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Review article

Connecting minds and sharing emotions through mimicry: A neurocognitive model of emotional contagion

Eliska Prochazkova^{a,b}, Mariska E. Kret^{a,b,*}^a Leiden University, Institute of Psychology, Cognitive Psychology Unit, Wassenaarseweg 52, Leiden 2333 AK, The Netherlands^b Leiden Institute for Brain and Cognition (LIBC), Albinusdreef 2, Leiden 2300 RC, The Netherlands

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ABSTRACT

During social interactions, people tend to automatically align with, or mimic their interactor's facial expressions, vocalizations, postures and other bodily states. Automatic mimicry might be implicated in empathy and affiliation and is impaired in several pathologies. Despite a growing body of literature on its phenomenology, the function and underlying mechanisms of mimicry remain poorly understood. The current review puts forward a new Neurocognitive Model of Emotional Contagion (NMEC), demonstrating how basic automatic mimicry can give rise to emotional contagion. We combine neurological, developmental and evolutionary insights to argue that automatic mimicry is a precursor to healthy social development. We show that (i) strong synchronization exists between people, (ii) that this resonates on different levels of processing and (iii) demonstrate how mimicry translates into emotional contagion. We conclude that our synthesized model, built upon integrative knowledge from various fields, provides a promising avenue for future research investigating the role of mimicry in human mental health and social development.

1. Introduction

In environments with many rapidly changing elements, brains provide an evolutionary advantage for survival by allowing organisms to extract patterns of information that aid predictions (Adolphs, 2001). Humans, like many other social animals, live in groups. On the one hand, groups can offer better prospects for survival by communication and cooperation, but on the other hand, group members can also form a threat within a group as they can free-ride or exploit other group members (de Dreu et al., 2010; de Dreu et al., 2016). As a consequence of responsiveness to one's own behavior, compared to the physical environment, the social environment is relatively unpredictable. Despite its complexity, humans are often readily able to intuit others' feelings and also understand and even anticipate others' actions. This is done seamlessly, without effort, and often without conscious awareness (Dimberg et al., 2000; Tamietto and Castelli, 2009; Tamietto and de Gelder, 2010; Kret et al., 2013a,b; Wood et al., 2016). The remarkable capacity to share others' affective states and empathize with others is the key characteristic of many of humanity's modern achievements. The development of social cognition is closely related to the development of emotional and affective communication between an infant and his or her mother (Adolphs, 2001; Francis et al., 1999; Simpson et al., 2014). Social capacities can be extremely sensitive to even small differences in

the environment (Crabbe et al., 1999). When infants are born, their verbal and motor abilities are still very limited and their communication relies mainly on subtle social cues from their environment.

The current literature argues that a potential mechanism that allows humans to recognize (Neal and Chartrand, 2011; Stel and van Knippenberg, 2008; Wood et al., 2016) and share emotions is automatic mimicry (Decety and Lamm, 2006; Schuler et al., 2016; Singer and Lamm, 2009). Automatic mimicry is defined as the unconscious or automatic imitation of speech and movements, gestures, facial expressions and eye gaze (for an extensive review see Chartrand and van Baaren, 2009). The tendency to automatically mimic and synchronize movements with those of another person has been suggested to consequently result in emotional contagion (Cacioppo et al., 2000). Although the focus in the literature has been predominantly on the mimicry of facial expressions or bodily postures (motor mimicry), evidence is accumulating that humans mimic on many more levels than the muscle movements alone. For example, this is demonstrated by the synchrony of heart-rate and pupil-diameter during social interactions, the tendency to blush when an interaction partner blushes and the contagiousness of crying or yawning (for a review, see Kret, 2015; Palumbo et al., 2016). During the present review, we refer to the mimicry or synchronization on this more autonomic level as 'autonomic mimicry'. Even though autonomic mimicry might have important

* Corresponding author at: Leiden University, Institute of Psychology, Cognitive Psychology Unit, Wassenaarseweg 52, Leiden 2333 AK, The Netherlands.
E-mail addresses: e.prochazkova@fsw.leidenuniv.nl (E. Prochazkova), m.e.kret@fsw.leidenuniv.nl (M.E. Kret).

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consequences for social behavior (i.e. Kret et al., 2015; Kret and de Dreu, 2017), it is an understudied topic in the field of social neuroscience and is therefore one of the key topics of this review.

In two different ways, this article aims to provide a new perspective on the role of automatic mimicry in the development of empathy. First, by building upon the perception-action model (PAM) of empathy (Preston and de Waal, 2002), the current review integrates mimicry studies coming from multiple scientific disciplines, ranging from developmental psychology, evolutionary biology and neuroscience in order to explain how automatic mimicry gives rise to complex social cognition. The second aim is to introduce a new Neurocognitive Model of Emotional Contagion (NMEC), which incorporates these additional autonomic pathways to explain how empathic abilities emerge from a dynamic synchronous activity between two interacting brains. The NMEC is a multidisciplinary conceptual model explaining mimicry on different levels of processing through which affective information can be shared. This model has laid out how information passes from a sender's face or body to a receiver's brain and subsequently to their face or body, and how the transition of perceptual inputs builds emotional understanding. The purpose of this review is not to provide a complete literature overview of all the mimicry studies that have been conducted (for an extensive review, see Chartrand and Dalton, 2009; Chartrand and van Baaren, 2009; Chartrand and Lakin, 2013; Kret, 2015; Palumbo et al., 2016). Instead, through the integration of evidence from various fields, we aim to provide novel insights into the role of automatic mimicry in the development of human socio-cognitive functions.

