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Theory of Mind in adults with right hemisphere damage: What's the story?

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ABSTRACT

Why do people with right hemisphere damage (RHD) have difficulty with pragmatics and communication? One hypothesis has been that pragmatic impairment in RHD is the result of an underlying impairment in Theory of Mind (ToM): the ability to infer the mental states of others. In previous studies evaluating ToM abilities in people with RHD, researchers have used judgment tasks based on story or still cartoon stimuli. However, ToM is likely to draw on kinetic information as well, and these tasks ignore this aspect. The aim of this study was to assess ToM abilities in people with RHD using participants' evaluations of animated films with moving geometric shapes. Participants were presented with eight films of animated triangles. Four of the films represented the triangles as intentional agents with mental states, while the other four represented the triangles as simply inanimate, though moving, objects. Films were evaluated by both button-press response and by oral descriptions. Analysis of the transcriptions revealed that participants with RHD had a reduced ability to discriminate between the film categories, and a bias toward reduced mental-state ascription in the ToM condition.

1. Introduction

The importance of the left cerebral hemisphere in supporting language has been known since the 1800s, and there has been a massive amount of research on this topic. The past few decades, however, have seen a growing awareness that the right hemisphere may also make important contributions to our ability to use language, particularly in the context of daily social interactions (Myers, 1999; Tompkins, 1995).

People with right hemisphere damage (RHD) can show a variety of language-related impairments, which tend to lie at least partially within the realm of pragmatics (Cummings, 2007). This can include impairment on tasks tapping humor comprehension (Bihrle, Brownell, Powelson, & Gardner, 1986; Brownell, Michel, Powelson, & Gardner, 1983; Winner, Brownell, Happe, Blum, & Pincus, 1998), indirect requests (Brownell & Stringfellow, 1999; Foldi, 1987; Hirst, LeDoux, & Stein, 1984; Stemmer, Giroux, & Joanette, 1994; Weylman, Brownell, Roman, & Gardner, 1989), and narrative (Brownell, Potter, Bihrle, & Gardner, 1986; Schneiderman, Murasugi, & Saddy, 1992; Wapner, Hamby, & Gardner, 1981).

It has been suggested that an underlying deficit in Theory of Mind (ToM) may be the cause of these pragmatic impairments (Brownell, Griffin, Winner, Friedman, & Happé, 2000; Griffin et al., 2006; Happé, Brownell, & Winner, 1999; Martin & McDonald, 2003; Winner et al., 1998). Briefly, ToM refers to the ability to infer the mental states of others. According to this account, successful communication rests on the ability to make inferences about the mental states of one's interlocutor. The idea that impairments in humor, indirect requests, and narrative comprehension might be related to difficulty in attributing mental states finds theoretical support in Sperber and Wilson's (1986) Relevance Theory, which proposes a central role for the attribution of and understanding of mental states in all communication. The relationship between mental-state attribution and comprehension of non-literal language has also been demonstrated experimentally in people with autism (Happé, 1993).

To date, empirical support for a deficit in ToM in people with RHD has been suggestive, but inconclusive (Weed, 2008), perhaps due to the type of experimental task used to measure social cognition. Tasks often require making judgments about the mental states of characters in single-frame cartoons, or in short stories. This type of task has been criticized, however, most prominently by Tompkins, who points out that these tasks usually require making meta-linguistic judgments about hypothetical situations, and may not accurately measure the underlying cognitive processes

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in question (Tompkins, Scharp, Fassbinder, Meigh, & Armstrong, 2006, 2008).

A more direct means of assessing participants' ability to impute mental states may be to measure their capacity to intuitively anthropomorphize. The spontaneous use of anthropomorphic language when describing animated objects moving and interacting in a purposeful way is a robust and well-known effect (see Rimé, Boulanger, Laubin, Richir, & Stroobants, 1985 for a review). However, to our knowledge, animated geometric-shape stimuli have not yet been used to measure social cognition in people with damage to the right hemisphere. Body movements are an important reflection of an agent's intentions, and the importance of this kinetic information in mental-state attribution cannot be assessed using stories or line drawings.

