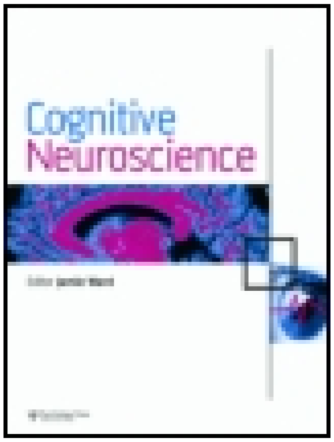




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# How mirror-touch informs theories of synesthesia

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# Commentary

## How mirror-touch informs theories of synesthesia

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**Abstract:** Ward and Banissy provide an excellent overview of the state of mirror-touch research in order to advance this field. They present a comparison of two prominent theoretical approaches for understanding mirror-touch phenomena. According to the threshold theory, the phenomena arise as a result of a hyperactive mirror neuron system. According to the Self-Other Theory, they are due to disturbances in the ability to distinguish the self from others. Here, we explore how these two theories can inform theories of synesthesia more generally. We conclude that both theories are not suited as general models of synesthesia.

The threshold theory of mirror-touch is based on the idea that the level of activity in the somatosensory mirror system crosses a threshold of awareness for some persons but not others. As typical forms of synesthesia are related to connections between distinct brain systems rather than relying on a single underlying subsystem (as the mirror system), an immediate generalization is not warranted. However, threshold theories have been proposed to account for crossmodal associations that can be found both in synesthetes and non-synesthetes (i.e., higher sounds pair with lighter colors) with the conscious awareness as the threshold. Moreover, within grapheme-color synesthesia a continuum exists between projectors who experience colors in the outer space and associators who experience colors in the mind's eye. An implicit assumption of any threshold model is that the characteristic underlies a unimodal distribution (e.g., a standard normal distribution). Independent of awareness, the criterion for the diagnosis of synesthesia can be empirically defined by maximizing specificity and sensitivity in a common test of consistency, which is the gold-standard for verifying synesthesia. Notably, as illustrated in Figure 1 the resulting distribution is bimodal, thus conflicting with the explanatory power of a threshold model as a general theory of synesthesia (Rothen, Seth, Witzel, & Ward, 2013).

The Self-Other Theory is based on the assumption that aberrant self-other representations produce mirror-touch. Specifically, difficulties in distinguishing the self from another person as the source of agency form the basis of the experiences. In terms of synesthesia, the latter would refer to difficulties in distinguishing between the physical and synesthetic experience (i.e., of touch). However, one of the hallmarks of synesthesia is that despite the vivid experience of synesthetic concurrents, there is no confusion between physical and synesthetic experience (cf., Meier, Rey-Mermet, & Rothen, in press). Indeed, the fact that synesthetes do not get confused by their additional sensations has been denoted as the "most intriguing question in synesthesia research" (Rouw & Ridderinkhof, 2014; cf. Seth, 2014). Thus, the Self-Other Theory is not suited as a general theory of synesthesia.

In a previous paper, we have argued that mirror-touch phenomena differ from synesthesia in several important points (e.g., neural basis, bandwidth, consistency, idiosyncrasy; Rothen & Meier, 2013). Here, we do not want to re-iterate these points. Rather, we would like to emphasize that typically synesthesia is a unidirectional phenomenon in which the inducer elicits a conscious experience, but not the concurrent. For instance, graphemes trigger color experiences in grapheme-color synesthesia but colors do not trigger grapheme experiences. Only very rarely the concurrent can also elicit a conscious experience of the inducer (Cohen Kadosh, Cohen Kadosh, & Henik, 2007), although the concurrent typically

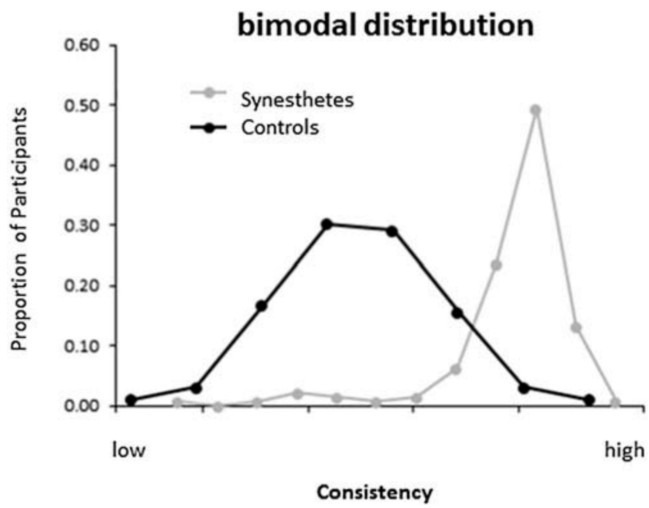


**Figure 1.** Bimodal distribution resulting from consistency scores of synesthetes and non-synesthetes (adopted from Rothen et al., 2013).



triggers the representation of the inducer on an implicit level (Brang, Edwards, Ramachandran, & Coulson, 2008; Meier & Rothen, 2007; Rothen, Nyffeler, Von Wartburg, Müri, & Meier, 2010). In contrast, for mirror-touch phenomena explicit bidirectionality is the common case. Specifically, observed touch (i.e., the inducer) triggers a touch experience (i.e., the concurrent) and, as a matter of principle, being touched physically (i.e., the concurrent) can always be observed (i.e., the inducer).

To conclude, the discussion of mirror-touch in relation to synesthesia is thought-provoking as it sharpens the definitional criteria. The co-occurrence of mirror-touch experiences with other forms of synesthesia is striking and may indicate that mirror-touch synesthesia is a special case of synesthesia (Banissy, Cohen Kadosh, Maus, Walsh, & Ward, 2009; Chun & Hupé, 2013). However, we suggest that it co-occurs with other forms of synesthesia as a by-product, similar to enhanced memory abilities, a distinct cognitive style, or a certain personality profile (Banissy et al., 2012, 2013; Meier, 2013; Meier & Rothen, 2013; Rothen, Meier, & Ward, 2012). This conclusion is in line with the fact that mirror-touch theories are restricted to these specific phenomena and are not suited as general models for synesthesia.

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