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Brief Report

Adding sound to theory of mind: Comparing children's development of mental-state understanding in the auditory and visual realms



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ABSTRACT

Theory of mind (ToM) gradually develops during the preschool years. Measures of ToM usually target visual experience, but auditory experiences also provide valuable social information. Given differences between the visual and auditory modalities (e.g., sights persist, sounds fade) and the important role environmental input plays in social-cognitive development, we asked whether modality might influence the progression of ToM development. The current study expands Wellman and Liu's ToM scale (2004) by testing 66 preschoolers using five standard visual ToM tasks and five newly crafted auditory ToM tasks. Age and gender effects were found, with 4- and 5-year-olds demonstrating greater ToM abilities than 3-year-olds and girls passing more tasks than boys; there was no significant effect of modality. Both visual and auditory tasks formed a scalable set. These results indicate that there is considerable consistency in when children are able to use visual and auditory inputs to reason about various aspects of others' mental states.

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Introduction

By 5 years of age, most children can reason about others' thoughts and feelings, a capacity referred to as theory of mind (ToM; Premack & Woodruff, 1978; Wimmer & Perner, 1983). ToM abilities enable children to predict others' desires, beliefs, and behaviors based on internal mental states even though mental states cannot be seen, heard, or felt (Scholl & Leslie, 1999). Whereas most early research on mental-state understanding represented ToM as a single cognitive ability indexed by false belief tasks, several contemporary researchers emphasize the importance of capturing a broader view that includes understanding of desires, knowledge, true and false beliefs, and emotions.

Wellman and Liu (2004) argued that ToM development is not a single cognitive achievement but rather a series of increasingly difficult insights about the mind (see also Bloom & German, 2000; Fabricius & Khalil, 2009). They designed five tasks—Diverse Desires, Diverse Beliefs, Knowledge Access, False Belief, and Real–Apparent Emotions—to determine whether ToM insights develop in sequence. Using Guttman's (1944) scalogram analysis, they found that the five tasks formed a scale. That is, achievement on some tasks consistently preceded achievement on other tasks, such that once a task was failed, all subsequent tasks along the scale likely were also failed. Since its debut, the ToM scale (Wellman & Liu, 2004) has been used to chart emerging mental-state abilities in children with developmental delays (Peterson, Wellman, & Liu, 2005; Zhang, Shao, & Zhang, 2016) and across cultures (Shahaeian, Peterson, Slaughter, & Wellman, 2011).

However, a key limitation to ToM assessment is the emphasis on the visual modality. Using predominantly visual tasks leaves open the possibility that ToM may emerge at a different rate or in a different sequence when children are reasoning about information they hear rather than see. Sounds contain properties that are private (Maclachlan, 1989) just like internal mental states; thus, assessing ToM abilities using auditory tasks can provide insight into how children reason about beliefs, desires, and emotions using information that they hear but do not see, a situation that is likely common for typically developing preschoolers. Furthermore, research using the current set of visual ToM tasks indicates that children with sensory challenges such as congenital blindness (Peterson, Peterson, & Webb, 2000) and autism spectrum disorder (ASD; Baron-Cohen, Leslie, & Frith, 1985) show substantial delays in developing ToM abilities. Our auditory ToM tasks may allow for a fuller assessment of how children with developmental difficulties understand others' minds.

Our goal was to investigate whether the rate and sequence of ToM development are influenced by whether a child reasons using auditory or visual information. Like visual information, auditory information is central to interpersonal communication and learning. For example, Yaniv and Schatz (1988) found that 3-year-olds understand that someone who is unable to see something may still be able to hear it, and Williamson, Brooks, and Meltzoff (2013) found that children as young as 2 years consider another's ability to perceive sound when trying to either wake or not wake a sleeping baby. In addition, Moll, Carpenter, and Tomasello (2014) demonstrated that 2-year-olds can track what sounds others have heard.

But several differences between the visual and auditory modalities may affect ToM reasoning. Whereas visual input provides fast reliable information from early infancy, speech gradually becomes the dominant source of information, especially about past and future events. Sounds offer cues unavailable to sight (Kirk, Diefendorf, Pisoni, & Robbins, 1995); however, in contrast to visual stimulation, they fade rapidly, leaving the child to reason without sustained input. These differences might make ToM tasks more difficult when children hear rather than see relevant information.

To date, few studies of ToM have directly compared children's use of visual and auditory information. Existing studies emphasize children's ability to understand the link between sensory perception and knowledge access (Melis, Call, & Tomasello, 2010; Schmidt & Pyers, 2014). For example, Melis et al. (2010) found that 3-year-olds can account for what others see and hear before committing a transgression. Furthermore, Wimmer, Hogrefe, and Perner (1988) found that 3- to 5-year-olds perform similarly on knowledge access tasks that are presented verbally or visually. Yet, it remains unclear when children begin using auditory information to reason about desires, beliefs, and emotions.

The current study extended Wellman and Liu's (2004) ToM scale, which asked preschool children to reason about mental states based on visual cues. We investigated when and in what sequence

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