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How do alternative ways of responding influence 3- and 4-year-olds' performance on tests of executive function and theory of mind?

Daniel J. Carroll [a,*], Kevin J. Riggs [b], Ian A. Apperly [c], Kate Graham [c], Ceara Geoghegan [a]

[a] Department of Psychology, University of Sheffield, Western Bank, Sheffield S10 2TN, UK
[b] Department of Psychology, University of Hull, Hull HU6 7RX, UK
[c] School of Psychology, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK

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ABSTRACT

A total of 69 preschool children were tested on measures of false belief understanding (the Unexpected Transfer task), inhibitory control (the Grass/Snow task), and strategic reasoning (the Windows task). For each task, children indicated their response either by pointing with their index finger or by using a nonstandard response mode (pointing with a rotating arrow). The means of responding had no effect on children's performance on the Grass/Snow task or on the Unexpected Transfer task, although children performed better on the Unexpected Transfer task when the key object in the story was removed. In contrast, performance on the Windows task was significantly better when children pointed with the rotating arrow. A follow-up experiment with 79 preschoolers found that this improved performance on the Windows task was sustained even after the nonstandard response mode was removed and children again pointed with their finger. These findings together suggest that nonstandard response modes do not help children to inhibit prepotent pointing responses but may help them to formulate response strategies on reasoning tasks by discouraging unreflective impulsive responding.

* Corresponding author. Fax: +44 114 276 6515.
E-mail address: d.carroll@sheffield.ac.uk (D.J. Carroll).

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Introduction

It is widely recognized that 3-year-olds have great difficulty in situations that require them to make a response that goes against their initial tendency or inclination. For example, children of this age have difficulty in postponing immediate gratification in order to obtain a larger reward later (e.g., Mischel, Shoda, & Rodriguez, 1989; Moore, Barresi, & Thompson, 1998). They have difficulty in controlling their tendency to give away the right answer in a game where their task is to deceive an opponent (e.g., Sodian, 1994). They find it difficult to respond to questions about other people's knowledge states when those states do not match up with their own (e.g., Wellman, Cross, & Watson, 2001). They also have substantial difficulty in learning to point to an empty box in order to be left with a second box containing a reward even over 20 repeated trials (Russell, Jarrold, & Potel, 1994). Understanding how children learn to overcome these problems to produce flexible goal-directed behavior informs us about their developing executive function. One way that has been found to help children overcome these difficulties is by changing the way in which they indicate their response. In the current study, we investigated the means by which nonstandard response modes (e.g., indicating a response by rotating an arrow rather than pointing with the hand) enhance children's ability to act on tasks that require them to respond in a counterintuitive manner.

One particularly informative paradigm in this regard is the Windows task, a test of children's strategic reasoning developed by Russell, Mauthner, Sharpe, and Tidswell (1991). Preschool children were presented with two closed boxes, one of which contained a treat (a candy or a sticker). During a training phase, children were taught that whichever box they pointed to would be taken away and given to an opponent, leaving them to open the box that remained. Once children had shown that they understood this rule, the opaque boxes were replaced with boxes that had windows cut into the side. By looking through the windows, children were able to see which box contained the treat. Children needed to infer that—under the task rules that the opponent took the box to which they pointed—they could now win the treat on every trial if they pointed to the empty box. However, nearly all of the 3-year-olds in Russell and colleagues' study failed to do this on the first trial, pointing instead to the box with the treat—and a majority of the children continued to point to (and therefore lose) the treat on all 20 test trials. Similar results have been observed in a number of other studies (e.g., Hala & Russell, 2001; Hughes & Russell, 1993; Russell, 1996; but see Russell, Hala, & Hill, 2003, and Samuels, Brooks, & Frye, 1996).

Although children's difficulty with tasks of this nature appear to be remarkably robust, a number of studies have shown that children's difficulties can be substantially reduced by changing the means by which they give their response. Carlson, Moses, and Hix (1998) used a paradigm somewhat similar to the Windows task in which children were encouraged to indicate the wrong box for an experimenter to open. When children indicated their chosen box by pointing with their hand, they performed relatively poorly (an average of 0.6 correct responses out of 3 attempts). In contrast, when children responded by placing a marker on their chosen box or by pointing to a box using a rotating arrow, their performance was significantly better (an average of 1.8 correct responses out of 3 attempts). Children who responded by pointing with an arrow were significantly more successful at indicating the empty box than children who pointed with their hand, and this benefit was apparent from the very first trial. Performance on the Windows task was also improved when children responded with an arrow or a marker (Hala & Russell, 2001). The authors of these two studies offered very different explanations for how this response mode effect arises. But although this question remains to be resolved, there is agreement on the basic finding that nonstandard response modes improve children's performance. Importantly, although these tasks are often glossed as requiring children to trick an opponent, there is direct evidence that deception in particular, and "theory of mind" in general, is not the source of children's difficulty. Russell and colleagues (1994) found no difference in children's error rates between versions of the Windows task that involved deception and versions that did not, and subsequent studies have confirmed that children have difficulty on the Windows task when there is no opponent to deceive (Carroll, Apperly, & Riggs, 2007a, 2007b). Thus, although Carlson and colleagues (1998) found that an arrow assists children's performance on a test of strategic deception, there are grounds for thinking that the arrow did not help children with the deceptive component of the task.