TRAINING AND TRANSFER OF TRAINING IN RAPID VISUAL SEARCH UNDER HIGH TARGET-BACKGROUND SIMILARITY

BY

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THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Arts in Psychology
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2012

Urbana, Illinois

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ABSTRACT

Near-perfect transfer of training was observed in a previous study when participants trained to search for targets on camouflage backgrounds (high target-background similarity) were just as quick to find the camouflaged targets from a different set of images (Boot, Neider & Kramer, 2009). This was achieved in a free viewing paradigm. The unusually robust transfer suggested that participants were learning some general ability to recognize camouflaged targets rather than how each target image stood out against its corresponding background. To explore changes in attentional networks with training in an MRI environment in the future, a paradigm suitable for an fMRI study was tested to determine if the training and transfer benefits remained when using a rapid presentation search paradigm that relies on covert attention. Two groups of participants were tested before and after training, and trained in either camouflage or non-camouflage background conditions. The results showed significant improvements with camouflage training and transfer benefits at the post-training camouflage background test, compared to the control group with non-camouflage training. Both groups were able to use covert attention to detect and recognize camouflaged targets in a brief display, and the camouflage training group transferred this skill to new image set.

ACKNOWLEDGEMENTS

I would like to acknowledge and extend my gratitude to the following people for this study. My advisor, Prof Art Kramer, and Dr Mark Neider and Dr Michelle Voss, provided sound advice in the development of experiments, statistical analyses and invaluable suggestions for writing this report. I also thank Ron Carbonari for his help with the debugging the test programs, the lab managers (John Powers, Stevie Schein, Shanna DeSouza, and Anya Knecht) for helping with the experiments, Dr Gillian Cooke for helping me check the final statistics analysis, and my fellow graduate students (Yusuke Yamani, Matt Windsor and John Gasper) for helpful pointers with data handling and using the statistics package.

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CHAPTER 1: INTRODUCTION

Visual search is a behavior that seems to be effortless and efficient. We sometimes realize our limits when we try to find our missing keys dropped onto a messy tabletop, or the baby's pacifier left somewhere together with her toys. More seriously, how does a medical doctor look at an ultrasound image and determine if a tumor is lurking in midst of other benign fibrous tissue? Could we be trained to search for objects more accurately, so that we do not miss that explosive device hidden in one of the many bags at the customs checkpoint?

There is a large literature which examines the mechanisms of visual search and the guidance of attention to search. One of the influential theories was proposed by Treisman and Gelade (1980). They developed the classic two-stage conceptualization of search, where a "pre-attentive" stage processes the whole scene in parallel, and a limited capacity stage where items or chunks of items are selected for further processing prior to recognition. Researchers have argued for two types of attention that drives visual search; top-down guidance (e.g. Folk, Remington & Johnston, 1992; Bacon & Egeth, 1994; Chen & Zelinsky, 2006), where attention is based on expectancies and experience, and bottom-up guidance (e.g. Yantis & Jonides, 1984; Theeuwes, 2004; Proulx, 2007), where object features in the physical world drive psychological attention.

As much of these studies were done with simple objects and backgrounds, Wolfe, Oliva, Horowitz, Butcher and Bompas (2002) investigated the effect of complex backgrounds on visual search. In that series of experiments, Wolfe and colleagues found that the information accrual stage preceding the target recognition stage was delayed by more complexity in the background. Neider and Zelinsky (2006) experimented with varying the target-background similarity or camouflage, and found that observers made more fixations to the background as the similarity increased, suggesting that the background might have been mistaken for potential targets. The test paradigm developed by Neider and Zelinsky used images of children's toys as targets and distractors, placed over either homogenous non-camouflaging or camouflaging backgrounds. These camouflaging backgrounds were created for the respective target images by repeatedly stitching together cut-out portions of the target images. This method created corresponding camouflaging backgrounds which contained a subset of features of the target, resulting in high target and background similarity. As the target and background were very similar, whereas the distractors were very different from the background, they suggested a top-down guidance of attention strategy to search the background as a more efficient way to find the target within this test paradigm. However, they found that the participants directed a large proportion of eye movements to the salient distractors. This led them to propose that feature guidance is applied to objects and salient discontinuities, which explains the fixations to the distractors and the background (looking for discontinuities that may indicate presence of a target).

Boot, Neider and Kramer (2009) extended this research by examining whether training to distinguish targets in camouflage would result in transfer to a novel set of target images. They trained one group of participants to perform the visual search task under camouflage conditions, and the other group under non-camouflage conditions. Accuracy and reaction time data were recorded over the training phase and at the transfer phase, where both groups received the visual search task under camouflage conditions with a different set of images. Both groups showed performance improvements during their training. Eye movement analyses showed that the camouflage training group did not develop the background search strategy even under instruction, but were able to fixate on the target with fewer eye movements and a quicker recognition response once they fixated the target. Perhaps more importantly subjects in the camouflage training group showed excellent transfer to novel target objects. That is, search performance with a novel set of objects was equivalent to that when subjects searched for the trained objects (and backgrounds). This transfer effect is remarkable because transfer of training in many visual perceptual tasks is often narrow and limited to the specific stimuli trained (e.g. Fiorentini & Berardi, 1981; Ahissar & Hochstein, 1996; Ellison & Walsh, 1998). The authors proposed that the participants could have learned that slight discontinuities in the background indicate a possible target, resulting in better performance than the non-camouflage training group in the transfer task with novel objects. The authors also noted that in many cases eye movements were directed toward salient objects, but fixated toward the middle of groups of objects. They suggested that the training could have resulted in a greater degree of covert attention (shifts in attention without eye movements) being allocated to search the background, but believed it was unlikely due to the tight coupling of covert and overt attention (e.g., Hoffman & Subramaniam, 1995; Peterson, Kramer, & Irwin, 2004).

