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# The development of cognitive flexibility beyond the preschool period: An investigation using a modified Flexible Item Selection Task



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### ABSTRACT

We explored the development of cognitive flexibility in typically developing 6-, 8-, and 10-year-olds and adults by modifying a common cognitive flexibility task, the Flexible Item Selection Task (FIST). Although performance on the standard FIST reached ceiling by 8 years, FIST performance on other variations continued to improve until 10 years of age. Within a detailed task analysis, we also explored working memory storage and processing components of executive function and how these contribute to the development of cognitive flexibility. The findings reinforce the notion that cognitive flexibility is a multifaceted construct but that the development of working memory contributes in part to age-related change in this ability.

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### Introduction

Cognitive flexibility describes the ability to begin solving a problem in one way and to then shift to solving the same problem in a different way. Despite this simple description, a more precise characterization of the principal cognitive processes that comprise cognitive flexibility has remained elusive (Cragg & Chevalier, 2012; Deak, 2004; Dick & Overton, 2010). This is because the standard tasks proposed to assess cognitive flexibility are likely simultaneously assessing multiple component executive functions (Hughes & Graham, 2002; Miyake et al., 2000), and it has been difficult to define and parse

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each of these components. In addition, there has been a renewed interest in characterizing the development of cognitive flexibility and other executive functions beyond the preschool period (Cragg & Chevalier, 2012), a period that has to date received the most attention (Best, Miller, & Jones, 2009; Garon, Bryson, & Smith, 2008). Here we addressed both issues. We conducted a focused analysis of cognitive flexibility development with an emphasis on the contributions of working memory, and we did so by adapting a Flexible Item Selection Task (FIST) developed by Jacques and Zelazo (2001) so that it remains sensitive to development in cognitive flexibility beyond the preschool period.

Classic investigations of cognitive flexibility have made use of several tasks, the most prominent of which is the Wisconsin Card Sorting Test (WCST; Berg, 1948; Grant & Berg, 1948). In this task, participants must sort picture cards by one dimension (e.g., color) and then switch to sort the cards by a different dimension that is guessed from experimenter feedback. The WCST has also been modified for preschool children (i.e., as the Dimensional Change Card Sort [DCCS]; Frye, Zelazo, & Palfai, 1995) by using fewer cards and by making the sorting rule explicit. Developmental investigations of the WCST and DCCS have revealed some surprising results. Despite success on the DCCS at around 4½ years of age, children have difficulty in performing the basic task requirements of the WCST until around 6 years of age, and when they do meet these requirements they make perseverative errors on a level identical to that of adults with prefrontal lesions, failing to perform at a normal adult level until around 10 years of age (Chelune & Baer, 1986; Chelune & Thompson, 1987; Crone, Ridderinkhof, Worm, Somsen, & van der Molen, 2004; Kirk & Kelly, 1986; Paniak, Miller, Murphy, & Patterson, 1996; Rosselli & Ardila, 1993; Welsh, Pennington, & Groisser, 1991). In addition, rather than the rapid change in success found between 3 and 4½ years of age on the DCCS (i.e., children tend to either pass or fail the task), improvement on the WCST is gradual (Chelune & Baer, 1986; Crone et al., 2004). More difficult variations of the DCCS also show age-related improvement across childhood, but these are not appropriate for preschool children (Zelazo, Craik, & Booth, 2004).

Another addition to this family of sorting tasks, and the focus of the current study, appears to measure cognitive processes similar to those of the WCST and DCCS. This task, called the Flexible Item Selection Task (Blair, Peters, & Granger, 2004; Blair & Razza, 2007; Jacques & Zelazo, 2001), requires participants to abstract a relevant matching dimension and to switch flexibly to a new matching dimension. In the standard FIST (referred to here as a 2-Match FIST), a child is presented with three objects, and they must select two objects that match in one way (i.e., the first selection). Thus, the child must abstract out a relevant dimension on which two objects are alike. For example, the child might be shown the following cards: one large red rabbit (Card 1), one large blue rabbit (Card 2), and one large blue boat (Card 3). The first abstraction could be accomplished by considering two cards in relation to a third card (e.g., Cards 1 and 2 are the same shape, which is different from Card 3). Next the child must flexibly abstract and switch to a second dimension. For example, for the second selection, the child must select two other objects that match in a way that is not like the third object (e.g., Cards 2 and 3 are the same color, which is different from Card 1).

Jacques and Zelazo (2001) conducted the first developmental investigation of the FIST. In their study, the authors assessed children on tasks containing two relevant dimensions (i.e., a 2-Match FIST) and reported the following pattern of development. First, 2-year-olds are unable to pass the criterial measures of the task. Second, relative to their older peers, most 3-year-olds show poor performance on both the first selection and the second selection. Third, 4-year-olds show good performance on the first selection but have difficulty in switching to the second selection. Fourth, 5-year-olds can flexibly abstract the relevant dimension of the first selection and perform better at the second selection than their younger peers. However, 5-year-olds are still performing only at 50% on the second selection and do not approach ceiling performance until 6 years of age (Yerys, Wolff, Moody, Pennington, & Hepburn, 2012).

The DCCS, WCST, and FIST share surface similarities (i.e., they all require sorting cards by perceptual dimensions), but it is unclear which specific skills are necessary for success on these tasks. Although children are able to successfully navigate the DCCS by 4½ years of age, they have considerable difficulty on the WCST for quite some time afterward. No extensive investigation of the FIST has been conducted beyond the preschool and early school-age period; thus, the developmental pattern beyond these years is unknown. This developmental question was explored in the current study. The existing literature investigating developing cognitive flexibility beyond the preschool period

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