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Discussion forum

Mirroring as Pattern Completion Inferences within Situated Conceptualizations

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It is increasingly apparent that mirroring is an important social process in humans and other species. In humans, individuals mirror the actions, emotions, speech, attention, postures, etc. of other perceived individuals, at least neurally, and sometimes bodily and behaviorally. These mirroring processes play important roles in individual cognition and social interaction, including action understanding, action preparation, social contagion, and learning via imitation.

The classic account of mirroring is that it results from mirror neurons, namely, neurons that have both motor and perceptual tunings. Mirror neurons not only become active when an action is performed, but also when it is perceived. Because these neurons become active during the perception of an action, they ground the perception in action simulation.

An alternative account constitutes the thesis developed here: Mirroring is a special case of a basic cognitive process common across species, namely, Pattern Completion Inferences within Situated Conceptualizations (PCIwSC). According to PCIwSC, the brain is a situation processing architecture (Barsalou, 2003, 2009; Barsalou et al., 2003; Wilson-Mendenhall et al., 2011; Yeh and Barsalou, 2006). In a given situation, multiple networks implement parallel processing streams that perceive and conceptualize various elements of the situation, including the setting, self, other agents, objects, actions, events, interoceptive states, and mental states. For example, the parahippocampal gyrus and parietal lobes process the spatial setting; regions of the cortical midline process self and others; the ventral stream processes objects; the motor system processes actions; and so forth. As individual elements of the current situation are perceived and conceptualized, higher-order configural conceptualizations in turn integrate these elemental conceptualizations into a coherent account of what is occurring more globally across the situation. Together, all conceptualizations of the situation across the elemental and configural levels are assembled into a *situated conceptualization* (SC) that represents and interprets the situation. For example, when some friends wave at you from across the street, an SC of this event conceptualizes the setting as a street, the other people as your friends, their action as waving, and their mental state as friendly. At the configural level, these local conceptualizations are integrated into a coherent meaningful event, with your friends recognizing you, experiencing pleasure on seeing you, and greeting you.

Once an SC is assembled in a situation, it becomes stored in memory. Because an SC is grounded in perceptual, interoceptive, and motor systems (Barsalou, 1999, 2008), it does not simply describe how the situation is conceptualized, but has the potential to implement relevant perceptions, bodily states, and actions via simulation within the respective modalities. Once an SC has been stored, it can be cued later when a similar situation is encountered again, or when just part of the original situation is perceived. Once cued, the SC reinstates itself in the brain and body, producing grounded inferences about what is likely to happen in the situation (with reinstatement and inference both behaving dynamically; Barsalou, 2003). Thus, the SC constitutes a pattern in memory, which when reinstated, produces pattern completion inferences (PCIs). On seeing your friends across the street again, for example, the SC stored on the previous occasion might become active and simulate them waving to you as a prediction, further preparing you to wave back and feel positive affect.

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PCIwSC potentially underlies a diverse set of basic cognitive activities. In situated action, PCIwSC produces functional affordances as inferences when a perceived object activates an SC associated with previously performing the object's function (Barsalou et al., 2005). In social cognition, PCIwSC produces evaluative responses from embodied states and vice versa (Barsalou et al., 2003). In emotion, PCIwSC produces emotion from objects and events that produced emotion previously (Barrett, 2006; McDonough Lebois et al., 2013; Wilson-Mendenhall et al., 2011). A wide variety of classic top-down contextual effects can generally be viewed as the results of PCIwSC. For example, objects are recognized faster when perceived in familiar scenes than in isolation (Biederman, 1981); words are perceived faster in meaningful sentences than in random word strings (Marslen-Wilson and Tyler, 1980); semantic inferences result continuously as texts are processed (Metusalem et al., 2012). In each case, bottom-up cues activate relevant SCs, which, in turn, activate associated perceptions, actions, and internal states likely to be relevant as top-down inferences in the situation. PCIwSC can also be viewed as underlying a continuum of conditional reasoning, with basic conditioning processes on one end, and formal reasoning procedures such as modus ponens on the other.

From this perspective, mirroring is simply another case of PCIwSC. On perceiving an action, vocalization, emotion, touch, attentional shift, etc. in another person, an associated SC becomes active that simulates an action as a PCI. Within this framework, mirror neurons that have multiple tunings do not exist. Instead, neurons are typically tuned for a single modality (e.g., vision, action), but can be also activated inferentially via PCIwSC.

PCIwSC is closely related to other learning accounts of mirroring (Brass and Heyes, 2005; Cooper et al., 2013; Heyes, 2011; Keysers and Perrett, 2004). Similar to these accounts, PCIwSC views mirroring as a special case of general mechanisms. Via the general process of PCI, many different kinds of SCs produce diverse cognitive phenomena (as just described). Furthermore, any part of an SC can trigger the rest of the SC as inferences, such that PCI takes many forms within a single SC (e.g., not only does perception trigger action inferences, action triggers perceptual inferences). Also similar to other learning accounts, PCIwSC has explanatory power comparatively across species, explaining a broad spectrum of intelligent processes in non-humans as well as in humans (Barsalou, 2005). Finally, a challenge for PCIwSC, as for all learning accounts, is explaining how the multimodal patterns that integrate perceptual and motor representations of the same action become established in memory. Ray and Heyes (2011) offer a compelling account of the requisite learning processes.

PCIwSC differs from other learning accounts in ways that provide possible topics for future research. First, PCIwSC assumes that the SCs underlying mirroring are stored as dynamically-processed exemplars in memory (cf. Nosofsky and Zaki, 2002; Ross, 1989), whereas other accounts utilize abstractionist learning mechanisms (Cooper et al., 2013). As a consequence, PCIwSC explains individual differences in mirroring as the result of different populations of SCs stored in memory for different individuals (McDonough Lebois et al., 2013; Wilson-Mendenhall et al., 2011). Second, PCIwSC is framed within the perspective of grounded cognition and thus contributes to a broad spectrum of processes, ranging from perception and action, to language and reasoning, linking these diverse processes together (Barsalou, 1999, 2008).

Author notes

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