In the present study I wished to further extend this research in several important ways. One goal was to design a version of this paradigm that could be used to explore changes in attentional networks with training in an MRI environment. To accomplish this goal some changes to the search task were necessary. The search task display duration was changed from participant terminated (due to the nature of self-terminating or exhaustive search), to a fixed rapid duration, so as to prevent eye movements and build in the timing constancy required for fMRI. The free-viewing eye movements directed by overt attention was therefore changed to a fixed-viewing, covert attention paradigm. Also, eye gaze was constrained to the center of the screen, and the targets and distractors were randomly placed within a pre-defined ring around the center, rather than random placement anywhere on the display.

In addition, Boot and colleagues (2009) used a single post-training set of novel stimuli to examine transfer. This procedure did not rule out the possibility that the two training groups differed before training, thereby complicating the assessment of transfer from the training to the novel transfer set of objects. Therefore, in the current study we administered pre-training and post-training transfer tests with stimuli not used during training. Also, the comparison between pre- and post-training tests would reveal practice effects which could be expected when participants take a test for the second time.

Hence, the aim of this study was to explore the effectiveness of training and transfer of training of the visual search task under high target-background similarity with rapid search display duration and carefully designed transfer of training assessment. Two groups of participants were tested with a pre-training set of objects that would be used to examine transfer performance. Then the groups were trained to search on either camouflage or non-camouflage background with a different set of objects and backgrounds, and retested after training with the pre-training objects and backgrounds to determine transfer effects. Specifically we asked the following research questions: a) does training in search with covert attention show improvements in search performance with complex displays, b) does visual search training with complex displays and real world objects show transfer to novel objects and (c) does the nature of the training situation (with or without camouflage) have implications for the magnitude of transfer?

CHAPTER 2: METHOD

2.1 Participants

Forty-eight students (age 18-29, M = 21.6, SD = 2.75; 20 males) at the University of Illinois participated in the experiment. Participants were randomly assigned to one of the two training groups (24 participants in each group), and the age and gender distribution are shown in Table 1. All participants demonstrated normal or corrected to-normal acuity and color vision, as assessed with a Snellen chart and Ishihara plates respectively. Participants were paid $56 for their participation in seven 40- to 60-min sessions that took place over seven separate days within a span of three weeks.

2.2 Apparatus and Stimuli

Displays were presented on a 21-inch CRT monitor with a resolution of 800 by 600 pixels (40cm by 30cm). An Eyelink II eyetracking system (SR Research, Inc.) sampled the position of each participant's left eye at a speed of 250Hz. Participants viewed the monitor from a distance of approximately 62 cm (visual angle of approximately +/- 17.9º horizontally, and +/- 13.6° vertically). A chin rest stabilized the head position and kept viewing distance constant. A Microsoft video game controller was used to collect responses (See Figure 1 for picture of experiment setup).

Stimuli were nearly identical to those used by Neider and Zelinsky (2006). Search items were selected from the Hemera Photo Objects database. Targets and distractors were 40 pictures of children's toys, including dolls, stuffed animals, blocks, and toy vehicles. Each toy image was scaled to fit within an 80 by 80 pixel (visual angle of approximately 3.7º by 3.7º) bounding box (Figure 2). A corresponding camouflage background for each toy image was created by taking a 35 by 35 pixel square from the center of the toy image and tiling it across an 800 by 600 pixel background. In non-camouflage search displays, the toy images were superimposed on a homogenous gray background.

On each trial, the target image was randomly selected from one of two sets of objects. There were 20 objects in each Set A and B (Figure 3 and 4 respectively) for use in either the pre- and post-training tests or training sessions. Distractors were randomly selected from the respective set, excluding the object that was selected as target in each particular trial. Targets and distractors were randomly assigned to any of 12 possible locations around the center of the screen, each at 150 pixels from the center of the screen (visual angle of approximately 6.9º).

2.3 Design and Procedure

Each participant completed a pre-training test session, five training sessions and a post-training test session. At the pre-training test sessions, each participant completed two distinct search tasks; one on a non-camouflage background and the other on a camouflage background. Both search tasks used objects from either Set A or B and had 120 trials. Half of the participants in each training group began with a non-camouflage background task while the other half began with camouflage background task. Similarly, half of the participants in each training group used Set A for the pre- and post-training tests and Set B for training, while the other half used Set B for the pre- and post-training tests and Set A for training. Following this initial evaluation, all participants completed five training sessions with 360 trials per session for a total of 1,800 training trials. Half of the participants were trained with a non-camouflage background while the other half trained with a camouflage background. Following training, all participants again performed the same two search tasks as in the pre-training test session. For each participant, the presentation order of the search task (non-camouflage, camouflage) in pre- and post-training tests was reversed in order to mediate practice and sequence effects on test performance. Hence there were four combinations of test sequences as shown in Table 2. There were six participants in each combination, for a subtotal of 12 participants in each training background, and a total of 24 participants in this study.

Participants began each trial by fixing their gaze at a small circle in the center of the screen, and pressing any button on the video game controller's direction pad to initiate that trial. The test could start only if the participant gaze was within 50 pixels from the center. After successfully starting, the following objects (and their duration in parentheses) were sequentially displayed in the center of the screen: gray fixation cross (500ms), white fixation cross (500ms), target image (1000ms), gray fixation cross (500ms), white fixation cross (500ms), search display (150ms), gray fixation cross (500ms) and question screen, where the participants were reminded to pull the right trigger on the controller to respond "Yes, target was present" or the left trigger for "No, target was absent" (See Figure 5). These responses along with the participants' eye tracking data were collected and processed to produce the accuracy measures for each session. Trials were rejected if the participants' gaze did not stay within 50 pixels (visual angle of approximately 2.3°) from the center, or if they blinked over the time when the search display was on. The mean percentage of accepted trials was 83.09% (SD = 12.76).

