The Polymodal Role of Consciousness in Adaptive Action: A Paradigm for Neuroimaging

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Introduction

Theoretical developments (e.g., Passive Frame Theory [PFT]) specify which stages of processing, from stimulus input to behavioral output, can occur unconsciously and which cannot transpire without involvement of the conscious field. In PFT, consciousness benefits action selection by enabling the response to one particular conscious content be influenced by the nature of the other conscious contents composing the field. This kind of contextually-sensitive processing yields "integrated action" (e.g., holding one's breath while underwater).

Complementing PFT, the Reflexive Imagery Task (RIT [Bhangal, Geisler, & Morsella, In press]) reveals that conscious contents can enter the conscious field in an insuppressible, reflex-like manner. In the basic version of the RIT, subjects are told to not think of the name of a soon-to-be-presented visual object (e.g., a star). Subjects report (by button press) that they subvocalize the object name involuntarily on roughly 80% of trials.

To investigate the contextually-sensitive kind of processing the consciousness affords, we developed a more elaborate version of the RIT. Subjects indicated by button press the basic RIT effect but, in addition, they had to press another button if and only if (a) the subvocalization rhymed with a word held in mind ("STIR"), and 2) there was a solid border around the image (as opposed to a dotted border). In this RIT variant, accurate responding with the second button requires a host of poly-modal processing (e.g., subvocalization, prospective memory, and visual processing). Can subjects perform this task successfully?

Method

Subjects.
San Francisco State University undergraduate students (n = 34) participated for course credit. The data from six subjects were excluded from data analysis because either they did not follow directions or the computer malfunctioned.

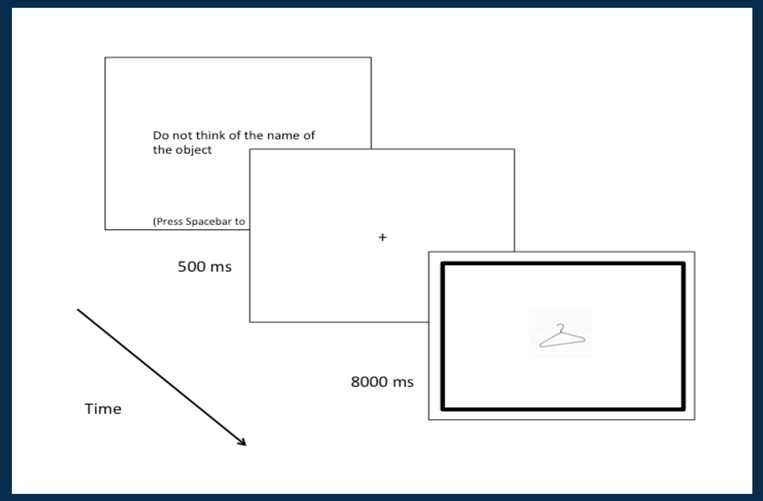
Stimuli.
Stimuli for the practice trials consisted of 10 different line drawings that resembled the line drawings presented in the critical trials. Five images had names that rhymed with "stir", and 5 did not. All 10 images were presented with a dotted line border and a solid line border surrounding the image for a total of 20 trials.

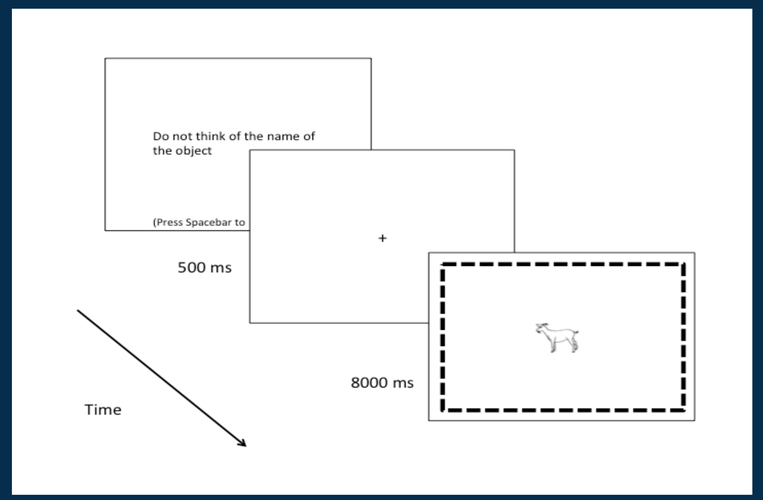
Stimuli for the critical trials (n = 100) consisted of 50 different pencil-drawn images taken from the Snodgrass image list (Snodgrass & Vanderwart, 1980). 25 images had names that rhymed with "stir", and 25 did not. The two sets of 25 images were balanced in terms of number of letters, number of syllables, and word frequency. Each object was presented twice, once with a solid line border surrounding it, and once with a dotted line border surrounding it.

