The Importance of Verbatim Report: A Between-subjects Investigation

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Abstract

Previous research manipulated the vision verb within task instructions and examined both response time and P300 differences in response to a stimulus using a within-subject oddball task. Response time and P300 differences between verb categories indicated the possibility of processing differences, however, these results could also have been a result of task switching given the nature a within-subject design. The current research used a between-subject oddball task to control for task switching and measure response time to stimuli following a specific task instruction. Results provide support for the task-switching account.

Introduction

The Importance of Verbatim Report of Task Instructions

Several studies have investigated the various verbs that exist to describe similar processes. For instance, participants in a study by Cacciari and Levorato (2000) were able to make a distinction between 37 Italian verbs related to visual processes based on slight differences in meaning. The English language is also equipped with numerous verbs to describe similar visual processes. The vast array of words available to describe similar functions have intrigued researchers about the importance of these words (Dickinson & Szeligo, 2008). If two functions are essentially the same, why should there be so many words to describe them? Research suggests that the subtle differences in word meaning are important because they are consistently identified by the individuals who use them, and may represent differences in cognitive processing (Naigles, 2000; Dickinson & Szeligo, 2008).

If word differences are so easily recognized by the individuals who use them, then it should stand to reason that verbatim report of task instructions during experimentation would be of the utmost importance (Dickinson & Szeligo, 2008). A study by Dickinson and Szeligo (2008) suggested that the lack of attention to the exact instructions that were given during an experiment could be a source of some of the inconsistency in research findings. If similar words are perceived differently by participants, it may lead them to respond differently which could yield varying experimental results (Dickinson & Szeligo, 2008). In order to investigate this possibility, Dickinson & Szeligo (2008) devised a task in order to determine if behavioral differences are elicited based on subtle differences in task instructions.

Measuring Behavioral Manifestations of Vision Verb Performance

Dickinson and Szeligo (2008) constructed a behavioral task in order to measure the differences in response time to the manipulation of visual verbs within task instructions. The target stimuli for the task were two green triangles which were preceded by a common instruction phrase that directed participants to, "Respond immediately after [they] _____ that the triangles are the same or different." Four verbs were selected that were similar in meaning while still being consistently differentiated based on multidimensional scaling values. The verbs 'see', 'are conscious', 'recognise', and 'distinguish' filled the blank in the task instruction and participants' response time to the target stimuli was measured for each of the four instructions. Response time to stimuli was then compared across each verb condition and significant response time differences were found between the verbs 'see' and 'distinguish', as well as 'recognize' and 'distinguish'. It took a significantly greater amount of time to make a response following instructions containing 'distinguish' than instructions containing 'see' or 'recognize'. These response time differences had two implications: either willingness to respond – such that the participants were responding in a way they felt they should; based on their conscious perception of the task, or processing differences – such that the instructions evoked different cognitive processes (Dickinson & Szeligo, 2008). In order to determine if the differences in response times were due to distinctive neurological processes it was necessary to use an event-related potential (ERP) method of investigation (Chamberland, Thomas, Cirelli, & Dickinson, Submitted Manuscript).

Analyzing Neurological Processes Through the Use of ERPs

The use of ERPs to determine if behavioral differences are the result of distinct neurological processes is common practice in cognitive research (Polich, 2007). In particular, at

approximately 300 ms after the onset of a stimulus, a positive peak is displayed in the ERP wave which is referred to as the P300 component (Polich, 2007). When differences in response time are paired with differences in P300 amplitude, it is suggested that these differences are a result of distinct neurological processes (Polich, 2007). Of particular importance is that the P300 component of an ERP response is not influenced by willingness to respond (Christensen, Ivkovich, & Drake, 2001). This makes the P300 component a particularly useful tool in differentiating between explanations for response time differences. In other words, the P300 component allows for the measurement of processing differences by controlling for willingness to respond (Christensen et al., 2001). A study by Chamberland et al. (Submitted Manuscript) used an ERP oddball task in order to investigate the neurological differences relating to the processing speed of visual verbs.

