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Planning and Navigating in an Unfamiliar Location: Effects of Outsourcing on Memory

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Abstract

Outsourcing is the process of using some external tool as a memory aid. There are a whole host of tools to outsource information that we want to remember. The purpose of this study was to better understand how outsourcing impacts memory for information outsourced and the information not outsourced. This study used different methods of navigation: simulated GPS as well as a self-generated route to involve the generation effect—generating the to-be-remembered information by oneself. Route accuracy and route tasks were measured by participants' memory. The independent variables in the study are navigation source (GPS determined versus self-generated) and test instruction (counter-outsourcing, outsourcing, or incidental learning group). The dependent variables of interest include the participants' memory for the route they took (outsourced material), and their memory for the tasks they were asked to complete at each location (non-outsourced material). When the participants used GPS, they were instructed on the specific route that they needed to take and what to do at each stop. When the participants were instructed to create their own route, they were informed of the stops that needed to be made, as well as the tasks they needed to complete. These findings will help clarify the role of the generation effect in outsourcing, and how outsourcing impacts memory for both outsourced material as well as non-outsourced material.

Keywords: outsourcing, generation effect

Planning and Navigating in an Unfamiliar Location: Effects of Outsourcing on Memory

There are many research experiments that have studied cognitive offloading; covering topics like what offloading is, its effects, and its usefulness for the average person (Risko & Gilbert, 2016). Risko and Gilbert (2016) defined cognitive offloading as the use of physical action to alter the information processing requirements of a task in order to reduce cognitive demand. To offload, one must change something in their external environment that will reduce how much they will process specific information. By doing so, it will reduce the amount of cognitive demand necessary to remember that certain task. An example of offloading is if an individual set a reminder on their smartphone, resulting in them no longer needing to remember the information themselves due to the phone reminding them at a predetermined time. This reduces the cognitive demand on the individual to know the information, because they are depending on the external source to keep that information for them. Therefore, they trust that through this action, they themselves will not end up losing the information or forgetting.

There are multiple reasons why people offload. Risko and Dunn (2015) acknowledged that one reason for people offloading is to reduce their mental effort concerning the to-be-remembered information. However, Risko and Dunn also found that it was more likely that an individual would offload for a perceived sense of greater accuracy of the information. People also offload because they lack personal confidence in their ability to remember the information and produce it accurately (Risko & Dunn, 2015; Hejtmanek, Oravcova, Motyl, Horacek, & Fajnerova, 2018; Risko & Gilbert, 2016). Trusting these external memory tools more than our own memory could be considered more relevant in today's society as these remembering tools are improving with every coming technological advance that is made.

People offload information through a wide variety of methods. These include writing down the information somewhere in the external environment or using technology to assist in reminding and maintaining accuracy (Risko & Gilbert, 2016). Relying on another person to remember the information for you and other external memory aids are non-technological ways to offload into the external environment (Intons-Peterson & Fourier, 1986). With a magnitude of options to aid in offloading, the individual does not need to know the information itself. They solely need to know where to find it (Risko & Gilbert, 2016; Storm, Stone, & Benjamin, 2017).

There are many ways that offloading can impact an individual cognitively. Information that was offloaded can be more accurate and reliable than information held internally in memory (Risko & Dunn, 2015). Because the information was not subjected to common human imperfections such as confusion and forgetfulness, it stood a better chance to remain accurate in its original form. Similarly, Risko and Gilbert (2016) found that cognitive offloading allowed a person to achieve cognitive abilities beyond normal human capacity.

On the other hand, it has also been found that offloading could result in worse memory abilities (Risko & Dunn, 2015), but may also improve memory for information that was not offloaded via pro-active inhibition. When offloading is used, the information offloaded should have a decreased likelihood to be recalled. However, for all the other information that was processed that the person was not able to offload, that information should have a better chance of being remembered. For example, if a student is trying to study for a test, but also needs to remember their weekly grocery list for the store, by offloading their grocery list onto a piece of paper, they would then have freed space in their brain to hold more information for their upcoming test. This idea is important to test because it could help us to better understand how offloading can effect tasks other than those that are originally being focused on.