Frith and Happé have developed a set of short, animated sequences involving moving geometric shapes (Abell, Happé, & Frith, 2000; Castelli, Happe, Frith, & Frith, 2000). Based on the classic experimental stimulus used by Heider and Simmel (1944), these new stimuli consist of several animations in three categories: ToM (animations intended to evoke spontaneous anthropomizing), Random (animations in which the geometric shapes moved in a self-propelled fashion, but were not intended to evoke an anthropomorphic reading) and Goal-Directed (a middle category, intended to evoke a description of intention, but not explicit reference to mental states). All stimuli featured the same two triangles, one small and one large, as the protagonists. For example, in one of the ToM animations, the small triangle appears to tease the large triangle by knocking on a door, and then hiding when the large triangle pokes its head out and looks around. In contrast, a typical animation from the Random category has the two triangles moving mechanically back and forth across the screen, or bouncing aimlessly like billiard balls. The triangles have no other features that would suggest an anthropomorphic reading, such as eyes or faces; it is the human-like movement alone that promotes an anthropomorphic reading of the ToM films and differentiates them from the other films (Scholl & Tremoulet, 2000). Samples of the stimuli can be seen at http://sites.google.com/site/utafrith/research.

Frith and colleagues have validated these animations with a healthy population and used them to investigate ToM in children with autism (Abell et al., 2000), in a woman with medial frontal brain damage (Bird, Castelli, Malik, Frith, & Husain, 2004), and in healthy participants in a brain-imaging experiment (Castelli et al., 2000). Other groups have used the animations to evaluate ToM abilities in women with Turner syndrome (Lawrence et al., 2007), in relation to fetal testosterone levels (Knickmeyer, Baron-Cohen, Raggatt, Taylor, & Hackett, 2006), high-IQ children with autism (Campbell et al., 2006), alexithymia (Moriguchi et al., 2007), and schizophrenia (Russell, Reynaud, Herba, Morris, & Corcoran, 2006). The aim of this study was to use these same animated stimuli as a new means of assessing ToM in people with RHD.

2. Methods

2.1. Materials

Eight animations were selected from the animations used by Abell et al. (2000): the four 'Random' animations and the four 'ToM' animations from the original experiment. We did not use the middle category ('Goal-Directed') for this experiment; pre-testing indicated that these were more ambiguous, and we assumed that the two extremes would give the clearest results, while reducing the amount of time we required patients to attend to the task. Two of the unused animations were used in the practice session. A detailed description of the stimulus materials, their development, and validation can be found in Abell et al. (2000). The stimulus animations were presented using the software extension Cogent 2000 (Wellcome Department of Imaging Neuroscience, University College London, London, UK; http://www.fil.ion.ucl.ac.uk) for MATLAB (Mathworks Inc., Sherborn, MA, USA), and oral descriptions of the animations were recorded using an Olympus digital voice recorder.

2.2. Testing procedures

All participants were tested in a quiet room. Prior to testing, the participants in the RHD group were given a clinical evaluation for hemispatial neglect. In addition, the participants were shown a picture on the computer screen, and were asked to describe what they saw in each of the four corners. All participants were able to satisfactorily describe the entire picture. Participants were instructed to view each film and then judge, by means of button-press, whether or not the film suggested a story to them, following which they were asked to describe the film they had just seen aloud. Participants completed two practice trials with the experimenter present, to insure they had understood the instructions. The experimenter then left the room while the participant completed the rest of the test alone.

The animations were presented in a randomized order on a computer screen. Following each animation, the participant was presented with the on-screen question "*Synes du der var en historie?*" (do you think/feel there was a story?). The wording of this test question was designed to encourage participants to rely on their intuitions about the films, rather than to make a more calculated judgment. Participants responded to this question by button-press. Following the button-press response, an on-screen instruction appeared asking participants to describe the animation they had just seen. Both the button-press and oral description tasks were self-paced.

2.3. Coding procedures

The oral descriptions were transcribed and coded by the primary investigator and two independent coders. The independent coders were both graduate students at the University of Aarhus, and were native speakers of Danish. Prior to coding, the individual transcriptions were randomly mixed together, so that the coders had no information about the identity of the speaker, or to which group the speaker belonged.

2.4. Coding for ToM

Transcripts were first categorized according to the procedure described by Abell et al. (2000), adapted to Danish. Each film description was categorized as either (1) a description of action, with no ascription of either intentional or mental states to the triangles, (2) a description in which the speaker appeared to ascribe intentions to the triangles, but made no reference to specific mental states, or (3) a description in which specific mental states are ascribed to the triangles. Although we did not use the Goal-Directed category from the original set of animations, we felt it was important to maintain the intentional language coding category, as this would allow for a more fine-grained analysis of the participants' descriptions.

Following Abell et al. (2000), descriptions such as "the red one tried to knock the blue one over" were categorized as ascribing *intentions* but not *mental states*. Verbs such as "to try" were not sufficient to categorize a description as a mental state description. However, a description such as "... it was a shy person on his way in, who knocked on the door but is a little bashful..." were categorized as mental state descriptions. In this example, the key