.” I said, “Yes, they are fleshy.”
It is interesting to compare the conversation that accompanied the production of the scientific illustration with the one which took place while illustrating a story immediately after it had been told. The difference is clearly seen in the following dialogue held by the same kindergarten education:

I told Raphael a story, *A Wedding in the Garden*\(^4\) and afterwards we talked about it. I asked what he thought about one of the characters, Grandfather Cucumber. Raphael said that Grandfather Cucumber insulted the eggplant and that this was not a nice thing to do. I said it really was not nice that he had insulted the eggplant, then I asked who he liked best out of all the "bridegrooms" and Raphael chose the eggplant. Throughout the conversation I used a language register appropriate to the pre-school age group. I used new words, such as “the behavior of the grandfather” and “the carrot was not respectful of the tomato’s opinions,” and “how would you feel if your opinion was not respected?” Raphael replied that he wouldn’t like it.

Raphael’s scientific illustration (see Figure 2.13a) was drawn with a high degree of precision. He observed detail, size and color and drew exactly what he saw. The narrative illustration (see Figure 2.13b), however, was influenced by his imagination. Raphael included items not featured in the story itself. He drew both vegetables with happy faces, and added legs and arms.
CHAPTER 2

ACTIVITIES WITH ILLUSTRATIONS

Activities with Student Teachers

Attitudes towards Children’s Drawings and Habitual Activities
The object of the following activity is to raise students’ awareness of the variety of attitudes held by educators towards children’s drawings.

Suggested Research: Students may interview kindergarten educators, school teachers and parents about their attitudes to children’s drawings. We refer readers to the article published by Rose, Jolley and Burkitt (2006) for ideas on possible interview topics. Students may also interview children about their opinions of the roles of drawing for them. Are there systematic differences between interviewees regarding those attitudes? Is it possible to learn from the interviews why children draw less frequently as they grow older? Is there a connection between the attitudes of adults and the range of kindergarten activities incorporating drawings?

Awareness of genres: The three activities suggested below are designed to increase students’ awareness of different drawing genres, their goals and their characteristics. The first two activities include hands-on experience of genres discussed in this chapter, and the third adds new genres.

Narrative Illustrations
We recommend choosing a children’s story-book about plants or animals (such as, The Wolf and the Seven Kids, Three Little Pigs, or The Very Hungry Caterpillar) and asking students to illustrate one of the scenes. How does the illustration combine real and imaginary details? Does it show anthropomorphism? How are the proportions between actual sizes represented? How many colors are used? How is the problem of three dimensional representation dealt with on paper by the illustrators?

The Contribution of Scientific Illustration to Observation and Communication
In this activity students are asked to observe and describe an insect or plant and formulate questions about them. Thereafter they are requested to observe and describe the same objects again, this time sketching as they do so. Does the actual act of drawing increase awareness of details not obvious on the first observation? Are there any extra details in the drawing that were not included in the verbal descriptions? Pay attention to the number of details, their location, their size ratios and the questions that arise following the observation.

Another procedure to foster awareness of the impact of drawing upon the process of conceptualization is presenting students who did not take part in the activity the verbal descriptions produced at both stages, the drawings and the combination of both and asking them to describe what the insect or plant look like. Which students provide a more precise and complete description?
Analysis of Illustrations
This activity consists of students looking at illustrated texts of different genres, which they have chosen themselves and are intended for different age groups. The analysis of the illustrations focuses on their size; location; color composition; whether the color composition is pleasing to the eye; the amount of information they contain; whether they emphasize or confuse the message; do they have captions? do the captions suit the illustrations? do they draw the readers’ attention to relevant details? does the text refer the reader to the illustrations? how? what information is learned from the illustration, from the text and from the combination of both?

Compare books from the point of view of their illustrations. Different books with the same content may be compared, or books of different genres. Examine the effect of the target age group on the above-mentioned variables.

Activities with Drawings and Illustrations in Preschool
It is crucial to bear in mind that children’s performance level is influenced, among other factors, by the nature of the instructions they are given and the quality of the mediation to which they are exposed. Therefore, the selected activities should help children grasp the goals the activities are designed to achieve and clarify how illustrations can help them achieve these goals. Hence we will try to expose them to a range of experiences with drawings and illustrations of various sub-genres, in contexts that allow children to be partners in activities that are meaningful to them.