Several cognitive offloading experiments allow some participants to use technology to offload information while others must generate that information on their own (Storm, Stone, & Benjamin, 2017). The generation effect can best be described as greater memory for self-generated information compared to provided information (Greenwald & Johnson, 1989). Simply put, when an individual generates the information themselves, relying on their own cognitive ability and drawing on their existing knowledge, they are more likely to remember that information than if they were told to remember something that they may be less familiar with. This effect occurs without deliberate effort (Greenwald & Johnson, 1989). The effect was supported again in Greenwald and Benaji's (1989) research when they found generating information was a tool of encoding and improved recall performance compared to recall for non-generated items. Storm et al. (2017) combined both the generation effect and cognitive offloading; however, did not look at memory for the offloaded information, but rather how willing participants were to continue to offload if given the chance. Because these variables were not looked at in terms of memory performance, this is precisely the gap of knowledge that is being aimed to fill with the current study.

This study focuses on a particular interest in offloading navigation through use of GPS, to compare between self-generated and provided routes and the impact the have on a person's memory for the route itself as well as other information that was not outsourced. In some conditions, the individual was not required to know the route information themselves, but rather depended on this external source—GPS—to know the information, decreasing their cognitive processing requirements for route information, and potentially freeing up processing to retain other information. Studies looking at GPS specifically have found that GPS supported navigation required less occupation with the task, allowing individuals to become less mindful of the

surrounding environment (Hejtmanek, et al., 2018). The self-generation effect can be used to explain this finding. The generation effect describes whether a person creates the information to remember or whether the information is given to them (Greenwald & Johnson, 1989). If the information is given to them, it is given less cognitive demand than if the information was generated by the participant. An example of this would be if a spouse wrote a grocery list for their partner versus if the partner wrote their grocery list themselves. They would have a greater chance at remembering what was on the list (had the list been left in the car) if they had written it than if their spouse had written it for them.

This study aims to combine these different areas to better understand the impact that offloading and generating information have on later recall. The findings of this study will assist in filling a gap in the existing research, especially in our understanding of how offloading impacts memory abilities for offloaded and retained information, mindful of the effects generating information have on performance. The hypotheses for this study aim to look at route accuracy as well as memory for non-outsourced tasks (see Figure 1 and Figure 2).

Method

Participants

The participants for this study included 62 students enrolled in the University of Nebraska at Omaha (UNO), all of whom were also enrolled in a psychology course through the University's Psychology Department within the College of Arts and Sciences. Of these 62 participants, 52 were female and 10 were male, all with the mean age of about 21-years-old. Within this pool of participants, 37 self-reported as being Caucasian/White, two self-reported as being African American/Black, four self-reported as being Asian, 13 self-reported as being

Hispanic, four self-reported as being Biracial/Multiple, one self-reported as being Indian, and one self-reported as being Egyptian.

Participants were also asked to self-report their highest education level held. This was used to help get a better overall understanding of our population of participants. Of the options available to choose from, eight self-reported their High School/GED, 43 self-reported that they had received some college, nine self-reported an Associates, and two self-reported a Bachelors. Each of the participants were randomly assigned into a group prior to testing. This allowed the six testing groups to remain equal in sample size throughout the entirety of the experiment.

Design

This experiment originally consisted of three different groups in a mixed-model design. The independent variables in the study were generation with two levels manipulated within subjects (GPS determined route versus self-generated route) and instructions with three levels manipulated between subjects (counter outsourcing, outsourcing, and an incidental learning group). Counterbalancing insured half of the participants completed the self-generated route first, and the other half completed the GPS generated route first. The dependent variables of interest were participants' memory for the route they took to get from one destination to another (material to be outsourced) and their memory for the tasks they were asked to complete at each location (other information to be remembered).

Once data analysis began, we switched the design to a between-subject's design, as our counterbalancing measure for self-generated route vs GPS route was showing order effects. Therefore, only the first level of generation that was completed by each participant was analyzed to look for memory differences.

Materials

Participants' memory for the route was measured by having the participants attempt to recreate the exact route taken in a follow-up route test. Participants drew the route onto a paper map (see Appendix 1).

Other information to be remembered included tasks participants were asked to complete at each location along the route. Their memory for these tasks were also measured as a free recall memory test to see if memory performance was impacted by outsourcing and the generation effect.

