Cognitive Development 43 (2017) 142–158

Contents lists available at ScienceDirect

Cognitive Development

From scribbling to drawing: the role of working memory

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ARTICLE INFO

Article history:
Received 25 July 2016
Received in revised form 5 January 2017
Accepted 6 March 2017

Keywords:
Drawing
Scribbling
Working memory
Toddlers
Neo-Piagetian models

ABSTRACT

This article presents a model of scribbling development, proposing that children's working memory capacity development constrains the acquisition of visual control, the development of form, and the attribution of meaning to one's own scribbles. An experiment with 86 participants (18–36 months old) is presented, using free drawing, drawing completion, and human figure drawing tasks, and the Imitation Sorting Task as a measure of working memory. Linear correlation, regression, and cross-classification prediction analyses are reported. The overall pattern of results supports our model, with particularly strong evidence for correlations between working memory capacity and drawing completion measures. An influence of drawing completion tasks on the subsequent human figure drawing was also found.

1. Introduction

What processes are involved in the transition from children's scribbling to representational drawing? A long-standing research stream describes children's developmental progress during the second and third year of life in their ability to control and coordinate motor and visual components of scribbling (Kellogg, 1969; Lowenfeld & Brittain, 1982; Machón, 2009). Representational drawing is more advanced than scribbling because it also involves meanings, using marks that stand for objects, and adjusting their shapes and arranging their placement in space so that they can have some analogy with the represented objects; it deals with intentions and interpretations. How can all this be put together? Around three, children start to communicate their intentions or interpretations about the marks they make on paper. However, the transition is not sudden; behaviors that can be described as "scribbling" or "drawing" are often mixed. Children around 30-36 months seem to have some representational competence, even though they do not yet show this competence in their habitual scribbling performance (Adi-Japha, Levin, & Solomon, 1998; Callaghan & Rochat, 2008; Jolley & Rose, 2008; Yamagata, 1997).

This article is concerned with the development of scribbling and the first steps of representational drawing, in the age range from 18 months to 3 years, focusing on the role of working memory. A role of working memory capacity in drawing development has already been demonstrated in older children (e.g., Case, Stephenson, Bleiker, & Okamoto, 1996; Dennis, 1992; Morra, 2005; Panesi & Morra, 2016; for reviews, see Morra, 2008a, 2008b). We are suggesting that working memory capacity has an essential role also at this earlier age range, because its growth enables the child to put together the various components (i.e., motor, visual, spatial, semantic, symbolic skills) involved in the emergence of drawing (Morra, 2008b). To test this idea, we used both recordings of children's behavior in unconstrained conditions, and tasks in which the representational intention is scaffolded by an incomplete drawing, which the child has to complete. The drawing data were

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http://dx.doi.org/10.1016/j.cogdev.2017.03.001
0885-2014/

related to the scores in a working memory task appropriate for this age range (Alp, 1992, 1994), with an individual-difference design.

1.1. Development from scribbling to drawing: cognitive underpinnings

There is a general consensus that children's drawing develops from disorganized scribbles to increasingly realistic representational forms (Cox & Parkin, 1986; Jolley & Rose, 2008; Kellogg, 1969). Luquet (1927) described four developmental phases of drawing realism: Fortuitous realism, Failed realism, Intellectual realism, and Visual realism; they are preceded by an initial phase, during which scribbling is a purely motor exercise. According to Luquet, at this point children have no representational intention, but rather they find visual and motor pleasure in scribbling. During the fortuitous realism phase, children give an interpretation after they have produced their graphic marks, but gradually they also come to express their representational intentions before or during their graphic performance. This leads to the emergence of Failed realism, when children appreciate their potential for symbolic representation. In this article we only consider the first phases.

Kellogg (1969) proposed an account influenced by Gestalt psychology, and posited four stages in the transition from scribbling to drawing: Pattern Stage (at about two years of age), Shape Stage (at about three years), Design Stage (between three and four) and Pictorial Stage (between four and five). In the first stage, children can coordinate the pen and the paper to produce marks; in the second stage, they produce simple forms called diagrams; in the third stage they put together more complex structures, called aggregates, which combine more diagrams; in the fourth stage, children finally produce representational drawings.

In the seventies, the "cognitive revolution" stimulated a shift from descriptive to process-oriented studies; memory, attention, problem solving were considered in explaining particular drawing characteristics. Freeman (1980) pointed out young children's limited planning ability, and studied experimentally the attentional biases that influence their production of drawings and the ways they try to solve representational problems. Golomb (1974) examined differences in children's ability to access stored information. Freeman (1980) was probably the first who used drawing completion paradigms, which enable the researcher to control closely the experimental tasks and define precisely which abilities (or biases) are tapped in each condition.

Some studies suggested a role of working memory capacity in older children, such as 4–10 years (Dennis, 1992) or 6–11 years (Morra, Moizo, & Scopesi, 1988). The role of working memory limited capacity in toddlers' drawing has not yet been studied empirically. However, Morra (2008b) proposed a theoretical account of early drawing development, based on two constructs: schemes and attentional resources. In this article, we attempt to validate that model.

1.2. Schemes and working memory in early development of children's drawing

Working memory is generally defined as a system that holds the information that a person needs to process and use in an ongoing task; in the recent decades, the prevailing theoretical model of working memory views it as the activated subset of long-term memory, with a major role for attentional resources that keep the relevant representations activated (Cowan, 1988). In particular, Cowan (2001) proposed that adults' working memory capacity is limited to four chunks of declarative memory, and children have an even smaller capacity. The proposal of this particular limit is widely debated (e.g., Morra & Patella, 2012); however, we must consider that Cowan's model does not refer to sensorimotor representations, but to the capacity of a system that attends to, maintains, and processes symbolic representations. Most current models of working memory development only apply to children who have already achieved symbolic representation. To account for scribbling development, however, we cannot refer to the more abstract units or memory chunks that are considered in most current models, but we must turn to theories that also model the attentional resources that a very young child can allocate to sensorimotor representations.

In the Piagetian and neo-Piagetian literature, a distinction is often made between figurative and operative schemes. Figurative schemes represent objects, concepts, and states, whereas operative schemes represent actions, transformations, and mental operations. Schemes can be activated by various sources, including attentional resources, which are supposed to be limited. Within neo-Piagetian frameworks, this limitation is often referred to as a person's working memory or M capacity. Specifically, in Pascual-Leone's Theory of Constructive Operators (Pascual-Leone, 1970, 1987) the term M capacity indicates the maximum number of schemes that a person can activate simultaneously with central attentional resources. Cowan's and Pascual-Leone's theory are strikingly similar because they both assume that working memory capacity is limited by the amount of domain-free resources that can be used to activate basic cognitive units, such as chunks or schemes. Regarding, in particular, the very first years of life Pascual-Leone and Johnson (1991) proposed an account of M capacity growth and its use with sensorimotor schemes. For instance, Piaget's primary circular reaction involves keeping a single scheme activated; performing the object permanence task without committing the A-not-B error would require co-activation of four sensorimotor schemes. According to this model, a typical two-year-old could co-activate up to six sensorimotor schemes for the most complex activities that are performed at this age.

Morra (2008a, 2008b) argued that M capacity sets an upper limit to drawing performance; young children can only activate few sensorimotor schemes at a time. Morra (2008b) proposed that uncontrolled scribbling, typical at about 18 months, requires coordinating five sensorimotor schemes, two of which are operative and three figurative. The figurative schemes involved are (a) a pencil, (b) the target surface, (c) the point of the pencil, which must be in contact with the target