Chamberland et al. (Submitted Manuscript) used a within-subjects design where vision verbs were embedded in task instructions. The instructions were to "Respond immediately after you _____ that the letter is an 'X'." The blank was filled with the verbs 'view', 'notice', 'sense', and 'distinguish'. Considering the nature of a within-subjects design, each participants' responses were recorded for each of the four target verb conditions in random order. It was hypothesized that if P300 and response time differences were observed between verb conditions it would signify a difference in neurological processes (Chamberland et al., Submitted Manuscript).

The response times for the four verb categories were analyzed across four regions of interest (ROI): the frontal, right and left temporoparietal, and occipital regions. A significant P300 difference was found in the frontal lobe accompanied by a significant response time difference between the verbs 'sense' and 'distinguish'. Considering the location of the P300

difference, it is possible that it may be representative of a P3a component; an element of the P300 observed during attentional tasks (Polich, 2007). There are two primary explanations for an elicited P3a component; either orientation of attention or task switching (Polich, 2007). Given the first explanation, the P3a as a representation of attentional orientation suggests that the resources allocated to performing a specified function are influenced by the instructions that are given (Polich, 2007). On the other hand, the P3a could have been elicited due to task switching which would indicate that the novelty of the task instructions led the participants to perceive them as different (Barcelo, Periaflez, & Knight, 2002; Polich, 2007). Given the fact that the study by Chamberland et al. (Submitted Manuscript) was conducted using a within-subjects design, it was not possible to differentiate between the two possible explanations for the P3a component. To clarify, task switching is an invariable component of the within-subjects design, therefore, in order to set apart these two explanations, a between-subjects design must be used to control for task switching and measure allocation of attentional resources.

Present Study

The goal of the present study was to determine if the P3a component elicited in the frontal lobe was a result of differential allocation of attentional resources or a result of task switching. A between-subjects design was used in conjunction with an oddball task in order to control for task switching and measure the devotion of attention toward a stimuli. The visual verbs ‘sense’, ‘notice’, and ‘distinguish’ were embedded in task instructions and response times were measured to the presentation of a stimulus. Measurements were made during the presentation of the stimulus as opposed to during the presentation of the instructions in order to ensure that data was collected with respect to the performance of the visual action as opposed to recording the responses to the properties of the verbs themselves.

It was hypothesized that if the verbs elicit distinctive neurological processes, there would be significant differences in response times between the verb categories. However, if differences in response time are not found, this would suggest that the differences in the P300 component previously discovered by Chamberland et al. (Submitted Manuscript) were likely a result of task switching.

Method

Participants

Sixty participants (14 males, 46 females) from Laurentian University participated in the study. They were between 18 and 48 years of age (*M* = 21.75 years, *SD* = 5.39). All of the participants had normal or corrected-to-normal vison and were working towards their undergraduate degree. All of the participants spoke English as their first language and, due to the limited amount of left-handed individuals available for testing, they were all right handed. As a result of brain lateralization, it has been shown that, in language tasks, right and left handed individuals tend to yield different results (Frost et al., 1999; Knecht et al, 2000; Szaflarski et al., 2002). It is for this reason that only right handed individuals were tested as there were not enough left handed individuals to constitute another research variable. Each participant gave informed consent to participate in the study, and they were compensated for their participation with course credit.

Materials

Stimuli were presented in English on a computer screen using E-Prime software (Schneider, Eschman, & Zuccoloto, 2002). A standard oddball task was used for random stimulus presentation (Luck, 2005). There were two different stimuli; a target ‘X’ and a non-

target ‘Y’. The participants were instructed to respond only to the target ‘X’. Target stimuli were displayed 20% of the time for a total of 60 out of 300 trials, and the non-target stimuli were displayed 80% of the time for a total of 240 out of 300 trials.