When the participants complete the GPS generated route, the researcher instructed them on the specific route that they needed to take to navigate to each point along the route. Along with the streets that the participants took, they were also informed of each stop they needed to make along the way before reaching their destination, as well as what tasks they will need to complete at each stop (see Appendix 2).

When the participants were instructed to create their own route, they were not given specific streets to take. They were only informed of the several stops that need to be made, as well as the tasks that needed to be completed at each. Participants were randomly assigned into one of the six conditions in the study (see Table 1).

Procedure

No matter which condition the participants were randomly assigned to, each received the same first map (Map 1), which was a portion of Phoenix, AZ. Phoenix was chosen because it had a similar grid-like layout to Omaha (the location of testing). However, none of the participants reported familiarity with Phoenix which ensured that it was truly an 'unfamiliar location.' Each participant heard identical instructions which consisted of every location they needed to visit

during their busy day of errands—two tasks they needed to complete at each of the six locations around the city—which served as the other information to remember.

At the end of the experiment, participants were administered a post-test which consisted of two parts. First, a blank map identical to the one used during the test (to measure their memory for the route itself) and second, they received a piece of paper to record each of their stops and the tasks that were completed at each stop (to measure the other information that was not outsourced). Once these were filled out, they were each given a demographics form to fill out and were then debriefed on the experiment as a whole.

Instruction Conditions

Counter-outsourcing group. The participants who were assigned to the counter-outsourcing condition were instructed that they would be tested on their map information after the experiment concluded, and therefore they needed to keep all of the information in mind. By being prompted of this, it discouraged the participant from outsourcing the route information. The test was mentioned to the participant twice during the initial instructions prior to the experiment.

Outsourcing group. In order to prompt the participants into outsourcing their information, they were informed that they would be tested on the route information later and that they could make any notes for use during the post-test. This encouraged the participants to outsource their information because they believed they could use these notes later to help them recall on the post-test. However, once the experiment was completed, they were informed that they actually had to take the post-test by memory and had to hand in their maps.

Incidental learning group. This group was not aware of the fact that they would be tested on their memory of the route and tasks later on. The participants were never prompted into thinking that there would be a post-test following the experiment. Therefore, all of the memory that they

had for this test was be simply due to the incidentals of either remembering the tasks and map, or by not remembering.

Data Analysis

A 2x3 between subjects ANOVA was conducted to determine the impact of instructions and generation on their memory for the route. A second ANOVA was conducted to examine the impact of instructions and generation for their memory for the other tasks.

Results

Route Accuracy

To calculate the percent accuracy on route memory for each participant, the map each participant created during the experiment was compared with their test map at the end of the experiment. Instead of looking at every single street, the researchers looked at the route as a whole from one stop to the next. Since there were six stops total for the participants to remember, they were each given a score out of six that was then computed into a percentage for their overall route accuracy (see Table 2).

The main effect of generation on route accuracy was significant, $F(1, 56) = 7.80$, $p < .01$, $\eta_p^2 = .25$, such that participants who self-generated their map ($M = .70$, $SE = .19$) had significantly higher route accuracy than participants who used GPS ($M = .58$, $SE = .16$). These results were in line with the anticipated results (see Figure 3). It shows that generation did have an impact on memory for the route during the post-test given to participants. The main effect of instructions on route accuracy was not significant. There was also not a significant interaction between the route instructions and the route accuracy.

Task Accuracy

To calculate the percent accuracy on task memory for each participant, the task memory each participant at the end of the experiment was compared with the tasks that were said during the experiment instructions at the beginning. Since there were 10 total tasks, each participant gained a score out of 10 for each task that they had remembered correctly. These numbers were then computed into a percentage for their overall task accuracy (see Table 3).

The main effect of generation on task accuracy was not significant, $F(1, 56) = .01$, $p > .10$, $\eta_p^2 = .00$. These statistics show that no matter if the participants self-generated their map or used GPS, it had no effect on their memory for tasks during the post-test. These results were not in alignment with the anticipated results (see Figure 4). The main effect of instructions on task accuracy was not significant. There was also not a significant interaction found between the route instructions and the task accuracy.

