Journal of Experimental Child Psychology 152 (2016) 1–11

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Drawing a dog: The role of working memory and executive function

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ARTICLE INFO

Article history:
Received 22 April 2016
Revised 29 June 2016

Keywords:
Drawing flexibility
Children's drawing
Working memory capacity
Executive function
Neo-Piagetian models
Preschoolers

ABSTRACT

Previous research suggests that young children draw animals by adapting their scheme for the human figure. This can be considered an early form of drawing flexibility. This study investigated preschoolers' ability to draw a dog that is different from the human figure. The role of working memory capacity and executive function was examined. The participants were 123 children (36–73 months old) who were required to draw both a person and a dog. The dog figure was scored on a list of features that could render it different from the human figure. Regression analyses showed that both working memory capacity and executive function predicted development in the dog drawing; the dog drawing score correlated with working memory capacity and executive function, even partialling out age, motor coordination, and drawing ability (measured with Goodenough's Draw-a-Man test). These results suggest that both working memory capacity and executive function play an important role in the early development of drawing flexibility. The implications regarding executive functions and working memory are also discussed.

Introduction

How is the development of drawing ability related to the general development of the cognitive system during childhood? Drawing research often has focused on task-specific or contextual variables or on developmental trends in a specific drawing task. Only few studies have focused on how drawing

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http://dx.doi.org/10.1016/j.jecp.2016.06.015
0022-0965/

development is affected by the development of general abilities or domain-general components of the cognitive system; these studies suggest in particular a role of planning ability (Freeman, 1980), working memory capacity (Dennis, 1992; Morra, 2008a, 2008b), and inhibitory control (Freeman & Adi-Japha, 2008; Riggs, Jolley, & Simpson, 2013) in children's drawing development.

Human figure drawing is an extensively studied drawing task (Cox & Parkin, 1986; Freeman, 1980; Goodenough, 1926; Lange-Küttner, Kerzmann, & Heckhausen, 2002). During an early stage of drawing development, children typically use a single shape to represent both the head and the trunk and often include only a single pair of limbs; at the end of preschool, they often differentiate the head from the trunk and depict both arms and legs. Although human figure drawing has been widely investigated, few studies have investigated the development of drawing animal figures (e.g., Lurçat, 1985). Silk and Thomas (1986) suggested that young children (3–6 years old), after having acquired a typical and schematic way to represent a person, may acquire the graphic scheme for a dog by differentiation from the human figure; Golomb (1992) provided converging evidence from young children's drawings of other animals. Consistent with Silk and Thomas's (1986) view, both Reith (1988) and Morra (2005) found that schoolchildren's drawings of a kangaroo are highly affected by their habitual scheme for the human figure.

Children's ability to modify their habitual drawing schemes is often referred to as "drawing flexibility," a term related to the more general concept of flexibility as an ability not to follow in a rigid way an established routine or scheme. Some studies have considered whether cognitive flexibility can be regarded as a general ability in children, but the results so far do not support this view (Déak & Wiseheart, 2015). In the domain of drawing, the term "flexibility" usually refers to a task in which a child has a dominant graphic scheme available and is required to make changes to it such as drawing a person who makes specific movements (Goodnow, 1978) or a person who "does not exist" (Karmiloff-Smith, 1990). If drawing schemes for animals are initially differentiated from the human figure scheme, then explaining children's creation of new schemes to draw animals can be regarded as an important achievement in the field of drawing flexibility.

Explaining drawing flexibility, however, is a controversial matter. At least three accounts have been proposed, all of which are related to different aspects of general cognitive development. An early account was proposed by Karmiloff-Smith (1990) in the context of her Representational Redescription theory. Karmiloff-Smith suggested that preschoolers are constrained by procedural rigidity; that is, they do not have access to their drawing procedures and, therefore, are not able to interrupt a habitual drawing procedure to make a novel drawing. Subsequent research (Barlow, Jolley, White, & Galbraith, 2003; Berti & Freeman, 1997; Spensley, 2001; Spensley & Taylor, 1999), however, reported evidence falsifying Karmiloff-Smith's account because preschoolers seem to have access to their drawing procedures. In particular, these studies showed that young children can insert novel items midway through a drawing procedure and can produce a flexible drawing if the instructions and materials make it clear to them what type of modification is required. Karmiloff-Smith (1999), in a reply to Spensley and Taylor (1999), acknowledged that young children's drawing procedures are not as rigid as she initially hypothesized.

A different account of drawing flexibility was proposed by Morra (2005, 2008a) in the framework of neo-Piagetian theory (e.g., Pascual-Leone & Johnson, 2005). This approach maintains that working memory growth has a central role in cognitive development; in particular, its capacity can set an upper limit to drawing performance. In this theoretical framework, a central attentional resource that can activate cognitive units or schemes is considered as the core of working memory; the term "M capacity" indicates the size of this attentional resource, which is assumed to increase steadily from infancy to adolescence (Pascual-Leone, 1987).

Morra (2005) hypothesized that working memory is essential in drawing flexibility because the child must keep in mind, in addition to a habitual scheme, its feature(s) that must be modified and the graphic devices that could represent those modifications. Specifically, Morra examined the role of M capacity in drawing flexibility with children in the age range from kindergarten to Grade 3. Two experiments concerned drawing a human figure in movement, and a third experiment required creating a novel scheme for drawing an unfamiliar animal (a kangaroo). The results showed that, in this age range, working memory capacity was highly relevant both to modify the human figure scheme to represent specific movements and to differentiate a kangaroo from the human figure.