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# Order Effects in Human Belief Revision

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Psychological investigations of human belief revision have revealed a robust finding – *the order effect* (e.g., Hogarth & Einhorn, 1992; Zhang, Johnson, & Wang, 1997). Generally speaking, the order effect refers to the phenomenon in which the final belief is significantly affected by the temporal order of information presentation. Normative theories, such as Bayes' Theorem, has no room for the order effect since it simply violates commutativity. Consequently, the order effect is generally regarded as yet another bias in human reasoning.

Several theories have been proposed to explain the order effect (see Wang, 1998 for a review). They are all based on a serial weight-assignment mechanism. According to this mechanism, evidence items are weighted differently based on their positions in the presentation sequence. A primacy effect occurs when earlier evidence item(s) are weighted more heavily, and a recency effect occurs when later evidence item(s) are weighed more heavily. Different theories differ in terms of what factors are important to determine the weight assignment. For some, the difference in weights results from memory decay so earlier items are weighted less than later items (e.g., Miller and Campbell, 1959). For some others, attention is more critical – attention decrement makes later items to be less weighted (e.g., Anderson 1981).

Wang (1998) proposes a different approach to the order effect in human belief revision. This approach is based on two important findings in the fields of epistemology and uncertainty management. First, human belief has a coherence foundation. Beliefs hold each other as a coherent system. As a result, in terms of belief revision, new positive evidence does not necessarily reinforce a belief, and new negative evidence does not necessarily discredit a belief. Second, human belief has a multi-component structure. A single probability number cannot capture all the important aspects of a belief. A confidence dimension, measured in terms of the amount of previous experience a belief is based on, determines how easily a belief can be revised.

The current study aims to investigate this approach, both empirically and computationally.

The probability/confidence distinction predicts that the order effect pattern may change with different levels of experience. Specifically, when one gains more experience about the environment, one's confidence increases. As a result, the order effect tends to diminish and disappear. The experiment, using a serial tactical decision making task, is designed to test this prediction. It is found that participants showed significant recency effects at the beginning of the

experiment when their experience about the environment is little. Recency effects disappeared as more training trials were performed. The disappearance of the recency effect suggests that instead of over-reacting in the light of new evidence, participants made more confident belief judgments, which eliminated over-reaction.

UEcho, first proposed in Wang, Johnson, and Zhang (1998) as an extension to Echo (Thagard 1989), is a coherence-based model of belief revision. It is further developed to model the experimental results. The modeling results show that UEcho is able to capture the changes of order effect patterns – the order effect occurs when confidence is low and it tends to disappear when confidence increases.

It is suggested that the fact that UEcho, constructed based on rational postulates and intended to prescribe what people should do, naturally shows order effects (when the confidence is low) convincingly “debiases” order effects. The ecological implications of the order effect are discussed.

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