CHAPTER 3: RESULTS

Analyses focused on the training sessions and then on the transfer effects (pre- vs. post-training tests, and training session 5 vs. post-training test). An omnibus ANOVA with all factors was conducted, followed by more specific analysis of factors such as training group and test type where omnibus effects were significant.

To examine whether the two training groups performance was equivalent at pre-test, the pre-training test data was entered into an ANOVA with type of test (non-camouflage vs. camouflage), target presence (present vs. absent), and set size (3 vs. 5) as within-participants factors and training group (camo vs. non-camo) as a between-participants factor. The training group factor did not show a significant difference [F (1, 46) = .75, $p > .05$], suggesting that the two training groups were not statistically different in their pre-training test performance (Figure 6).

3.1 Training Effects: Training Session 1 through 5

Accuracy data was entered into an ANOVA with training session (1, 2, 3, 4 and 5), target presence (present vs. absent), and set size (3 vs. 5) as within-participants factors and training group (camo vs. non-camo) as a between-participants factor. Figure 7 shows the mean accuracy of both groups over the five training sessions. Mauchly's test indicated that the assumption of sphericity had been violated for the main effects of training session, χ^2 (9) = 53.96, $p < .001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .58$). Main effects included training session [F (2.34, 107.41) = 11.05, $p < .001$], target presence [F (1, 46) = 31.22, $p < .001$], set size [F (1, 46) = 146.00, $p < .001$], and training group [F (1, 46) = 50.80, p

< .001]. There was a significant interaction between training session and training group [F (4, 184) = 7.68, p < .001], which suggests that the camouflage training group improved more than the non-camouflage training group through the five training sessions. Target presence and training group [F (1, 46) = 23.90, p < .001] (Figure 8) and set size and training group [F (1, 46) = 30.50, p < .001] (Figure 9) also interacted, showing that the camouflage task accuracy was more sensitive to the conditions that made search more difficult (higher set size and target absence). This is similar to Boot and colleagues' findings (Boot, Neider & Kramer, 2009). There was also a significant interaction between training session, target presence and set size [F (4, 184) = 2.85, p < .05]. We analyzed the training groups separately to further interpret these interactions.

Camouflage training group. An ANOVA with training session (1, 2, 3, 4 and 5), target presence (present vs. absent), and set size (3 vs. 5) as within-participants factors was done, and Mauchly's test indicated that the assumption of sphericity had been violated for the main effects of training session, χ^2 (9) = 35.84, p < .001. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε = .51). There was a significant main effect of training session [F (2.06, 47.27) = 11.72, p < .001], target presence [F (1, 23) = 28.37, p < .001] and set size [F (1, 23) = 106.60, p < .001]. The main effect of training session shows that the camouflage training had significant overall benefit across the five training sessions. There was also a significant interaction between training session, target presence and set size [F (4, 92) = 3.32, p < .05].

Contrasts revealed that accuracy was significantly higher between training sessions 1 and 2 [F (1, 23) = 8.38, p < .05], and 2 and 3 [F (1, 23) = 10.93, p < .05]. This shows that there was significant training benefit only over the first three sessions, which were 1080 training trials (about 2 hours in total).

Non-camouflage training group. The ANOVA with training session (1, 2, 3, 4 and 5), target presence (present vs. absent), and set size (3 vs. 5) as within-participants factors showed a significant main effect of set size [F (1, 23) = 39.40, $p < .05$]. Similar to the camouflage training group, this main effect of set size shows that the non-camouflage group was more accurate at trials with smaller set size. The lack of main effect for training session [F (2.51, 57.67) = 1.29, $p = .29$] shows that the non-camouflage training did not have significant learning benefits. This was likely due to the fact that non-camouflage training group participants exhibited very high accuracy throughout training (~95%).

3.2 Transfer Effects: Pre- vs. Post-training Tests

The accuracy data was entered into an ANOVA with test type (non-camouflage vs. camouflage), target presence (present vs. absent), and set size (3 vs. 5) and sessions (pre- vs. post-training) as within-participants factors, and training group (camouflage vs. non-non-camouflage) as the between-participants factor. Of central interest was the effect of type of training on the test type. Main effects were observed for test type [F (1, 46) = 439.70, $p < .001$], target presence [F (1, 46) = 36.75, $p < .001$], set size [F (1, 46) = 31.59, $p < .001$] and session [F (1, 46) = 54.60, $p < .001$]. There was a significant interaction between test type, session, and training group [F (1, 46) = 4.67, $p < .05$], test type and target presence [F (1, 46) = 26.98, $p < .001$], and test type and session [F (1, 46) = 34.93, $p < .001$]. As test type interacted with multiple other factors, we analyzed the test type separately to further interpret this three-way interaction.

Non-camouflage background test. Data for only the non-camouflage background test was entered into an ANOVA with target presence (present vs. absent), set size (3 vs. 5) and session (pre- vs. post-training) as within-participants factors, and training group (camouflage vs. non-non-camouflage) as between-participants factor. Main effects of target presence [F (1, 46) = 16.10, $p < .001$] and set size [F (1, 46) = 32.97, $p < .001$] were observed. The lack of session [F (1, 46) = 2.50, $p = .12$] and training group [F (1, 46) = .83, $p = .37$] main effects suggest that neither training groups improved on the non-camouflage background (Figure 10). It is worth noting that both groups displayed high accuracies in this test type.

Camouflage background test. A similar ANOVA was done with only the camouflage background test data. There were main effects of target presence [F (1, 46) = 33.80, $p < .001$], set size [F (1, 46) = 14.52, $p < .001$], and session [F (1, 46) = 51.80, $p < .001$]. Importantly, there was no main effect of training group [F (1, 46) = .06, $p = .81$] and a significant interaction between session and training group [F (1, 46) = 4.88, $p < .05$]. Inspection of Figure 11 suggests that the camouflage training group improved significantly more than the non-camouflage training group on the camouflage background test. Both groups improved over the pre- and post-training test sessions, and camouflage background task coupled with the training sessions resulted in significant benefit over the non-camouflage training group.