Procedure

Participant testing was completed individually in a booth designed to reduce noise from the external environment. Each testing session lasted approximately 30 minutes. Participants were randomly assigned to one of three verb conditions; sense, notice, or distinguish. Each participant was then seated in a sound attenuated booth approximately 25 inches from a computer screen where they were presented with a set of general instructions. These instructions appeared on the computer screen and explained the experimental procedure. After the appearance of the general instruction screen, a practice block was used in order to acquaint the participant with the experimental procedure. Once the practice block was completed, the experimental session began where a common instruction phrase was displayed for 3000 ms before each trial. The common instruction phrase stated to, “Respond immediately after you _____ that the letter is an ‘X’,” where the blank was filled with a vision verb either to ‘sense’, ‘notice’, or ‘distinguish’. These verbs were selected based on the previous findings by Chamberland et al. (Submitted Manuscript) that suggest that these verbs might be processed differently in the brain based on response time differences. This experiment was conducted using a between-subjects design to control for task switching, therefore, each participant responded to a task instruction containing the same visual verb for every trial. After the common instruction screen, a blank screen appeared for a random amount of time between 750 and 2000 ms in order to eliminate expectation of the stimulus. The target ‘X’ or non-target ‘Y’ stimuli was then presented in random order for 500 ms and the participant could either respond on not by using a

response box clicker. The trial ended with another blank screen for 500 ms after the presentation of the stimuli in order to allow the participant some time to respond. The participants completed a total of three blocks, and were allotted a short break after each block. Mean and median response times to the target stimuli were analyzed across verb conditions and between blocks (Ruddell & Hu, 2001).

Results

A between-subjects ANOVA was used to investigate the impact of verb condition (sense, notice, and distinguish) on response time (see Table A1 in the Appendix). No significant main effects of verb condition on mean or median response time were found; $F(2)=0.79$, $p>.05$ and $F(2)=0.62$, $p>.05$ respectively. Response accuracy for each verb condition was 97.5% and above with no significant differences between conditions, $F(2)=2.16$, $p>.05$. Observed power = 0.178.

Discussion

Results for this experiment suggest that manipulating the vision verb within task instructions does not elicit different cognitive processes. The mean and median response times for each of the instructional conditions were not significantly different. These results provide support for the idea that response time and ERP differences found in previous research (Chamberland et al., Submitted Manuscript; Dickinson & Szeligo, 2008) were a result of task switching.

Research by Barcelo, Perianez, and Knight (2002) investigated the impact of task novelty on ERP recordings. A modification of the Wisconsin Card Sorting Test was used where participants were asked to sort stimuli based on a certain instruction criterion such as color, size, or shape. The criterion for sorting the stimuli would change at random intervals, and when it did

a significant change in the P3a was observed. From these results researchers suggested that the simple act of switching tasks could be enough to elicit a change in the P3a component. The results from the current experiment support this finding such that, once the possibility of task switching as a contributor to response time differences was removed, no significant differences were found between instructional conditions.

Even though no significant differences were found, it is possible that the task was too long which may have led to fatigue effects (Boksem, Meijman, & Lorist, 2005; Langner, Steinborn, Chatterjee, Sturm, & Willmes, 2010; Lorist et al., 2000; van der Linden, Frese, & Meijman, 2003). It was hypothesized that if fatigue had an impact on response time this would be reflected in a significant difference between the blocks of each instructional condition. More specifically, it was hypothesized that the average response time in earlier blocks would be significantly less than the average response time in later blocks which would reflect the participants' alertness (Langer et al., 2010).

In order to test this hypothesis, a 3x3 mixed-design ANOVA was conducted where the within-subject factor was the three blocks within each instructional condition (Block 1, 2, and 3) and the between-subjects factor was the three instructional conditions (sense, notice, and distinguish). A significant main effect of block on mean and median response time was found; $F(2)=3.90$, $p<.05$, $\eta^2=.06$ and $F(2)=4.22$, $p<.05$, $\eta^2=.07$ respectively. Post-hoc analysis using least significant differences indicated that response times in Block 1 and 2 were significantly less than in Block 3 (see Table A2). The slower responses in the third block provide support for the idea that participants experienced fatigue towards the end of the experiment which subsequently impacted response time (Langer et al., 2010). Therefore, the fact that a significant difference was not found between instructional conditions could be a result of the task being too long.

