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Deaf children's use of clear visual cues in mindreading



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ABSTRACT

Previous studies show that typically developing 4-year old children can understand other people's false beliefs but that deaf children of hearing families have difficulty in understanding false beliefs until the age of approximately 13. Because false beliefs are implicit mental states that are not expressed through clear visual cues in standard false belief tasks, the present study examines the hypothesis that the deaf children's developmental delay in understanding false beliefs may reflect their difficulty in understanding a spectrum of mental states that are not expressed through clear visual cues. Nine- to 13-year-old deaf children of hearing families and 4–6-year-old typically developing children completed false belief tasks and emotion recognition tasks under different cue conditions. The results indicated that after controlling for the effect of the children's language abilities, the deaf children inferred other people's false beliefs as accurately as the typically developing children when other people's false beliefs were clearly expressed through their eye-gaze direction. However, the deaf children performed worse than the typically developing children when asked to infer false beliefs with ambiguous or no eye-gaze cues. Moreover, the deaf children were capable of recognizing other people's emotions that were clearly conveyed by their facial or body expressions. The results suggest that although theory-based or simulation-based mental state understanding is typical of hearing children's theory of mind mechanism, for deaf children of hearing families, clear cue-based mental state understanding may be their specific theory of mind mechanism.

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1. Introduction

It is difficult to understand other people's mental states and to predict their behavior. This ability, namely "theory of mind" (Premack & Woodruff, 1978), is difficult to acquire because mental states per se are invisible and must be inferred. By the age of approximately 4, typically developing children can infer other people's false beliefs (Wellman, Cross, & Watson, 2001). Deaf children of deaf families perform identically to hearing children on standard false belief tasks (Peterson & Siegal, 1999; Schick, de Villiers, de Villiers, & Hoffmeister, 2007), and thus their theory of mind normally develops. However, it is challenging for deaf children of hearing families to gain insight into others' mental worlds. Although deaf children of hearing families can freely attribute mental states to others in storytelling tasks at the age of 9 (Marschark, Green, Hindmarsh, & Walker, 2000), they have

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difficulty in standard false belief tasks until the age of approximately 13 (O'Reilly, Peterson, & Wellman, 2014; Peterson & Siegal, 1995; Russell et al., 1998; Wellman & Peterson, 2013). Thus, it is suggested that 9–13-year-old deaf children of hearing families have an awareness of mental states but still fail to infer mental states precisely. Their theory of mind has not matured as much as that of typically developing children over 4.

Theory of mind delay in deaf children of hearing families is manifested mainly in the understanding of false beliefs. Numerous studies demonstrate that the deaf children perform poorly on standard false belief tasks (Courtin & Melot, 2005; de Villiers & de Villiers, 2012; Moeller & Schick, 2006; Peterson, 2002; Peterson & Siegal, 1999; Peterson & Slaughter, 2006; Schick et al., 2007). However, they perform relatively better on theory of mind tasks that assess the understanding of desires and intentions (Rhys-Jones & Ellis, 2000; Scott, Russell, Gray, Hsieh, & Hunter, 1999; Want & Gattis, 2005). Are false beliefs more difficult to understand than desires or intentions for deaf children of hearing families? Wellman and Liu (2004) asked typically developing preschoolers to complete different theory of mind tasks, and found that their understanding of desires preceded their understanding of false beliefs. Peterson, Wellman, and Liu (2005) demonstrated a similar developmental sequence of theory of mind in deaf children of hearing families. Moreover, studies on maternal talk show that mothers' mental state talk is consistent with children's theory of mind developmental progression. Mothers first frequently talk about desires and then their desire language decreases, whereas their belief language increases over time (Taumoepeau & Ruffman, 2006, 2008). Previous studies provide solid evidence that understanding of desires is easier and develops before understanding of false beliefs. However, the reason why false beliefs are more difficult to understand needs to be further clarified. The discrepancies between understanding of different types of mental states lie not only in whether the mental states to be understood are beliefs, desires or intentions but also in whether these mental states are implicit or explicit. In standard false belief tasks, the protagonist's false belief is completely implicit and must be understood through reasoning or simulation. In the desire or intention understanding task (Scott et al., 1999), for example, the protagonist's desire or intention is clearly expressed through his or her eye-gaze direction. Therefore, it is not false beliefs per se that are more difficult to understand than desires or intentions for deaf children of hearing families but mental states without clear cues that are harder to comprehend than those with clear cues. In other words, deaf children of hearing families seem incapable of understanding a spectrum of mental states that are not expressed through clear cues.