3.3 Transfer Effects: Training Session 5 vs. Post-training Test

An ANOVA was done to compare the post-training camouflage background test and the final camouflage training session prior to the post-training test for the camouflage training group. This analysis was done to determine whether there was any change in search performance from the end of the training sessions to the novel transfer objects and backgrounds. This analysis between the last camouflage training session and post-training camouflage background test did not include the non-camouflage training group because they only trained with non-camouflage background, and hence they did not have a camouflage background training session in order to compare with the camouflage background post-training test. Similar analysis between the last non-camouflage training session and post-training non-camouflage background test may not yield any significant results, because the performance for this task was always near or at ceiling. The non-camouflage training neither showed significant training benefits nor improvements between pre- and post-training tests.

Target presence (present vs. absent), set size (3 vs. 5), and session (training session 5 vs. post-training) were entered in an ANOVA as within-participants factors. Main effects of target presence [F (1, 23) = 25.00, $p < .001$] and set size [F (1, 23) = 52.76, $p < .001$] were observed. Importantly, there is no main effect of session [F (1, 23) = 1.34, $p = .26$], which suggests there is no evidence for significant difference between training session 5 and post-training test. Figure 12 shows the group's accuracy from pre-training, through the training sessions and the post-training session. The group improved from pre-training mean accuracy of 0.665 to 0.812 by the final training session, which was an improvement of 0.147, and the post-training mean accuracy of 0.794 with no significant difference from the final training session. This is a repetition of transfer effect found by Boot et al (2009).

CHAPTER 4: DISCUSSION

The purpose of this study was to investigate the effectiveness of training and the transfer of training in visual search with rapid display duration under high target-background similarity. Specifically, we wanted to know if the participants could be trained to search for camouflaged targets using covert attention. Also, we were interested in determining whether the high transfer effects reported by Boot and colleagues (2009) would also be repeated here when the participants were trained to search with covert attention.

Covert attention. The camouflage training group showed accuracy improvements through the training sessions, and its improvement at the camouflage transfer task was significantly greater than that of the non-camouflage training group. Thus, to offer explanation for the improvements and better transfer effect, I speculate that the participants could have adopted the search strategy suggested by Neider and Zelinsky (2006) and tested by Boot and colleagues (2009), which was to search for discontinuities in the background as a more efficient way to determine if a camouflaged target was superimposed on the background. And rather than deploying overt attention which guides the eyes to search for the target in the previous studies, the participants in this study might have improved in using covert attention to search the region around their centered gaze fixation. As there was no recorded measure of the participants' attention or verbal report of their search strategy, we do not know the exact nature of the adaptation of their covert attention over the training phase for this task. The adaptations could take several forms, for example, in terms of widening or narrowing attention, participants could have widened their scope of attention in a circular form from a smaller central area in order to cover the circular display area where the targets and distractors would be, or limited their attention from the whole display to only that of the target/distractor circle. In terms of the shape, they could have adopted a circular search area or a ring form (McCalley, Bouwhuis & Juola, 1995). The latter would presumably lower sensitivity to the center for greater sensitivity to the ring. Also, we might speculate either a static covert attention search area with a uniform sensitivity, or a dynamic search spotlight that tended to emphasize certain sectors at different times, which could be driven by unconscious top-down expectancies. This study suggested that the rapid display camouflage training improved the participants' ability to search for background discontinuity with covert attention, which concurred with a proposed idea in Boot and colleagues' (2009) paper that covert attention may be allocated to search the background to a greater degree with training. However, it must be pointed out that this rapid presentation paradigm artificially constrained the eye position near the screen center. If the participants were given free-viewing conditions, eye movements should show tight coupling of covert and overt attention (e.g., Hoffman & Subramaniam, 1995; Peterson, Kramer, & Irwin, 2004).

On the other hand, the non-camouflage training group also deployed covert attention and achieved high search performance throughout the non-camouflage test and training sessions. In the earlier analysis of camouflage background test results between the pre- and post-training test sessions, the combination of a significant main effect of session and non-significant main effect of group (camouflage training vs. non-camouflage training groups) suggested that both groups improved significantly on this test type. Practice effects could explain this significant improvement, although transfer between non-camouflage background training to camouflage background test might possibly have contributed.

More importantly, the significant interaction between session and group showed that the camouflage training group's improvement from pre-training tests was significantly greater than the non-camouflage training group, suggesting that the camouflage background coupled with covert attention training was the reason for beneficial training effects on top of the practice effects. Lastly, this training benefit showed transfer between a training image set and a test image set. This suggested that trained participants could have learned generalizable search skills.

Processing speed. One question that emerges from but not investigated in this study is the possibility that the participants might be improving due to faster speed of processing of visual stimuli. Speed of processing is defined as a cognitive skill concerned with the rate of processing visual information (e.g. Thorpe, Fize & Marlot, 1996). Due to the shorter 150 ms search display duration imposed on the training groups, the participants might have been improving at the speed they were processing the visual stimuli in addition to the discontinuity search strategy using covert attention explained earlier. If so, the improvements to the participant's visual processing speed may be detected by including a visual processing speed test in the pre- and post-training tests. Given that Thorpe and colleagues (1996) found that we can distinguish images of animals from other images of natural scenes with 94% accuracy at only 20 ms unmasked exposure, it would be interesting to see if the longer 150 ms search display duration with camouflaged objects had any processing speed training effect on the participants.

In summary, camouflage training showed significant improvement and transfer to a different set of camouflaged objects, demonstrating that the camouflage trained participants were potentially learning some general ability in recognizing objects through covert attention that was transferrable.

