Cognition 146 (2016) 8–15

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/COGNIT

Perceived interpersonal synchrony increases empathy: Insights from autism spectrum disorder

Svenja Koehne [a,*], Alexander Hatri [a], John T. Cacioppo [b], Isabel Dziobek [a,1]

[a] Cluster of Excellence, Languages of Emotion, Freie Universitat Berlin, Habelschwerdter Allee 45, 14195 Berlin, Germany
[b] Department of Psychology, University of Chicago, 5848, S. University Avenue, Chicago, IL 60637, USA

ARTICLE INFO

Article history:
Received 9 March 2015
Revised 20 July 2015
Accepted 7 September 2015

Keywords:
Synchronization
Imitation
Empathy
Theory of mind
Autism

ABSTRACT

This study investigated the effect of unilateral interpersonal synchrony on empathy in two simple leader–follower finger tapping communication tasks in individuals with and without autism spectrum disorder (ASD). In unilateral synchronization, one individual within a dyad (the follower) unilaterally adjusts his or her movements to entrain to the movements of the other (the leader). *Perceived* synchrony, i.e., being followed by a synchronous virtual partner when leading an interaction, increased subjective cognitive empathy (understanding other's mental states) towards the virtual follower in participants without, but not those with ASD. In the ASD group, the degree of *produced* synchrony, i.e., entrainment to the virtual leader when following in an interaction, was associated with higher cognitive empathy performance as measured with external objective tasks. These results point to a mediating role for interpersonal synchronization in cognitive empathy, a mechanism that seems attenuated, yet not absent, in ASD.

1. Introduction

A lack of empathy is one of the key characteristics of individuals with autism spectrum disorder (ASD, Baron-Cohen & Wheelwright, 2004), a psychiatric condition characterized by impaired development in social interaction and communication (American Psychiatric Association, 2013). While results for impairments in emotional empathy, i.e., the capacity to share the feelings of others, have been somewhat inconsistent (Dziobek et al., 2008), it has repeatedly been shown that individuals with ASD have difficulties in cognitive empathy, i.e., in attributing mental states including thoughts, intentions, and emotions to others (Baron-Cohen, 2001; Baron-Cohen, Leslie, & Frith, 1985; Dziobek et al., 2006; Frith & Happé, 1994).

A proposed mechanism for the empathy deficits observed in ASD is coming from imitation impairments (for an overview, Ramachandran & Oberman, 2006). It is assumed that spontaneously imitating observed mental states allows for a direct first person access to that state, thus it can follow that impairments in imitation also affect empathy functions (Gallese & Goldman, 1998; Oberman & Ramachandran, 2007). Findings from neurotypical (NT) individuals support the link between imitation and social cognition showing that imitation of postures, mannerisms, facial expressions, and other behaviors can occur spontaneously with positive social consequences, for instance: liking, emotion recognition, generosity, and reduced racial prejudice (Chartrand & Bargh, 1999; Dimberg, Thunberg, & Elmehed, 2000; Inzlicht, Gutsell, & Legault, 2012; Stel & van Knippenberg, 2008; Van Baaren, Holland, Steenaert, & van Knippenberg, 2003). However, whether or not imitation difficulties contribute to the deficits in cognitive empathy typical for individuals with ASD is still a matter of debate (Bird, Leighton, Press, & Heyes, 2007; Hamilton, Brindley, & Frith, 2007).

Although most of the research investigating the link between motor matching and social cognition has focused on imitation, similar effects have been reported for temporal coordination of movements, i.e., interpersonal synchrony, such as walking in lock-step or joint drumming, which led to the assumption that synchronization and imitation reflect two facets of interpersonal coordination (Chartrand & Lakin, 2013). Similar to imitation, interpersonal synchrony can occur spontaneously (Issartel, Marin, & Cadopi, 2007). For instance, Richardson, Marsh, Isenhower, Goodman, and Schmidt (2007) found that visually-coupled individuals sitting side-by-side in rocking chairs spontaneously synchronize their movements even if the natural period of the rocking chair was different. Both, in-phase and anti-phase synchrony, have

* Corresponding author at: Berlin School of Mind and Brain, Humboldt Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany.
E-mail address: svenja.koehne@hu-berlin.de (S. Koehne).
[1] Present address: Berlin School of Mind and Brain, Humboldt Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany.

http://dx.doi.org/10.1016/j.cognition.2015.09.007
0010-0277/

been shown to occur spontaneously and to be equally stable (Richardson et al., 2007; Van Ulzen, Lamoth, Daffertshofer, Semin, & Beek, 2008). In addition, a growing body of research provides evidence for social consequences of interpersonal synchrony by showing associations with greater rapport, pro-social behavior, and cooperation (Bernieri, 1988; Hove & Risen, 2009; Kirschner & Tomasello, 2010; Valdesolo, Ouyang, & DeSteno, 2010; Wiltermuth & Heath, 2009).

In an effort to further break down the complex process of interpersonal synchronization, previous research has focused on unilateral (in contrast to reciprocal) synchronization (Cacioppo et al., 2014). In unilateral synchronization, one individual within a dyad (the follower) unilaterally adjusts his or her movements to entrain to the movements of the other individual (the leader) within the dyad, where the leader moves periodically but does not adjust his or her movements in reciprocation to promote synchrony. The more passive experience of synchrony in the leader role has been referred to as *perceived synchrony,* whereas the experience of the follower, who actively adjusts his or her movements to entrain to the movements of the leader, can be described as *produced synchrony*. Interestingly, similarly to produced synchrony, perceived synchrony has also been found to increase feelings of affiliation (Cacioppo et al., 2014).