Discussion

After running the statistical analyses for this experiment, we came to the conclusion that the only variable that had an effect on the memory of our participants was that of the initial map instructions. The only finding that was significant within our research was the conclusion that if participants generated Map 1 themselves, they then had a higher memory for the route during the posttest than the participants who were given GPS instructions during the experiment. There were no significant findings to support our hypothesis that outsourcing the route material impacted the participants' ability to remember more tasks during the posttest.

There is a wide variety of experiments that have already studied the topic of cognitive offloading, its usefulness to humans and what exactly it is (Risko & Gilbert, 2016). In order to offload, the individual must change something in their environment (i.e. using a planner to

remember important doctors' appointments) that will then help to cue their memory into better remembering the item. The reasons why individuals offload their information have been for multiple different reasons. One of these reasons has been found to reduce their mental effort concerning the information that they want to remember (Risko & Dunn, 2015). People have also been found to offload because they do not have the confidence in their own memory to remember certain items (Hejtmanek et al., 2018).

Through past research, it has been found that the mode of offloading can be on a spectrum from technology to planners, calendars to even other people. It has also been shown that offloaded information could be more accurate than ones' own memory. The idea of cognitive offloading has been around for years, and this experiment attempted to help fill some gaps in the research that is already out there. However, the conclusions made from this experiment only seemed to strengthen the idea of the generation effect, and how that phenomenon can be used to strengthen ones' own memory for items that they have created themselves.

Future Research

When thinking of future research that should be conducted to get a better sense of these findings, both age and prompting method would be interesting to look further into. The age of the participants is extremely important because age cohorts may use different memory aids. We would expect to see that younger generations are more likely to use technology to assist in their memory, while the older generations are far more likely to use alternative methods to remember things – like a planner or written calendar. Looking at these differences would be interesting because it could help to dive deeper into the type of aid utilized, as well as the accuracy of memory for different age groups.

For the prompting method, this is in regard to the instructions for outsourcing in the experiment. By using a more distinct prompting method, participants might be more likely to outsource even more information. This could then, in turn, either increase or decrease the amount that they remember on the free-recall post-test. By prompting for outsourcing or counter-outsourcing to a greater degree, the results might be more defined, which would give a better idea on whether outsourcing actually has an impact on one's memory for items.

Limitations

There are multiple limitations that need to be discussed when examining this experiment as a whole. First, due to the world-wide pandemic of COVID-19 that was occurring during the data collection stage, the number of subjects that were able to participate in the study were quite limited. Originally, it was calculated that at least 118 participants were needed to get a good sense of the effects of the experiment as a whole. Due to COVID-19, this collection was cut short by at least six weeks, resulting in reduced data collection only gathering half of our anticipated sample. This is a major limitation within the study because it limits the validity of our results when looking at a larger scale. In order for any experiment to show great external validity, the sample size must be appropriate for the estimate effect size under scrutiny. External validity allows us to generalize the results to the entire population, and due to the small sample that we had, this is difficult to do. Though some of the results in the study were still found to be significant, the external validity could be questioned by other researchers simply because of the lack of participants within this study.

Another limitation that should be discussed is the process of participants being chosen. The study was submitted to SONA, the psychology research study participation website for UNO, which allowed students to select the study if they chose to participate in research. The

struggle with this is that many participants only did so to receive extra credit within their psychology courses. They could also only sign up for pre-determined times that worked with the two researchers. This limited the availability for each participant and therefore seemed to shrink our subject pool. It also seemed like participants only signed up towards the end of the semester when their grades needed the extra credit. This is a limitation because again, due to COVID-19, students had not reached the end of the semester and therefore were not signing up for the study through SONA.

Conclusion

Outsourcing memory using external means has been around and studied by psychologists for many years. Depending on the condition in which the participant was randomly assigned to, the effects of instructions to outsourcing their memory did not seem to show many results within this experiment. However, the generation effect did have an impact on the route accuracy. These findings deviated from the past research looking at memory and outsourcing; outsourcing information has historically been shown to have an effect on one's memory – both positively and negatively. As depicted before, future work should be done to further examine these ideas and the more specifics behind them; however, outsourcing memory using external memory aids will always be prevalent within society in this day and age.