There were a few issues that could be addressed for future work on this rapid search paradigm. First, response time could be included with accuracy as the performance measures. This is typical of most visual search and attention studies, and would make analyses and comparisons to other studies and search theories more straightforward, and results might be more telling about training benefits especially for close to ceiling performance Second, backward masking of the search display could be included, so that the duration of exposure and visual processing could be better controlled. Iconic memory could become a confounding factor if the participants could continue to process the search stimuli for between 100 and 300ms after stimulus offset (Loftus, Johnson, & Shimamura, 1985; Loftus, Duncan, & Gehrig, 1992; Rolls et al., 1999). Fourth, real world scenes such as looking for keys on a cluttered countertop could be introduced so as to determine whether the training benefits on this children's toy context could transfer beyond its context to other kinds of real world images and tasks. The results may inform the mechanism involved in learning and transferring visual search skills necessary for our daily lives, and for specialized application fields such as medical imaging, border customs and military.

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APPENDIX A: FIGURES AND TABLES

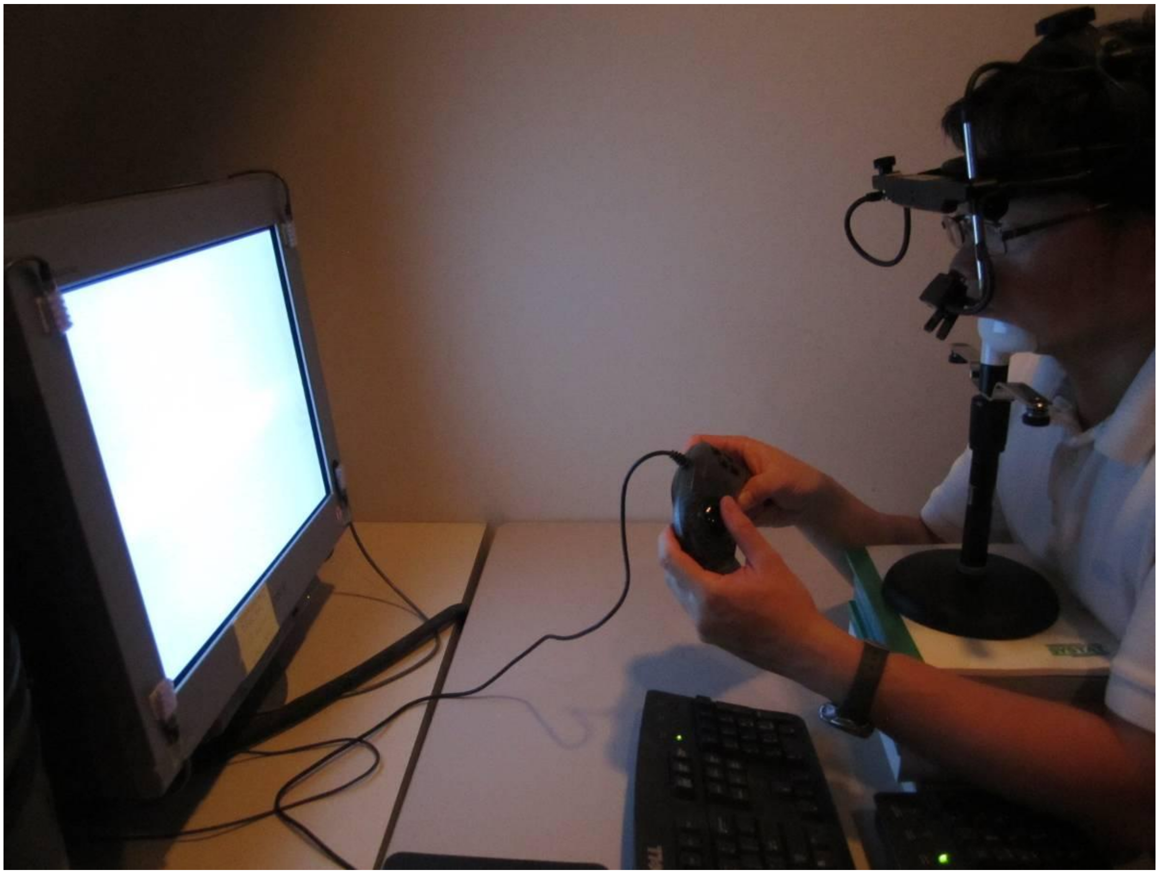


Figure 1: Apparatus setup

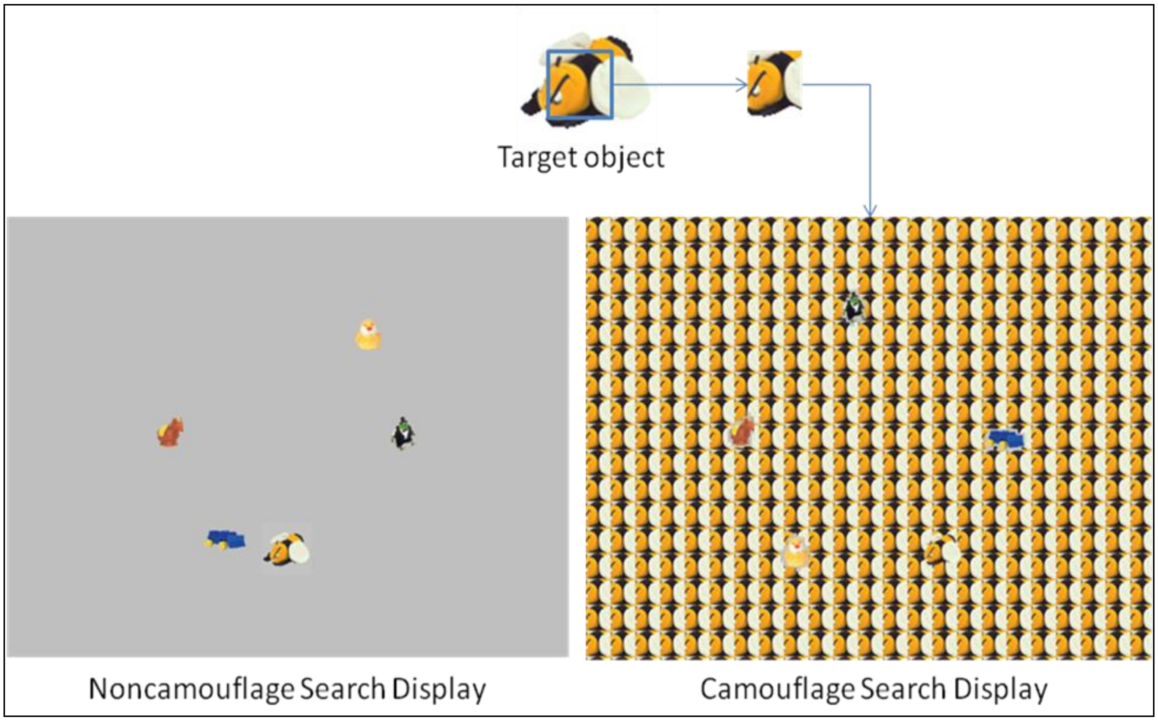
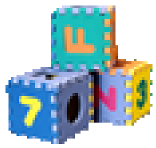


