



Neither Shaken nor Stirred: Reply to Bertenthal and Scheutz

Richard P. Cooper,^a Caroline Catmur,^b Cecilia Heyes^c

^a*Department of Psychological Sciences, Birkbeck, University of London*

^b*Department of Psychology, University of Surrey*

^c*All Souls College & Department of Experimental Psychology, University of Oxford*

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The crux of the debate between ourselves and Bertenthal and Scheutz (2013) (B&S) is whether imitative compatibility effects reflect the operation of specialized imitation-related mechanisms or instead arise from the same associative learning processes thought to underlie spatial compatibility effects. Our conclusions were, and remain, more modest than B&S imply. We do not claim that our model rules out the possibility that spatial and imitative compatibility depend on qualitatively distinct processes, but we believe it supports a “same mechanisms” over a “different mechanisms” view.

1. Strategic factors

Bertenthal, Longo, and Kosobud (2006) analyzed time course within blocks and found a difference between spatial and imitative effects. Catmur and Heyes (2011) analyzed time course across an entire experiment and failed to find an interaction between block and spatial/imitative compatibility effects. We agree with B&S that there is no direct conflict between these two results; the latter does not make the former any less likely to be a genuine and reliable effect. Rather, we argued that the second result supports the view the first was due to strategic responding resulting from presentation of compatible and incompatible trials in separate blocks. B&S asserted that this was not the case but, as far as we can see, did not bring further evidence to bear on this issue.

Correspondence should be sent to Richard P. Cooper, Department of Psychological Sciences, Birkbeck, University of London, Malet Street, London WC1E 7HX, United Kingdom. E-mail: R.Cooper@bbk.ac.uk

2. Mental state attribution

Summarizing their review of evidence that imitative and spatial compatibility depend on different processes, B&S suggest that “imitative compatibility, but not spatial compatibility, is modulated by mental state as well as the surface appearance and kinematic properties of the stimulus.” This conclusion overlooks evidence that spatial compatibility effects can also be modulated by mental state attribution (Sebanz, Knoblich, & Prinz, 2003; Zwickel, 2009). The effects of mental state attribution on both imitative and spatial compatibility appear to be mediated by attention (Heyes, 2011)—a factor that could be easily incorporated in our model (e.g., by assuming that attention modulates the strength of our intentional route).

3. Size of effects

We find B&S’s objections to our model’s assumptions rather puzzling. The empirical literature indicates that the size of both imitative and spatial compatibility effects is not absolute but a function of the experimental design. For example, whether spatial or imitative compatibility effects are stronger appears to depend on the spatial arrangement of the stimuli. Left/right spatial arrangements produce stronger spatial than imitative compatibility effects (Bertenthal et al., 2006; Catmur & Heyes, 2011), while up/down arrangements show the reverse result (Brass, Bekkering, & Prinz, 2001) or no difference (Wiggett, Downing, & Tipper, 2013). Our view is that associations between stimulus features and responses are acquired through standard processes of associative learning—a view substantiated by more recent work in which the CCH model is augmented with associative learning mechanisms that modulate strengths of associations between sensory and motor units (Cooper, Cook, Dickinson, & Heyes, *in press*). This work goes some way to addressing B&S’s concern that we model too few empirical effects.

4. Transitory excitation

For left/right spatial arrangements of the type we modeled, Proctor, Miles, and Baroni’s (2011) review concludes that the Simon effect decreases with increasing RT. This supports our assumption that excitation of task-irrelevant nodes is transitory; however, we agree with B&S that it is still unclear whether this is also the case for more complex stimuli. B&S also state that RTs for identification of a task-relevant finger’s identity versus its spatial location are not significantly different (Boyer, Longo, & Bertenthal, 2012). Yet in Bertenthal et al. (2006), mean RT for Experiment 3a (respond to finger identity) was around 30 ms slower than for Experiment 3b (respond to spatial location). This supports our assumption that temporal onset of excitation is earlier for movement location than for finger identity. Relatedly, measures of corticospinal excitability suggest that

information regarding the occurrence of a finger movement reaches motor cortex at least 100 ms before information regarding its anatomical identity (Cavallo, Heyes, Becchio, Bird, & Catmur, unpublished data).

5. Reversal

Boyer et al. (2012) confirmed that a spatial compatibility effect can be reversed by instructions to respond using an alternative body part (Heyes & Ray, 2004). However, their failure to find reversal of an imitative compatibility effect must be interpreted with caution because this kind of reversal has been reported elsewhere in the literature (van Schie, van Waterschoot, & Bekkering, 2008). One possibility is that Boyer et al. (2012) found reversal of the spatial but not the imitative effect because in the imitative but not the spatial condition their participants could adopt the strategy of responding away from the absolute (rather than the relative) location of the stimulus movement. Another possibility is that reverse compatibility effects arise only at very long RTs—an effect that would appear in the CCH model if irrelevant sensory input were actively suppressed during the course of a trial. Thus, further work will be needed to establish whether our “same mechanisms” model, and the “different mechanisms” model favored by B&S, can capture the full range of reverse compatibility effects.

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