Procedures.
All instructions were presented on the computer screen. Participants were instructed to keep their eyes focused on the center of the screen at all times. To begin a trial, participants pressed the spacebar key. Next, a fixation cross was presented for 500 ms. Finally, the image of an object was presented in the center of the screen. The object was surrounded by either a solid line or a dotted line border (8 s). Images were presented in random order.

Participants were instructed to not think of the name of the object. If they did think of the name of the object (the RIT effect), they had to press a certain button on the keyboard. If the subvocalization of the object rhymed with "stir", and if there was a solid line border around the image, then they had to also press another button. Response times (RTs) were recorded for both button presses.

Sample Trials





Results

Replicating the basic RIT effect, involuntary subvocalizations occurred on a high proportion of the trials, .85 (SD = .17) of the trials. Mean RT for this response was 2,115.32 ms (SD = 1303.04).

On trials yielding an RIT effect, subjects pressed the second button correctly on .78 (SD = .18) of trials, which is higher than what would be expected by chance, $t(27) = 15.84$, $p < .001$. Mean RT for the second button was 2,495.10 ms (SD = 1288.96).

Frequency (from 100 trials) and Latency By Subject

Subject	RIT Freq.	Mean RT	Second Button Freq.	Mean RT
1	99	1622.18	24	2011
2	64	2938.59	24	2775.83
3	67	2523.55	19	2976.16
6	99	1818.37	23	1929.22
7	100	1960.26	24	2426.29
8	81	1070.27	21	1541.14
9	97	2714.43	22	3092
10	92	2853.09	18	2868
11	43	2345.21	5	3437.4
12	99	954.63	23	1248.17
13	99	2156.24	13	3067.38
14	96	1827.67	17	2360.71
15	99	1375.81	21	2708.76
17	92	1968.35	21	2284.81
19	45	3486.84	24	3260.33
20	92	2098.83	12	3415.42
22	87	2683.82	17	2390.82
23	81	2353.58	18	2157.78
24	64	3072.75	15	3221.07
26	95	1758.02	23	2155.3
27	74	2953.41	20	3686.8
28	95	1653.79	24	1938.04
29	92	1729.04	19	1831.84
30	82	1991.9	22	2445.45
31	86	2168.28	16	2753.5
32	100	1427.76	21	1490.71
33	62	3768.89	19	3564.84
34	89	2346.12	18	2748.44

Discussion

This study reveals that subjects are able to perform a task requiring integrations among disparate tokens and modalities, including involuntary conscious content (the subvocalization), an item held in prospective memory (the phonological form of the rhyme target), and a visual go/no-go cue (the solid or dotted border). Somehow, these disparate, multimodal conscious contents yield a single "integrated" action—the correct response with the second button. Subjects were able to make this multi-determined response accurately (~78% accuracy) and reliably.

According to PFT (Morsella et al., in press), this kind of processing, in which the action selection in response to one conscious content (e.g., the involuntary subvocalization) is made in light of the other contents composing the field (e.g., the solid border), is the primary function of conscious processing. When coupled with neuroimaging technologies, this new variant of the RIT may enable researchers to investigate further the neural correlates of consciousness.

References

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Snodgrass, J. G., Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory, 6,* 174-215.