Figure 2: An example of the types of search displays participants viewed, with and without a camouflage background

Serial No.	Test Image
3	
5	
9	
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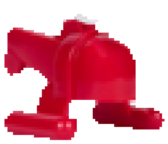
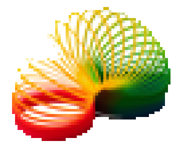
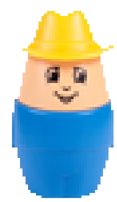
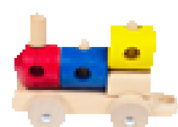
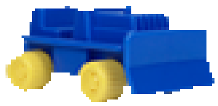
17	
18	
19	
20	
21	
24	
25	
26	
28	
34	
35	
38	
41	
45	
48	

Figure 3: Images in Set A

Serial No.	Training Image
4	
6	
7	
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11	
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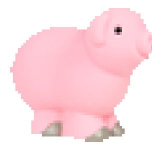
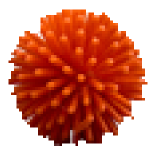
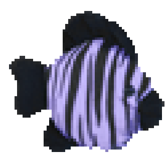
14	
16	
22	
23	
27	
29	
30	

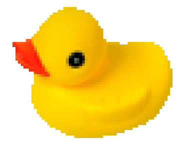
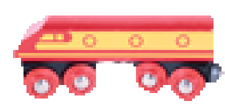
31	
32	
33	
36	
42	
43	

Figure 4: Images in Set B

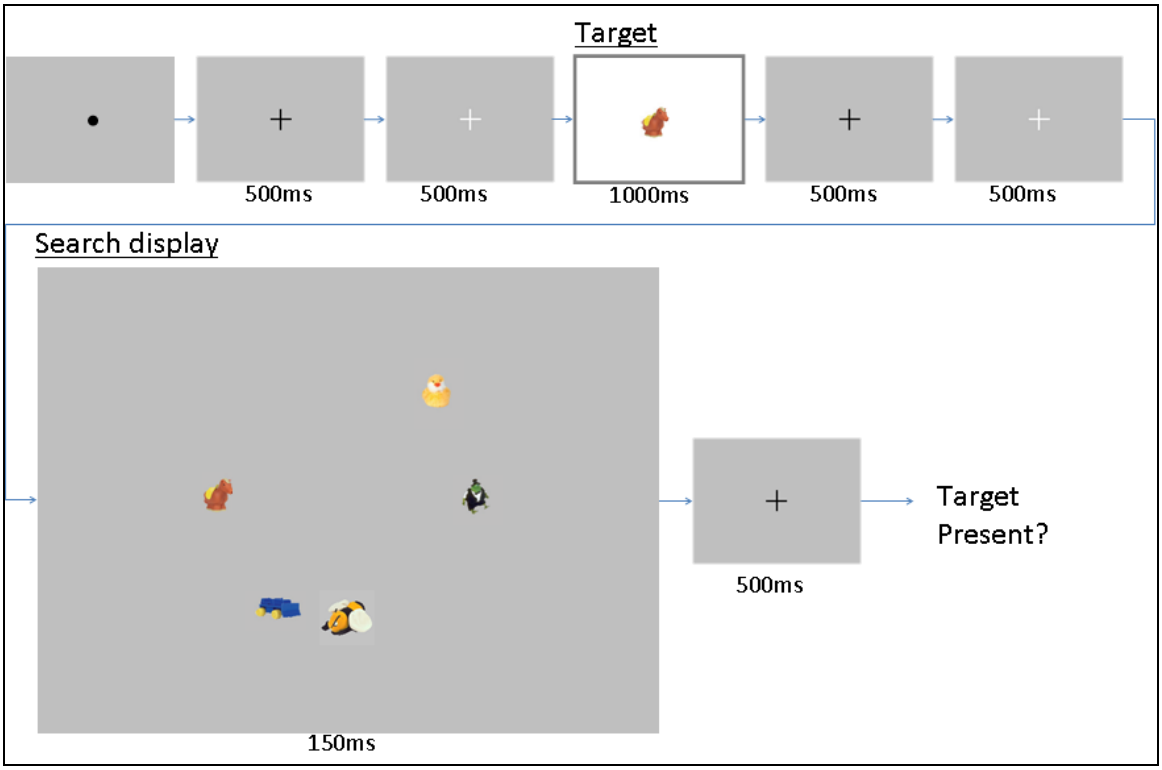


Figure 5: Stimulus sequence and duration.