2. Definitions and terminology

2.1. Different types of automatic mimicry

First, we define the mimicry terms that we will be using. Although we are fully aware of the fact that 'what is pure mimicry and what is not' is a matter of debate and there are some gray areas, the present review uses the term 'automatic mimicry' as an umbrella term for the different types of synchronous behaviors. A distinction in automatic mimicry will be made between 'motor mimicry' controlled by the motor muscles which are partly implicit but can also be consciously controlled, and 'autonomic mimicry' which relies on an unconscious signaling system that is controlled by the autonomic nervous system (ANS) (Fig. 1). For example, 'motor mimicry' occurs when two or more people engage in the same behavior within a short time window (typically between 3 and 5 s), and includes mimicry of motor movements such as facial expressions (Dimberg et al., 2000; Niedenthal et al., 2001), body postures (Tia et al., 2011), vocal characteristics (Gregory and Webster,

1996; Webb, 1969), contagious yawning (Helt et al., 2010), speech gestures (Goldin-Meadow and Alibali, 2013) and laughter (Estow et al., 2007). The second type of automatic mimicry, 'autonomic mimicry' involves any associative pattern in the physiologies of interacting partners, such as synchrony in heart rate (Feldman et al., 2011), breathing rhythm (Creaven et al., 2014; Van Puyvelde et al., 2015), pupil diameter (Fawcett et al., 2016; Kret et al., 2015; Kret and de Dreu, 2017) and hormonal level (Laurent et al., 2012; Saxbe et al., 2014).

2.2. Emotional contagion

Observation of emotional expressions has been shown to elicit not only motor and autonomic mimicry but also corresponding emotional responses (Hatfield et al., 1994). The literature refers to this type of emotional mimicry as to 'emotional contagion'. Emotional contagion is defined as the tendency to take on the sensory, motor, physiological and affective states of others (Hatfield et al., 1994). Hatfield et al. (1994) argued that one of the main mechanisms underlying emotional contagion is automatic mimicry (synchronization of expressions, vocalizations, postures and movements with those of another person). When people unconsciously mimic their partner's expressions of emotion, they come to feel reflections of those emotions as well. It is important to note that while emotional contagion is related to mimicry, it is not the same phenomenon. Emotional contagion is a multilevel phenomenon that can arise from several types of mimics occurring at different levels of processing (sensory, motor, physiological and affective). For example, if someone mimics our facial expressions, it does not necessarily mean that he or she is experiencing the same emotional state as we do. This is because the affective component from motor muscles alone may not always extend to full emotional experience, that is, the psychological feeling associated with it. For example, while facial muscles' feedback may help an observer to correctly attribute emotional valence of an expression, a visceral arousal may be necessary to fully emotionally converge (Laird, 1974). In other words, emotional contagion is a higher cognitive/emotional construct that is not necessarily tied to one specific mimicry form.

3. The evolution of empathy

Many theories share common definitions of empathy. Much disagreement in the field is the result of scientists failing to agree on what specific psychological processes empathy encompasses. We adapt the working definition of empathy based on the idea that empathy consists of two main processes:

Emotional contagion/hot empathy: the tendency to take on the

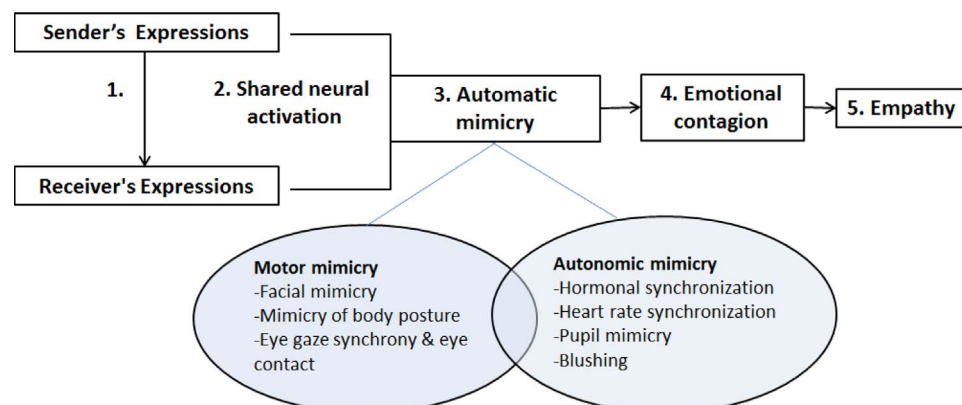


Fig. 1. Schematic Representation of Empathy Development: (1) The sender's (mother's) emotional state is reflected in her nonverbal motor movements (facial expressions, body postures, and eye-gaze) and physiological responses (heart rate, hormonal levels, sweating, facial color, pupil diameter). (2) The perception of a target's state instantly activates the observer's (child's) neural representations that are also active during the first-hand experience of that same state (shared neural activation). (3) Shared neural activation in turn activates *somatic* and *autonomic* responses resulting in motor mimicry & autonomic mimicry. (4) Automatic mimicry facilitates physiological and motor feedback inducing emotion in the receiver (emotional contagion). (5) This helps observer to understand sender's mental state better (empathy).

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