

Prestructure through Reference Frames: Dynamic Field Theory of Spatial Stimulus-Response Compatibility

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Introduction

Humans are capable not only of establishing highly complex stimulus-response associations but of selectively adjusting them and switching between different mappings on a very fast time scale according to situational constraints. How may this high flexibility be achieved?

We claim that the high amount of flexibility results from prestructure in the system and that stimulus-response compatibility (SRC) (overview by Hommel & Prinz, 1997) is a consequence of this prestructure.

Methods

Our account is based on Dynamic Field Theory, a mathematical framework for decision making based in continuous neural activation fields (for a review see Erlhagen & Schöner, 2002). Wilimzig & Schöner (2005) provided an account how the problem of stimulus-response association can be solved for a stimulus that is unpredictable about this response dimension. Here we claim that in many cases the stimulus is not unpredictable but rather the stimulus dimension has an automatic entrance into the response dimension due to prestructure of the system.

Results

For spatial SRC we show how the alignment of reference frames between stimulus and response dimensions makes the stimulus specific not only for the response but also for the stimulus dimension being either be compatible or incompatible. The Simon effect results from this prestructure. That the establishment of common reference coordinates is important for the occurrence of the Simon effect is supported by experimental evidence from variations of the Simon paradigm (Ansoorge & Wühr, 2004). Pretrial effects show that the Simon effect is indeed a result of rapidly adjusting and continuously updated reference frames (Stürmer et al., 2001) as it disappears after incongruent trial. Further support comes from inversions of the Simon effect through performing spatially incongruent tasks in intermittent trials (Marble & Proctor, 2000).

Discussion

In contrast to other accounts to the Simon paradigm in our model the Simon effect is not due to a separate route for

relevant and irrelevant (spatial) information (f. e. Kornblum, Hasbroucq, Osman, 1990) but caused by the stimulus itself specifying both a feature and a response dimensions. This view is supported by evidence about necessary preconditions for the occurrence of the Hedge & Marsh reversal of the Simon effect (Proctor & Pick, 2003).

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