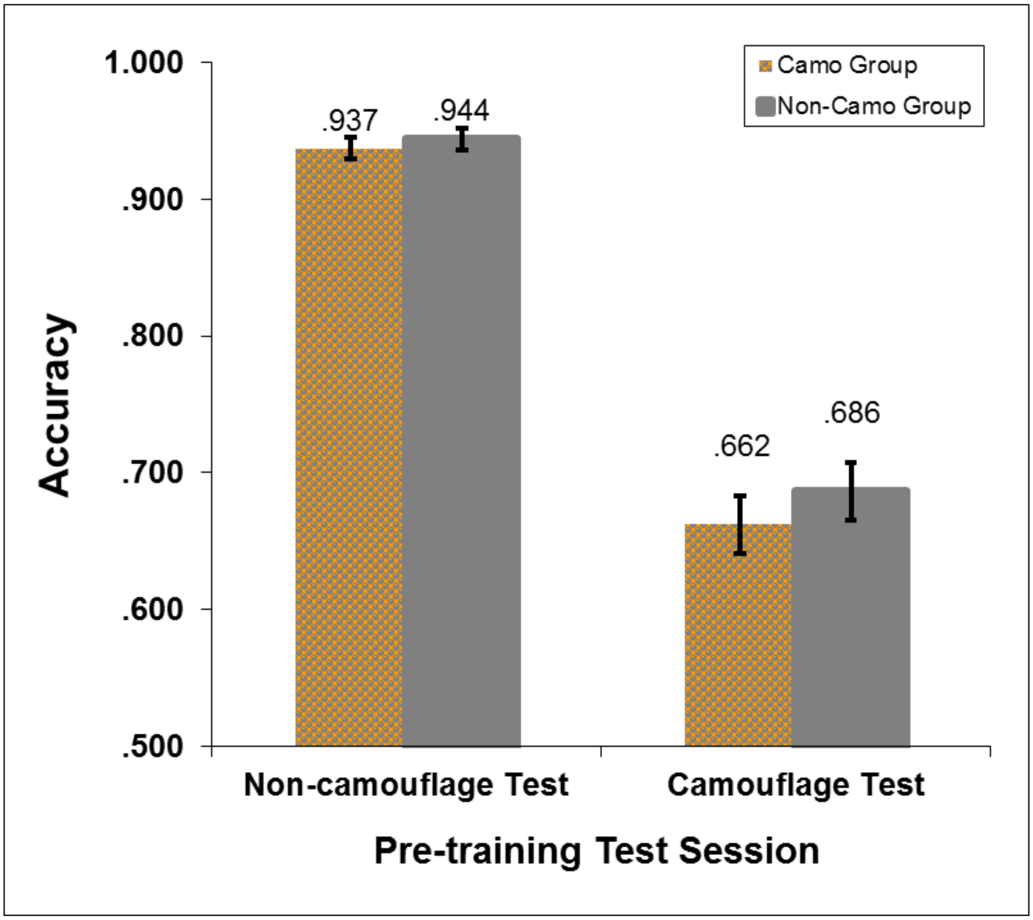


Figure 6: Mean Accuracy of the camouflage and non-camouflage training groups at the pre-training camouflage and non-camouflage background test sessions.

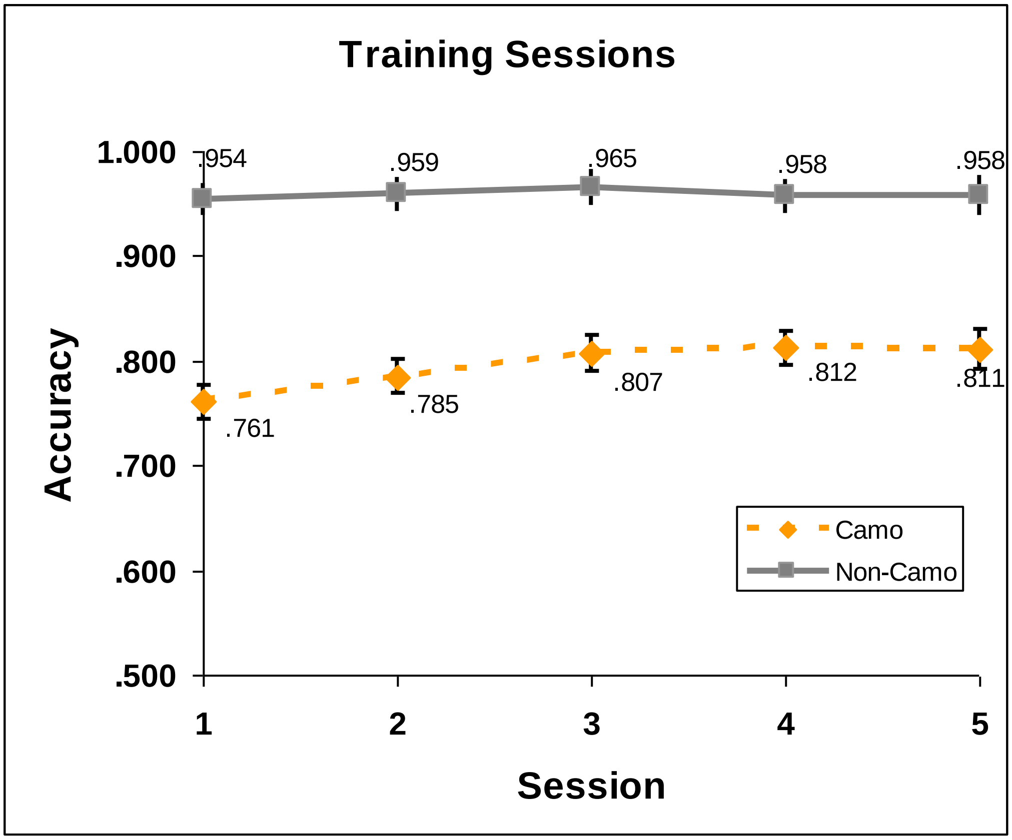


Figure 7: Mean Accuracy of the camouflage and non-camouflage training groups over the training sessions 1 through 5.