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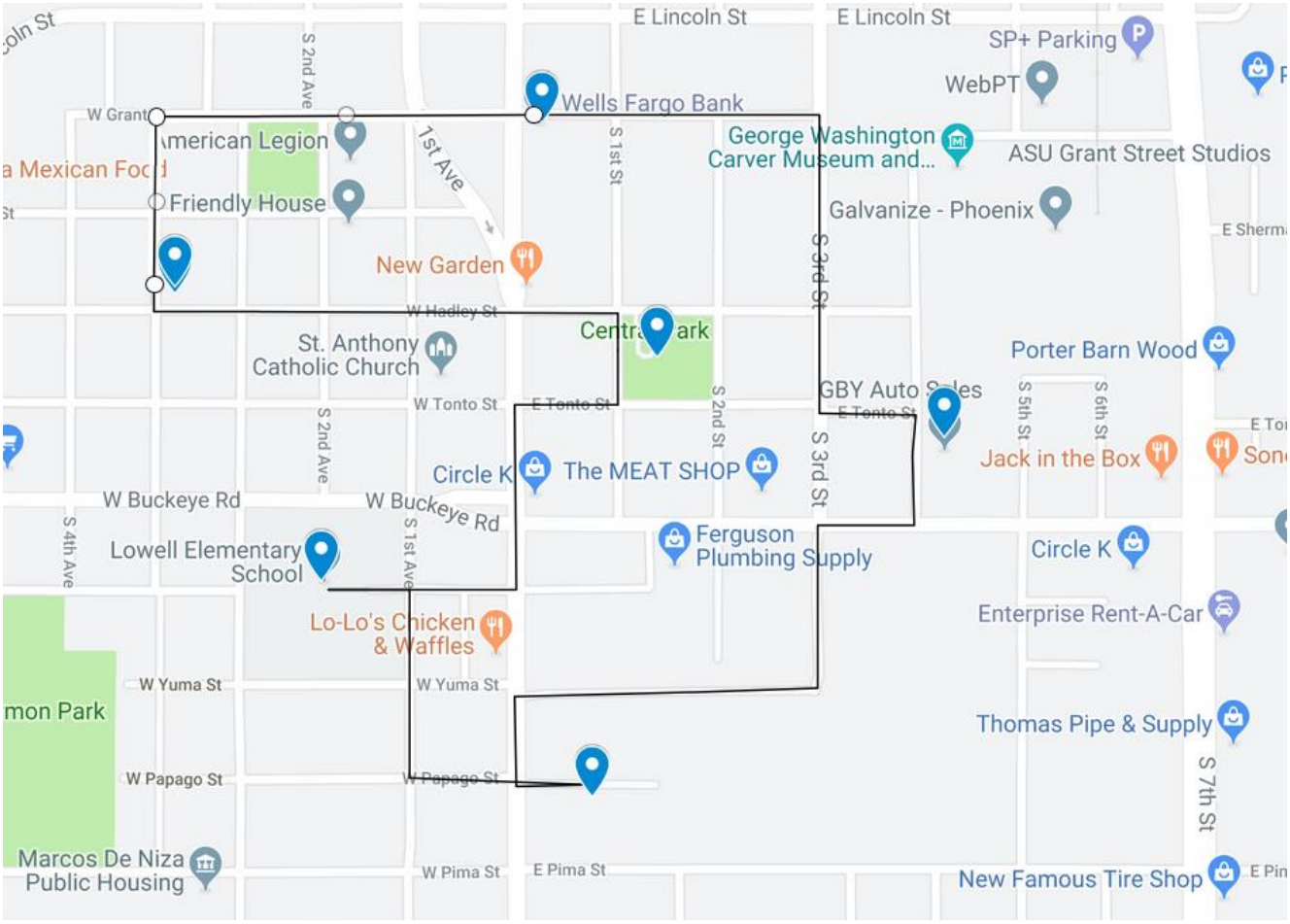
Appendix 1.



Note. Map 1 completed GPS route given to participants.

Appendix 2.

Please listen closely to the tasks you have to do today. You have a long list of things-You have a lot of things to accomplish and you should try to remember all of these tasks so you don't miss anything.

You make a plan to complete all of your errands in the most efficient order-starting out with withdrawing $50.00 from your bank and depositing your paycheck.

Your second stop is the Auto Shop-you need to pick up a new headlight for your car. You also need to get more coolant.