It is theoretically important to investigate mental state understanding under different cue conditions in deaf children of hearing families. With respect to the mechanisms of theory of mind, there have been some predominant perspectives. According to the "theory theory" (Gopnik & Meltzoff, 1997; Gopnik & Wellman, 1994), folk psychology as a theory is used for mental state reasoning. The theory involves a body of knowledge about the mind, including the causal relationships among various mental states and behavior. Another theory, the "simulation theory" (Harris, 1992), emphasizes that an individual gains insight into others' mental states by imagining what he or she will think if placed in the situation of others. Although the inferences are based on different processes according to the mechanisms above, both of these mechanisms are particularly used to infer implicit mental states. Conversely, when mental states are expressed through clear cues, they are completely explicit and thus can be easily understood without complex reasoning or simulation. If 9–13-year-old deaf children of hearing families show the competence to infer mental states with clear cues, it suggests that clear cue-based mental state understanding may be another theory of mind mechanism that is dissociated from theory-based and simulation-based mental state understanding. More importantly, for deaf children of hearing families, clear cue-based mental state understanding may be their specific theory of mind mechanism.

Because language development is severely delayed in deaf children of hearing families (Lederberg, Schick, & Spencer, 2013; Schick et al., 2007), the deaf children are likely to be more sensitive to visual cues than to linguistic cues of mental states. Few empirical data are available regarding deaf children's understanding of mental states with visual cues. Pellicano and Rhodes (2003) explored the role of clear visual cues in the understanding of false beliefs in typically developing children. In their experiment, the protagonist's false belief was clearly expressed via her eye-gaze direction. The results showed that 3-year-olds performed significantly worse than 4-year-olds in the eye-gaze cue condition, which suggests no facilitative role of clear visual cues in typically developing 3-year-olds' false belief understanding. However, several explanations may be considered. First, the notably different performances of the two groups are most likely due to their language skill gap; thus, controlling for the effect of language abilities is a necessity. Second, it is not clear whether young children pay attention to the protagonist's eye-gaze direction. Therefore, control questions should be asked to ensure their attention to the visual cues. In addition, some studies have examined deaf children's understanding of emotions with clear visual cues but have found mixed results. For example, Hsieh, Gray, Russell, Scott, and Hunter (1998) demonstrated that deaf children of elementary school years were able to recognize other people's emotions that were expressed through their facial expressions. Dyck, Farrugia, Shochet, and Holmes-Brown (2004) found similar performance on the Emotion Recognition Scale in hearing-impaired children and hearing children matched for verbal ability. Nevertheless, poor performance of deaf children on a facial expression-based emotion recognition task was observed in Ludlow, Heaton, Rosset, Hills, and Deruelle's (2010) study. More evidence is needed to indicate whether clear cue-based mental state understanding is the specific theory of mind mechanism for deaf children of hearing families.

The present study aimed to investigate mental states understanding under different cue conditions in deaf children of hearing families. The deaf children's performances on false belief tasks under different cue conditions were first examined to clarify whether they could understand exclusively false beliefs with clear visual cues. Pellicano and Rhodes's (2003) false belief task with eye-gaze cues was used to assess their understanding of false beliefs with clear visual cues. A task adapted from Pellicano and Rhodes's (2003) experimental paradigm was used to explore their understanding of false beliefs with

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