Observation of Different Genres of Drawings and Illustrations
A comparison between illustrations of different genres can contribute to understanding the connection between the objective of the text and the characteristics of the accompanying illustration, as well as to distinguishing between illustrations of different genres. For instance, children might come across an illustration of a frog in a newspaper article, reporting how a bus driver stopped her bus to rescue a frog that was hopping along the road; in a fictional story about a prince turning into a frog; or as part of a scientific observation on the development of tadpoles in a puddle in winter. It is worthwhile to examine the characteristics of each genre of illustration (e.g. How big is the frog in relation to the whole picture? Which pictures give the frog a more anthropomorphic appearance? What color palette is used in the different genres?). It might also be useful to have children look at readily available pictures and choose those that are suitable to use as an illustration for each genre of text, explaining their choice.

Drawings with and without the Aid of Photographs
This activity is designed to provide children with a tool that helps to represent a three dimensional reality in a two dimensional surface. Photography is a convenient tool for this purpose. Take photographs of children as they engage in different activities in the kindergarten (photographs of objects or landscapes can also be used). The children will observe the photographs and draw themselves (or
some other photographed subject). There are a number of advantages to using photographs: as a two dimensional object they make it easier to represent reality on the page; they allow for prolonged observation of a reality which by definition changes rapidly (people and animals move, the wind blows through leaves, daylight and shadows change). Also, photographs enable children to observe themselves.

**Suggested Research:** Ask children and adults to draw an object from observation of the same object both in reality and in a photograph, and compare the results so as to evaluate the contribution of photographs to the attainment of two dimensional representations of three dimensional reality.

**Critical Reading Supported by Analysis of Illustrations**
Analyzing illustrations is meant to promote critical reading. Children may examine an illustration on a familiar text and express their opinion: Is the information in the illustration identical to that in the written text? What items appear in the illustration and not in the written text? What items are mentioned in the written text but left out of the illustration? Does the illustration complement the written text, contradict it, or is it perhaps irrelevant to it? Ask the children to provide an illustration of their own.

**Scientific Illustration as a Guiding Tool to Focus Observations**
Scientific illustration can enhance precise observation; hence it is of the utmost importance that illustrations be incorporated into the study of scientific subjects. For instance, following the growth and development of plants planted by the children in kindergarten; observing the life cycle of a silk worm; or conducting an experiment to investigate a preference for different foods by guinea pigs. Observation can benefit from adult supervision, in order to guide the children as to which details are worth examining and how to record what they see. For example, the number of seeds planted, what changes occur in the seeds during germination, how many seeds germinated in daylight and how many in the dark.

It is important for the children to take note of the different parts that comprise the objects under observation, their location, relative size, color, and so forth. The observation offers a valuable opportunity for the interaction between adults and children, leading to the substitution of deictic expressions so prevalent in children’s speech with scientific terms appropriate to the subject (e.g. calling the first growth of a plant the “shoot” instead of “that little thing”). When drawings produced during observations are kept in an easily accessible place, protected from wear and tear, they become re-usable whenever relevant. It is their consistent and frequent use which makes them meaningful.

Discussion on the subject allows for questions to be answered (e.g. what is the purpose of the shoot? what conditions are needed for rapid growth, and why?). The observations can also lead to more questions and further observations to be undertaken as a consequence of the original ones (e.g. Do guinea pigs that like carrots eat them even when they are cooked?). Long-term follow-up can be carried
out and comparisons of different conditions made (do guinea pigs eat the same amount of food in summer and winter?).

Observation records allow children to share with their peers (or other addressees) the results of observations conducted in their absence. Discussion of previous observations also offers a good opportunity to discuss the drawings: Is their meaning clear to children who did not make them? Is it clear to the children who made them after some time has elapsed since they were made and memory of the events has faded? If not, there are conclusions to be drawn: how to make records so that they will still be clear in the future, as well as to the children who were not present at the time of the observations. Unless the drawings and observations are used repeatedly, there is no point in going through the effort of preparing them.

In the case of children who are reluctant to draw, it might be possible to attain similar beneficial effects by encouraging them to engage in focused observations that enable them to direct the educator’s drawing – in the same way that educators usually mediate children’s drawings using words and gestures. While drawing, educators can echo the children’s instructions, and substitute deictic expressions used by them with appropriate content words. This allows educators to expose the children to the relevant vocabulary at the precise moment when they are focusing on its referents. In addition, the educator can add clarifying statements in order to draw the children’s attention to important characteristics.