Your third stop is at the Arizona Supplies store-you need to buy an umbrella and a bleacher seat cushion before you go to a baseball game later today. Forecast is calling for rain, unfortunately.

Your next stop is to your child's elementary school-you need to drop off a signed permission slip for a field trip as well as pick up your child.

Your last stop is the park-you need to remember to tell the baseball coach that your child will be missing practice tomorrow, and also talk with Mrs. Ruby about what you can bring for the team bake sale next week.

Note. Instructions given to participants regarding the tasks they would need to complete at each stop during Map 1

Table 1. *Experimental Design Display*

	Told about Memory Test (Counter-Outsourcing)	Told Nothing (Incidental Learning)	Told about Test but Lied about Use of Map (Outsourcing)
Not Generating (GPS)	100s	300s	500s
Generating (Map)	200s	400s	600s

Note. Counterbalancing was going to allow for the collapsing of the 100s and 200s, 300s and 400s, and 500s and 600s; however, they showed different performance and so the generation independent variable was instead analyzed using the just the first Map instructions.

100s: Told about Memory test; Map one uses GPS; Map two is generated

200s: Told about Memory test; Map one is generated; Map two uses GPS

300s: Told Nothing; Map one uses GPS; Map two is generated

400s: Told Nothing; Map one is generated; Map two uses GPS

500s: Told about Test but Lied about use of Map; Map one uses GPS; Map two is generated

600s: Told about Test but Lied about use of Map; Map one is generated; Map two uses GPS

Table 2. *Descriptive Statistics for Route Accuracy.*

Map 1 Instructions	Outsourcing	Mean	Standard Deviation	N
GPS	Counter-Outsource	.52	.15	9
	Incidental Learning	.59	.09	11
	Outsourcing	.62	.22	10
Self-Generated	Counter-Outsource	.77	.17	11
	Incidental Learning	.68	.20	10
	Outsourcing	.65	.20	11

Note. Counter-Outsource group was told about the memory test. Incidental Learning group was not aware of any test. Outsourcing group was told about test but lied to regarding map use on test.

Table 3. *Descriptive Statistics for Task Accuracy*

Map 1 Instructions	Outsourcing	Mean	Standard Deviation	N
GPS	Counter-Outsource	.29	.17	9
	Incidental Learning	.26	.16	11
	Outsourcing	.24	.14	10
Self-Generated	Counter-Outsource	.33	.21	11
	Incidental Learning	.17	.16	10
	Outsourcing	.28	.23	11

Note. Counter-Outsource group was told about the memory test. Incidental Learning group was not aware of any test. Outsourcing group was told about test but lied to regarding map use on test.