While imitation and interpersonal synchronization share certain features, they also differ in important ways. As a result they are considered as two different processes. Whereas imitation always yields behaviors that are similar in form and close in timing, synchronization may or may not yield behaviors that are similar in form. Although behaviors are temporarily close in imitation, timing of behavior is critical to determining whether one person behaves synchronously with others (Chartrand & Lakin, 2013). Interestingly, in addition to imitation deficits, less spontaneous synchronization and difficulties voluntarily synchronizing with another person have recently been reported for individuals with ASD and have been suggested to also contribute to their social deficits (Fitzpatrick, Diorio, Richardson, & Schmidt, 2013; Gowen & Miall, 2005; Marsh et al., 2013). However, associations between synchronization and cognitive and emotional empathy have not yet been investigated directly in individuals with or without autism.

We therefore assessed the potential deficit in *producing* interpersonal synchronization, i.e., entrainment to a virtual leader when following in an interaction, in adults with ASD, and its relation to individual cognitive empathy performance. To this end we investigated whether a subject would synchronize her behavior more with a putative human partner than with a non-human partner (computer), assuming that the social framing would increase *produced* synchronization in neurotypical individuals but not those with ASD. This hypothesis was based on previous research showing a so-called animacy or human imitation bias in non-autistic individuals, i.e. increased automatic imitation when observing human movements compared to a robot (Bird et al., 2007; Kilner, Paulignan, & Blakemore, 2003; Press, Bird, Flach, & Heyes, 2005; Press, Gillmeister, & Heyes, 2007). In addition, we attempted to relate *produced* synchronization behavior to objectively measured individual cognitive empathy functions. We assumed that higher tendencies to synchronize with a human partner correlate with higher cognitive empathy performance.

We also assessed the effect of *perceived* synchrony on empathy through examining whether an individual, who is followed by somebody in a highly synchronous way, reports higher cognitive and emotional empathy towards that specific partner than when followed by somebody in a less synchronous way. In this context, cognitive and emotional empathy were assumed to vary between specific contexts, i.e., at the state level (De Vignemont & Singer, 2006; Zaki, 2014).

2. Materials and methods

2.1. Participants

Twenty adults with ASD (16 men, mean age = 33.0) and 22 NT participants (16 men, mean age = 32.5) with no reported history of psychiatric or neurological disorders participated in the study (see Table 1 for details). The groups were comparable in age ($t(40) = -.19$, $p = .85$), fluid intelligence (as assessed through a strategic reasoning test (Leistungsprüfsystem (LPS), subscale 4, Horn, 1962; $t(39) = -.75$, $p = .46$) and crystalline intelligence as assessed through a German vocabulary test (Wortschatztest (WST), Schmitz & Metzler, 1992, $t(33.85) = -1.28$, $p = .21$). ASD participants were recruited through the autism outpatient clinic of the Charité – Universitätsmedizin Berlin, or were referred by specialized clinicians. All of the participants were diagnosed according to DSM-IV criteria for Asperger syndrome and autism without mental retardation (American Psychiatric Association, 1994). Diagnosis included the Autism Diagnostic Observation Schedule ($n = 18$, Lord, Rutter, DiLavore, & Risi, 2002), and the Autism Diagnostic Interview – Revised ($n = 12$, ADI-R; Lord, Rutter, & Le Couteur, 1994) if parental informants were available. Additionally, diagnoses were confirmed with the Asperger Syndrome and High-Functioning Autism Diagnostic Interview ($n = 17$, ASDI; Gillberg, Gillberg, Råstam, & Wentz, 2001). All of the participants gave written informed consent prior to their participation, and the study was approved by the ethics committee of the German Society for Psychology (DGPs).

2.2. Minimal synchrony paradigm

2.2.1. Experimental design

Participants were asked to engage in a tapping interaction similar to using Morse code for communication in which a simple light signal (produced by a single tap on the space bar) replaced an acoustic signal as the carrier of a "message". Participants were told that the study was designed to investigate minimal non-verbal communication for potential use in cell phone applications. For each round one participant would be assigned the role of the leader, who would be responsible for creating a series of light signals at a designated rate (fast: 1 beat every 1 s; slow: 1 beat every 1.5 s), and the other participant would be assigned the role of the follower, who would be responsible for responding by creating a light signal following each signal produced by the leader. The graphical interface contained two circle-like avatars (subject and partner). Light signals were visually represented by a simple animation where the circle-shaped avatar acquired a red glow. Unbeknownst to the participants, the ostensible partner in both the leader and follower rounds was always a computer program. Substantial effort was made to disguise the aims of the study: the cover story framed the aim of the study in terms of "communication" so that neither the target concepts of cognitive and emotional empathy nor related constructs such as liking or affiliation were mentioned. All individual difference measures of empathy were administered in a separate testing session. Additionally participants were never asked to synchronize their movements to their partners' movements. In contrast to previous research (Cacioppo et al., 2014), subjective synchrony was not probed during the experiment.

2.2.1.1. Leader task. The leader task, adapted from Cacioppo et al. (2014), was designed to assess the effect of *perceived* interpersonal synchrony on cognitive and emotional empathy. Participants were assigned the role of the leader and instructed to send a light signal in either fast or slow tempo, while the computer program generated a light signal that followed each participant's signal and was