Another option for children who avoid drawing is to have them produce their representation of the observed object in plasticine. This offers a similar opportunity for verbally mediated and focused observation.

**Suggested Research:** Compare children’s drawings before and after using plasticine.

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**The Impact of Illustrations on Text Comprehension**

The object of the last proposed activity in this chapter is to allow students to perform their own examination of whether narrative illustration advances children’s understanding of the text of a story.

**Suggested Research:** This study requires a minimum of two groups. The children in both groups will listen to the same story. One group will look at illustrations accompanying the text, and the other will not. Afterwards the children will be asked to illustrate the text or give both verbal and pictorial answers to various questions, such as: What does the main hero of the story look like? What does his house look like? Where did the story take place? The answers and illustrations could be compared for comprehension of the text and for the variety of ideas raised by the children. Scheuer, de la Cruz, Pozo, and Huarte (2009) provide an interesting example of interviews with children about their conceptions of the contribution of drawing to learning.
NOTES

1 There is a large body of literature addressing the contribution of drawings to emotional well-being (e.g., Malchiodi, 1988). For this reason we have chosen to concentrate primarily on the contribution of drawings to cognitive development.

2 It is commonplace to assume that the development of simpler concepts precedes that of complex ones. However, this is not always the case since there are additional factors crucial to concept learning, such as usage (Wittgenstein, 1953; Nelson, 2007).

3 It should be noted that in some contexts metaphorical use is made of both figurative drawings and spoken language. Such cases are second order symbols, e.g. a dove as a symbol of peace in both speech and drawing.

4 The contexts involve very different degrees of familiarity and experience.

5 See a more detailed description of the activity in the chapter on Maps.

6 Selected chapters of the Old Testament are part of the Kindergarten curriculum. Exodus 4:10 describes how God persuaded Moses to accept leadership. Moses expressed his reluctance, arguing that he was not “an eloquent man”: “Moses said to the Lord, ‘Pardon your servant, Lord. I have never been eloquent, neither in the past nor since you have spoken to your servant. I am slow of speech and tongue’”. The children were taught the standard Hebrew text (Massorah) in which Moses says literally: “I am not an eloquent man”.

7 With the aid of plastic-coated magnetic shapes laid on a metal board.


10 Edward Wilson is considered to be one of the founders of the theory of island biogeography, chemical communication, ecology and sociobiology.

11 A Petri dish is a shallow circular dish with a loose-fitting cover, used to culture bacteria or other microorganisms. It is named after the German bacteriologist Julius Richard Petri (1852-1921).

12 The fable, which first appeared in Aesop’s writings, relates that in the summer months, when food is plentiful, the ant stores food in an anthill, while the grasshopper plays. When winter arrives the hungry grasshopper goes to the ant for help, but is turned away and told to “keep on playing”.

13 A deictic expression indicates a referent rather than naming it. For example: this, that, there. Deictic expressions are frequently used by speakers who are not familiar with the appropriate context-specific terminology, or unused to using the specific terminology. Adult use of context-specific expressions enriches children’s vocabulary and enables them to express themselves accurately and clearly, even in the absence of supporting context. It is important to readily supply children with the appropriate terms rather than expect them to make the effort to retrieve them from their memories.

14 This is a story for preschoolers about a cucumber grandfather and his friend, a carrot, who are repeatedly trying to find a suitable match for the tomato (the cucumber’s grand-daughter). She rejects each of the proposed candidates (various vegetables, such as a potato and an onion) and falls in love with an eggplant, who is a black oriental prince. The eggplant is rejected by the grandfather and his friend but later, as a consequence of the protests of all the garden community, they recognize their mistake. The couple marries and has a child.

15 The Frog Prince by the Brothers Grimm.

16 It is a good idea is to keep the drawings in a clear plastic folder and file them in a ring binder, organized by subjects. This will allow the children to add later observations to the file and record processes over time. The ring binders should be kept somewhere accessible, so that the children are
able to look at them whenever they wish. Different subjects could be separated by colored dividers to make it easy for the children to find what they are looking for.

17 See above, for example, the educator’s suggestion: “Let’s choose another leaf and see how it is attached to the stalk”.

DRAWINGS AND ILLUSTRATIONS