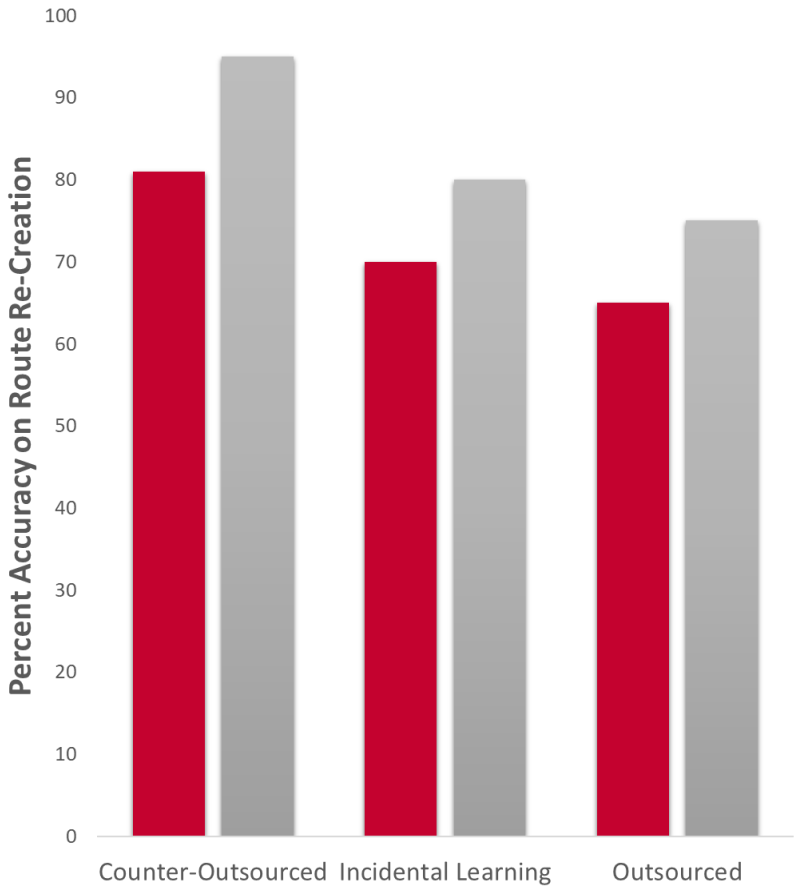


Figure 1. *Anticipated Findings for Route Accuracy*

Note. Generated

GPS

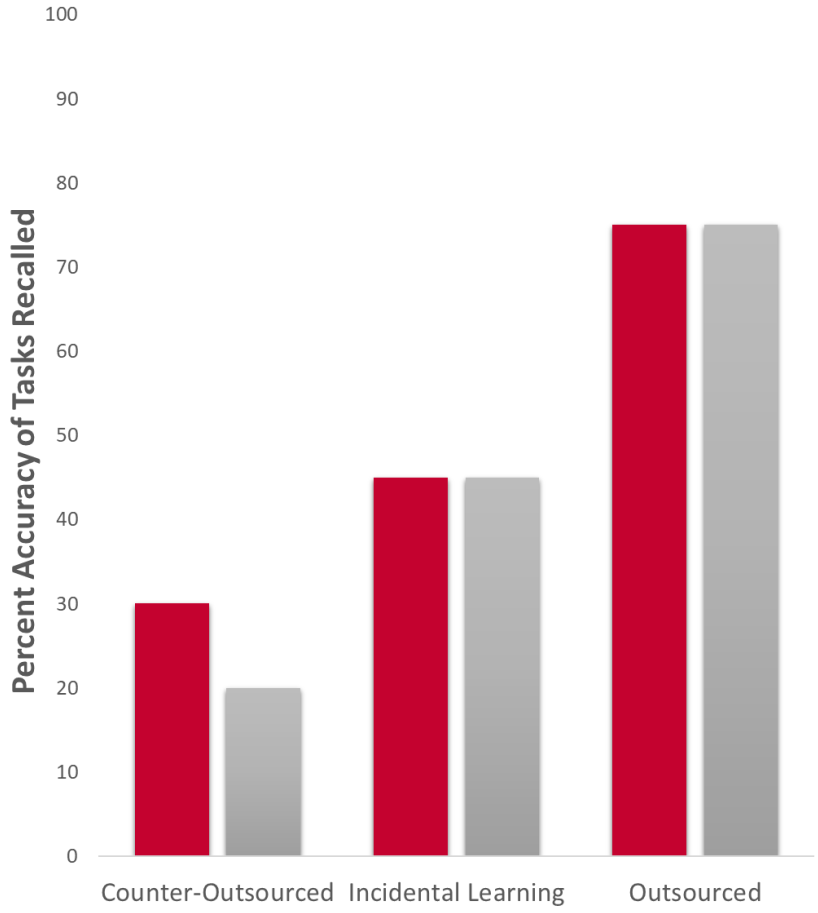


Figure 2. *Anticipated Findings for Memory for Non-Outsourced Tasks*

Note. Generated

GPS

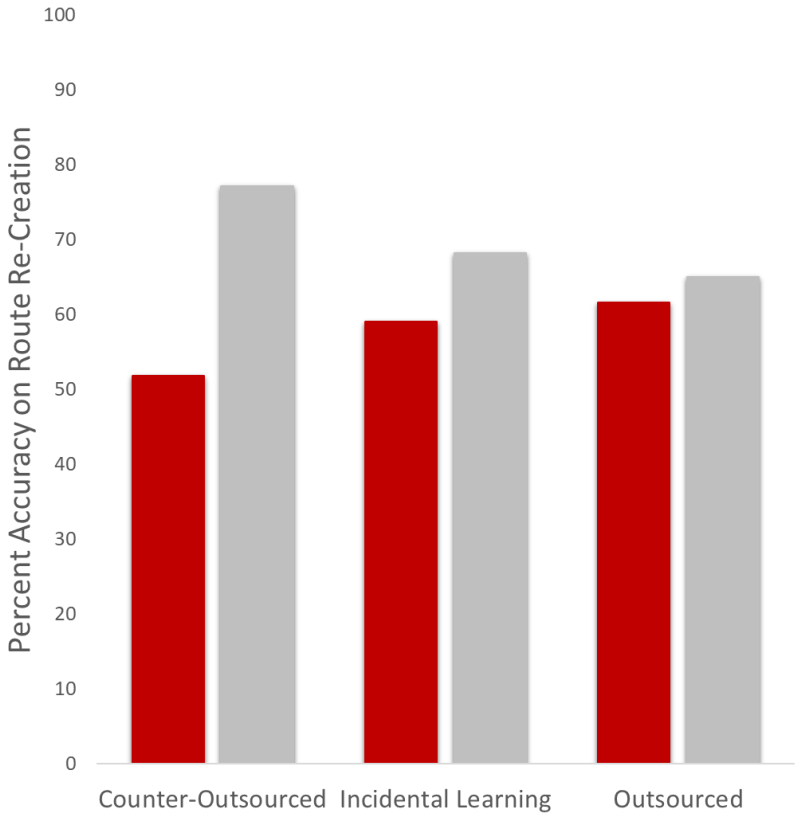


