Intentional Binding Experiment

Lab Report

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GitHub Link:
https://github.com/dhwanitm1-lgtm/Lab_in_Psychology/tree/Intentional-Binding

Introduction

Intentional binding (IB) describes the perceived temporal contraction that exists between a voluntary action and that action's sensory outcome: actions are later and effects are earlier when there is a clear causative connection, resulting in a shorter perceived time interval (Haggard, Clark, & Kalogeras, 2002). Because IB represents a perceptual consequence of voluntary control, it has become a particularly popular implicit measure of a sense of agency, defined as the pre-reflective sense that one is the causal author of an action and its accompanying effects (Moore & Obhi, 2012). Implicit measures like IB serve as a useful supplement to explicit self-report, capturing automatic, perceptual correlates of agency that are not vulnerable to demand characteristics or reflective re-interpretation (Moore & Obhi, 2012; Muth, 2020). Most importantly, IB is sensitive to any number of context factors such as action–outcome contingency, expectedness, and valence. Some studies report stronger binding for unexpected outcomes, while others find stronger binding for outcomes that have expected; expectation may modulate the perceptual integration that produces an agency effect (Majchrowicz & Wierzchoń, 2018; Takahata et al., 2012). In this report we follow the PSY310 format to explore the difference in interval estimates for expected versus unexpected outcomes, using a dataset from a single participant, and the pre-computed group means for 3 delay levels.

Method

The design and method of the study followed the tradition of the IB interval-based estimation paradigms. The participant performed a series of voluntary button presses leading to auditory and/or visual consequences after a certain delay. The delays had only one of three possible timings, namely, 100 ms, 400 ms, and 700 ms. Each trial, in which the participant supplied a numerical estimate of the interval between action and outcome, was set in two expectation conditions: expected, whereby the outcome frequency or identity was consistent with the participant's expectations, and unexpected, whereby the outcome and expected outcome were not consistent. The provided data, as outlined in the course guide, is a total of 400 observations for one participant based on three speed and two expectation conditions. The condition means and condition differences for these 3 x 2 = 6 levels are included in the provided analysis file. No graphs have been included as per the course instructions.

Results

exp 100	exp 400	exp 700
534.0190476	508.0190476	436.2
unexp 100	unexp 400	unexp 700
490.3714286	467.4857143	491.2571429
Difference in interval estimates across two levels		
100	400	700
43.64761905	40.53333333	-55.05714286

For the two shortest objective delays of 100 and 400 ms, the participant estimated longer intervals in the expected condition than in the unexpected condition. However, for the longest delay of 700 ms, the participant estimated a shorter interval in the expected condition than in the unexpected condition, which means that the greatest temporal compression took place at 700 ms in anticipation of the interval role. Since this was a single-participant study, no inferential statistics (i.e., t-test or confidence intervals) were considered in the analysis file; thus, the results are purely descriptive, limited to these mean differences observed.

Discussion

In the current single-participant descriptive pattern, the outcome expectation exhibited a mixed effect on interval estimation: stronger expectation was associated with larger interval estimates at

the 100 and 400 ms intervals, yet greater compression (stronger binding) at 700 ms. These heterogeneous effects in direction are consistent with literature indicating that expectation or unexpectedness can operate in complex engagements with IB. Some studies report increased temporal binding for surprising or unexpected outcomes—possibly indicative of increased postdictive integration, in contexts when prediction has been shown to be violated (e.g., Majchrowicz & Wierzchoń, 2018). Other studies report that predictable action–outcome contingencies increase subjective agency and binding (e.g., Moore & Obhi, 2012). The importance of method, either interval versus Libet-clock paradigms, outcome valence, and delay critically impacts whether or not expectation enhances or mitigates IB (e.g., Muth, 2020; Takahata et al., 2012). The present pattern of stronger binding for expectation only at the longest delay condition—may serve to reflect the tempo-limiting windows for predictive relative to postdictive integration: at long objective delays expectancy may facilitate anticipatory temporal alignment instigating compression or stronger binding; whereas, at the short intervals the perceptual system may weigh postdictive cues responsively altering the sign of the effect (conceptually consistent with multi-mechanism accounts as thus reviewed; Moore & Obhi, 2012; Muth, 2020).

Therefore, there are serious limitations that need to temper any interpretations. First, this report is based upon a single participant and wholly descriptive methods; thus, we were not able to generalize by using inferential statistics. Second, the point and interval estimation can be subjected to errors because of response biases and possible scalar variation in time estimation. The Libet-clock could provide more information in the same modality. Third, the dataset yielded did not report variability, SD/SE, or trial-level covariates, such as lapses of attention or trial order, which complicated our ability to model nuanced expectations effects or outlier analysis. Finally, because the mix direction of delays is ensured, replication with multiple participants using inferential tests would be needed to see whether this observation is a reliable effect or idiosyncratic noise.

Despite these limitations, the current descriptive results show some clear merits of IB as a measure of implicit experience: it does capture perceptual correlates of agency that may be dissociated from explicit judgment of agency and allows subtle expectancy effects to be explored based on timing (Moore & Obhi, 2012; Majchrowicz & Wierzchoń, 2018). Other disadvantages include: vulnerable to methodological parameters (paradigm, clock parameters), difficult to interpret (binding can reflect causal binding but not per se agency), and need for converging explicit measures or neurophysiological measures in order to claim strong conclusions (Muth, 2020; Takahata et al., 2012).

References

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