Furthermore, there is an additional explanation for the insignificant results of this experiment. Previous research on verbs describing similar processes has often been conducted where participants are asked to make verb judgements about one verb in comparison to another (Cacciari & Levorato, 2000; Chamberland et al., Submitted Manuscript; Dickinson & Szeligo, 2008; Naigles, 2000). It could be that when participants are able to make comparisons between verbs with similar meanings; the verbs are processed differently with respect to one another (Olsen, 1970). Participants might need the contrast between similar verbs in order to fully understand the differences between them. This would explain why, when a single verb was isolated, response time differences were not observed. Participants were not able to make comparisons between the verbs embedded within the task instructions (sense, notice, and distinguish) and so it is possible that the understanding of those specific verbs diminished (Barsalou, 1982; Olsen, 1970).

For example, when participants were asked to ‘notice’ the ‘X’ in the current study, they may have responded subjectively based on the core meaning of this word (some visual process) (Barsalou, 1982). The specific meaning of ‘notice’ might not have been understood because the participants were not given any context (Barsalou, 1982; Olsen, 1970). However, in the previous study by Chamberland et al. (Submitted Manuscript), when participants were asked to ‘notice’ the ‘X’ as opposed to ‘distinguish’ the ‘X’, the specific meaning of the word ‘notice’ was able to be processed because the participants were given context (Barsalou, 1982; Olsen, 1970). Research by Barsalou (1982) on context-dependent and context-independent properties of words supports this hypothesis. His research suggests that there are verbs that can be processed in the same way regardless of context (context-independent), however, some words require context in

order to be understood (context-dependent). Additionally, individual responses to a context-dependent word varies based on subjective interpretation of the word unless context is provided.

In order to test this hypothesis, future research could allow one group of participants to view a list of verbs describing similar visual processes so that they gain a sense of the verb meanings in relation to one other. Another group of participants would not be provided with this list. Response times could then be measured to only one of the verbs on the list in an oddball paradigm similar to the one used in this experiment. Response time results could then be compared between the groups to test the effect of verb contrasts on response time while still controlling for the possibility of task switching.

Finally, the insignificant results of this experiment could be attributed to low power (0.178). In between-subject designs a large number of participants are required in order to obtain probable results. The current study used N=60 participants which appears to have been an inadequate sample size. If a larger sample was used, this could increase the power for the experiment which could, in turn, yield significant results. With that said, the low power for this experiment implies the limited reliability of the results.

Conclusion

The insignificant results of this study suggest that manipulating the verb within task instructions does not elicit distinct cognitive processes, however, these results do not necessarily suggest that previous research results were obtained due to task switching. The length of the task could have fatigued the participant which may have subsequently impacted response time. Additionally, further research could be conducted to test the effects of verb contrasts on response

time. Overall, the observed power for the experiment was only 0.178 so strong conclusions cannot be drawn from these results.

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DOI: 10.1016/S0001-6918(02)00150-6

Appendix

Table A1

Mean and Median Response Times with Standard Deviations (SD) Measured in Milliseconds for Each Verb Condition

Verb Condition	Mean	SD	Median	SD
Sense	449.42	56.34	433.43	54.78
Distinguish	449.05	63.22	435.25	61.54
Notice	428.32	62.70	416.80	57.02

Table A2

Mean and Median Response Times with Standard Deviations (SD) Measured in Milliseconds for Each Block

Block	Mean	SD	Median	SD
1[a]	436.50	59.13	424.51	59.41
2[b]	440.60	62.28	425.38	62.23
3[a,b]	450.34	72.77	438.48	69.65

Note. Blocks with matching superscripts were found to have significant response time differences ($p<.05$) in post-hoc comparisons.