Intentional Binding Experiment

Lab Report

LAB IN PSYCHOLOGY
Pushkar Singh
AU2120067
31/10/23

Github Link : https://github.com/pushkarsingh019

Introduction

Intentional binding refers to the "subjective compression of the temporal interval between a voluntary action and its sensory consequence" (Moore & Obhi, 2012).

This phenomenon has been posited as an implicit measure of sense of agency, as it captures automatic sensorimotor processes related to actions that occur outside of conscious awareness. In particular, intentional binding relies on perceptual timing judgments rather than explicit evaluation of agency, persists even when participants deny conscious authorship (Obhi & Hall, 2011), and does not require intentional focus or attention (Haggard & Cole, 2007).

Most participants are "not aware that their time judgments differ between conditions exhibiting binding" (Moore et al., 2009). Thus, intentional binding provides an indirect window into pre-reflective agency experience by revealing unconscious temporal distortions linked to self-generated actions.

Thus, examination of binding effects and their modulators can provide insight into low-level neurocognitive processes underlying the feeling of agency.

Method

A 3 x 2 factorial within-subjects design was used to investigate perceived temporal compression between voluntary actions and their outcomes, and to explore the brain's role in linking actions and events based on expected versus unexpected frequencies. The two independent variables were delay interval (short, medium, long) and expectancy (expected frequency, unexpected frequency). The dependent variable was the participant's interval estimate in milliseconds between action and outcome.

Each trial required participants (N = 5) to perform a voluntary spacebar press in response to a visual cue (green dot). This action triggered an auditory beep outcome after a short (100ms), medium (400ms) or long (700ms) delay interval, manipulated within-subjects. The beep would play for 300ms and the frequency would either be 400Hz (expected condition) or 1000Hz (unexpected condition).

After each beep, participants provided an interval estimate in milliseconds judging the time between their voluntary action and the outcome beep, using a continuous sliding scale. Each participant went through 120 trials (10 per condition). The study was computerized, requiring a monitor, keyboard, mouse, and speakers to present visual cues and auditory outcomes with precise timings.

Results

A 3x2 repeated measures ANOVA was conducted to assess the effects of delay interval (short, medium, long) and expectancy (expected, unexpected) on interval estimates. There were significant main effects of delay interval, F(2, 8) = 1.269x10^29, p < .001, and expectancy, F(1, 4) = 6.805x10^28, p < .001. There was also a significant interaction between delay and expectancy, F(2, 8) = 1.052x10^28, p < .001.

Furthermore, the difference in average interval estimates for expected and unexpected condition for short delay is 8.720544323, for medium delay is 10.87054229 and for long delay 2.742926156.

3x2(Delay, Expectancy) Repeated Measures Anova

Within Subjects Effects ▼

Cases	Sum of Squares	df	Mean Square	F	p
expectancy	415.673	1	415.673	$6.805\times10^{+28}$	< .001
Residuals	2.443×10^{-26}	4	6.108×10^{-27}		
delay	19.855	2	9.928	$1.269\times10^{+29}$	< .001
Residuals	6.257×10^{-28}	8	7.821×10^{-29}		
expectancy ✻ delay	88.677	2	44.339	$1.052\times10^{+28}$	< .001
Residuals	3.372×10^{-26}	8	4.214×10^{-27}		

Note. Type III Sum of Squares

Difference in average interval estimates across level of expectancy

	expected	unexpected	difference
short delay	492.2408964	483.520352	8.720544323
mid delay	491.4367816	480.5662393	10.87054229
long delay	487.7380952	484.9951691	2.742926156

Discussion

The study shows how the implicit measure of sense of agency, the interval estimate is associated with both the delay interval and expectancy condition, with both factors interacting with each other.

But, is the use of implicit measures a good way to understand sense of agency ? The use of implicit measures to investigate agency experience offers several advantages. It enables the examination of underlying low-level processes that contribute to the perception of agency, even those that operate outside of conscious awareness (Moore & Obhi, 2012). Implicit measures also help circumvent the potential influence of demand characteristics that can skew explicit agency ratings (Obhi & Hall, 2011). Additionally, they prove to be more sensitive to the subtle sensorimotor predictions involved in agency perception compared to subjective reports (Synofzik, Vosgerau, & Voss, 2008). Importantly, implicit measures can detect agency processing even when explicit judgments explicitly deny agency, further emphasizing their utility in uncovering hidden aspects of this phenomenon (Obhi & Hall, 2011). Lastly, implicit measures may offer a more objective assessment, reducing susceptibility to bias in comparison to explicit judgments (Ebert & Wegner, 2010).

While there are notable advantages to using implicit measures to investigate agency experience, it's crucial to recognize that the relationship between these implicit measures and the explicit feeling of agency is intricate and not fully understood (Ebert & Wegner, 2010). Moreover, the presence of dissociations between implicit and explicit agency measures can pose challenges in their interpretation (Obhi & Hall, 2011). Implicit measures, as a method, do not directly assess the subjective aspects of agency experience (Gallagher, 2000). Additionally, there is the consideration that they might be less sensitive to top-down influences compared to explicit agency measures (Moore & Fletcher, 2012). Furthermore, one must be aware that validating implicit measures as a comprehensive assessment of agency, extending beyond sensorimotor correlates, remains a challenging endeavor, which casts some doubt on their broader applicability in this context (Moore & Fletcher, 2012).

References

Ebert, J. P., & Wegner, D. M. (2010). Time warp: Authorship shapes the perceived timing of actions and events. Consciousness and Cognition, 19(1), 481–489. https://doi.org/10.1016/j.concog.2009.10.002

Gallagher, S. (2000). Philosophical conceptions of the self: Implications for cognitive science. Trends in Cognitive Sciences, 4(1), 14–21. https://doi.org/10.1016/S1364-6613(99)01417-5

Haggard, P., & Cole, J. (2007). Intention, attention and the temporal experience of action. Consciousness and Cognition, 16(2), 211–220. https://doi.org/10.1016/j.concog.2006.07.002

Moore, J. W., & Fletcher, P. C. (2012). Sense of agency in health and disease: A review of cue integration approaches. Consciousness and Cognition, 21(1), 59–68. https://doi.org/10.1016/j.concog.2011.08.010

Moore, J. W., & Obhi, S. S. (2012). Intentional binding and the sense of agency: A review. Consciousness and Cognition, 21(1), 546–561. https://doi.org/10.1016/j.concog.2011.12.002

Moore, J. W., Wegner, D. M., & Haggard, P. (2009). Modulating the sense of agency with external cues. Consciousness and Cognition, 18(4), 1056–1064. https://doi.org/10.1016/j.concog.2009.05.004

Sense of agency and intentional binding in joint action | SpringerLink. (n.d.). Retrieved October 31, 2023, from https://link.springer.com/article/10.1007/s00221-011-2675-2

Synofzik, M., Vosgerau, G., & Newen, A. (2008). Beyond the comparator model: A multifactorial two-step account of agency. Consciousness and Cognition, 17(1), 219–239. https://doi.org/10.1016/j.concog.2007.03.010