Figure 3. *Route Accuracy Results*

Note. Generated

GPS

The only significant finding was a main effect of generation with a difference overall between the grey and maroon bars

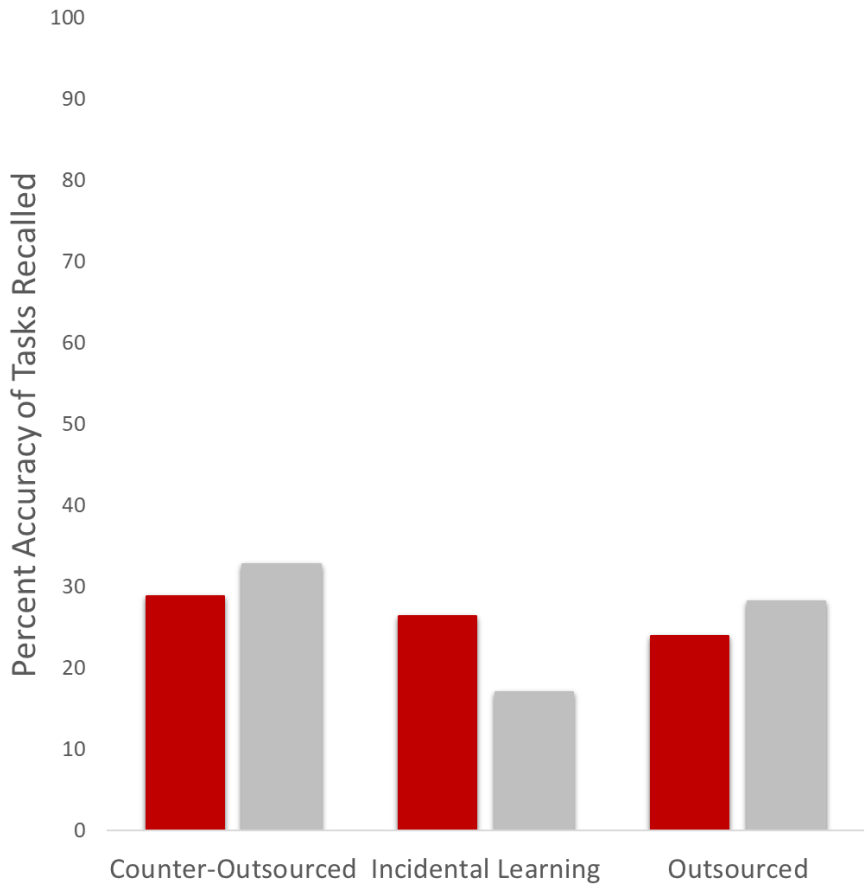


Figure 4. *Task Accuracy Results*

Note. Generated

GPS