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## Testing the validity of a continuous false belief task in 3- to 7-year-old children

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### ARTICLE INFO

#### Article history:

Received 1 June 2016

Revised 13 March 2017

#### Keywords:

False belief

Theory of mind

Inhibition

Early childhood

Validity

Continuous measurement

### ABSTRACT

In two studies, we examined young children's performance on the paper-and-pencil version of the Sandbox task, a continuous measure of false belief, and its relations with other false belief and inhibition tasks. In Study 1, 96 children aged 3 to 7 years completed three false belief tasks (Sandbox, Unexpected Contents, and Appearance/Reality) and two inhibition tasks (Head–Shoulders–Knees–Toes and Grass/Snow). Results revealed that false belief bias—a measure of egocentrism—on the Sandbox task correlated with age but not with the Unexpected Contents or Appearance/Reality task or with measures of inhibition after controlling for age. In Study 2, 90 3- to 7-year-olds completed five false belief tasks (Sandbox, Unexpected Contents, Appearance/Reality, Change of Location, and a second-order false belief task), two inhibition tasks (Simon Says and Grass/Snow), and a receptive vocabulary task (Peabody Picture Vocabulary Test). Results showed that false belief bias on the Sandbox task correlated negatively with age and with the Change of Location task but not with the other false belief or inhibition tasks after controlling for age and receptive vocabulary. The Sandbox task shows promise as an age-sensitive measure of false belief performance during early childhood and shows convergent and discriminant validity.

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## Introduction

For the past 40 years, young children's theory of mind (ToM) has been predominantly measured by standard false belief tasks (Gopnik & Astington, 1988; Premack & Woodruff, 1978; Wellman, 1990; Wellman, Cross, & Watson, 2001; Wellman & Liu, 2004; Wimmer & Perner, 1983). In a standard false belief task, such as Change of Location, children learn about two characters who initially share knowledge about the location of a ball in a box. The first character then leaves the room, and while she is gone a second character moves the ball to the basket. When the first character returns, children are typically asked two types of questions, namely, where will the first character look for the ball? (in the box or the basket; false belief question) and where is the ball really? (memory control question). To pass the false belief question, children must appreciate that the first character holds a false belief about the item's location because she did not observe the movement of the ball by the second character. Children must also inhibit their own knowledge of the item's true location to pass the false belief question. Finally, children's responses are scored as pass or fail depending on whether they can answer both the false belief and memory control questions (Baron-Cohen, Leslie, & Frith, 1985; Wimmer & Perner, 1983).

Researchers have suggested moving away from these pass/fail false belief tasks (Birch & Bloom, 2007; Bloom & German, 2000) because (a) they require abilities other than ToM, such as inhibitory control, working memory, and language (e.g., Carlson & Moses, 2001; German & Leslie, 2000; Milligan, Astington, & Dack, 2007; Riggs, Peterson, Robinson, & Mitchell, 1998; Roth & Leslie, 1998), and (b) ToM involves abilities beyond understanding false beliefs, such as emotion understanding, the ability to imitate intended and completed actions, modifying one's behavior based on others' knowledge states, and detecting agency in non-animate objects that move as if they were animate (e.g., Carpenter, Akhtar, & Tomasello, 1998; Johnson, Slaughter, & Carey, 1998; O'Neill, 1996). The field, however, has persisted in the use of such tasks. These false belief tasks are able to detect age-related changes in false belief understanding between 3 and 5 years of age; however, they are of limited utility beyond 5 years once children can pass such tasks. Accordingly, the need for new ToM tasks has been identified, and some new measures have been developed (Begeer, Bernstein, van Wijhe, Scheeren, & Koot, 2012; Bloom & German, 2000; Devine & Hughes, 2013; Dumontheil, Apperly, & Blakemore, 2010; Lagattuta, Sayfan, & Harvey, 2013; Peterson, Wellman, & Slaughter, 2012; Sommerville, Bernstein, & Meltzoff, 2013; Tahiroglu et al., 2014).

For example, a continuous measure of preschoolers' false belief understanding that diverges from the typical pass/fail scoring of standard false belief tasks has recently been introduced. The "Sandbox task" yields a continuous score that indexes children's false belief bias (Begeer et al., 2012; Sommerville et al., 2013). This score measures how biased children are by the *true* location of an object when they reason about a person's *false belief* about the location of the object. In the real-object version of the Sandbox task, children are placed in front of a three-dimensional box and hear a story about a protagonist who puts an object in one location (L1). Then, while the protagonist is absent, a second character moves the object to a second location (L2). Children are then asked the critical false belief question of where the first protagonist will look for the object when he returns. To answer this question, children point to where the protagonist will look for the object in the sandbox rather than selecting one of two options of where the protagonist will look as is typical in standard false belief tasks (e.g., in the box or in the basket). Based on the difference between their response and the location where the first protagonist should look (L1), children receive a false belief bias score (measured in centimeters or millimeters). This continuous measure of false belief has important advantages as compared with a dichotomous choice because it does not treat false belief understanding as an all-or-none phenomenon. Furthermore, the task has the potential to detect more subtle development of false belief understanding when comparing children under and over 5 years of age.

Begeer and colleagues (2012) and Coburn, Bernstein, and Begeer (2015) developed a paper-and-pencil version of the Sandbox task in which children (aged 6 years and older) and adults viewed a picture of the sandbox (Fig. 1) rather than a three-dimensional object. In this version, an "X" was marked to show where the protagonist placed the object and then where the second character moved the object while the protagonist was gone (these marks remained visible during the story). Children then

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