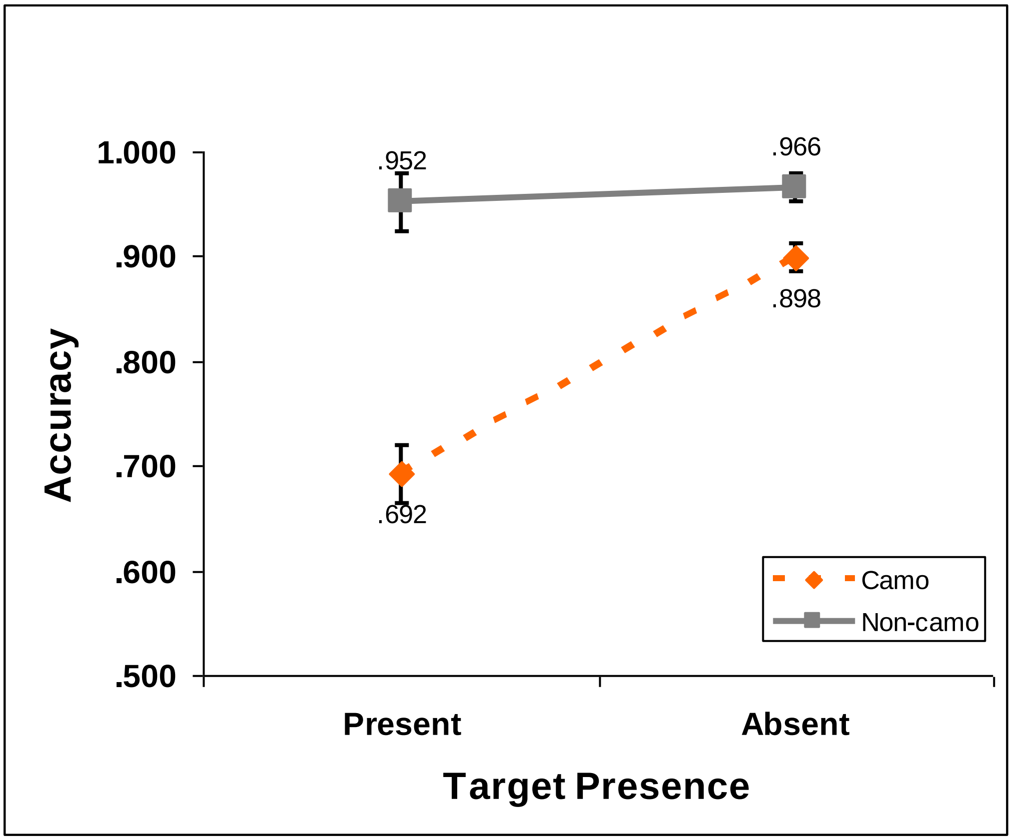


Figure 8: Mean accuracy of the training groups over the training sessions, looking at target presence conditions against training groups.

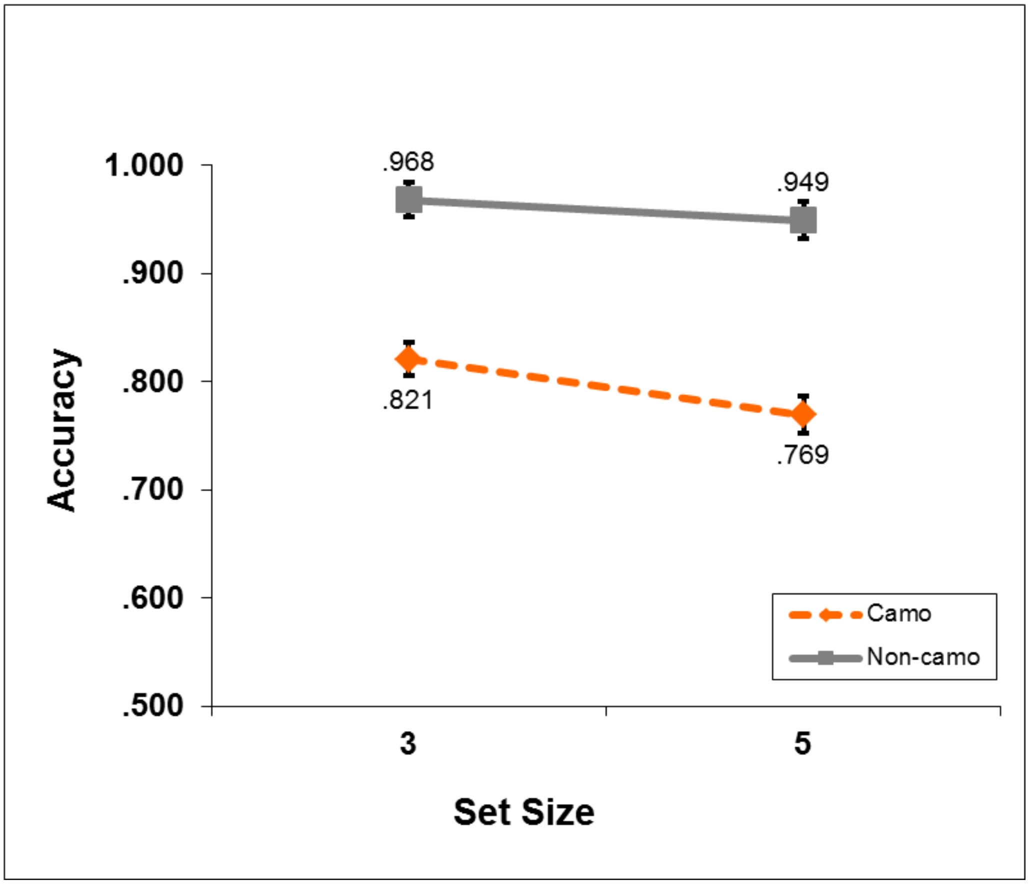


Figure 9: Mean accuracy of the training groups over the training sessions, looking at set size conditions against training groups.

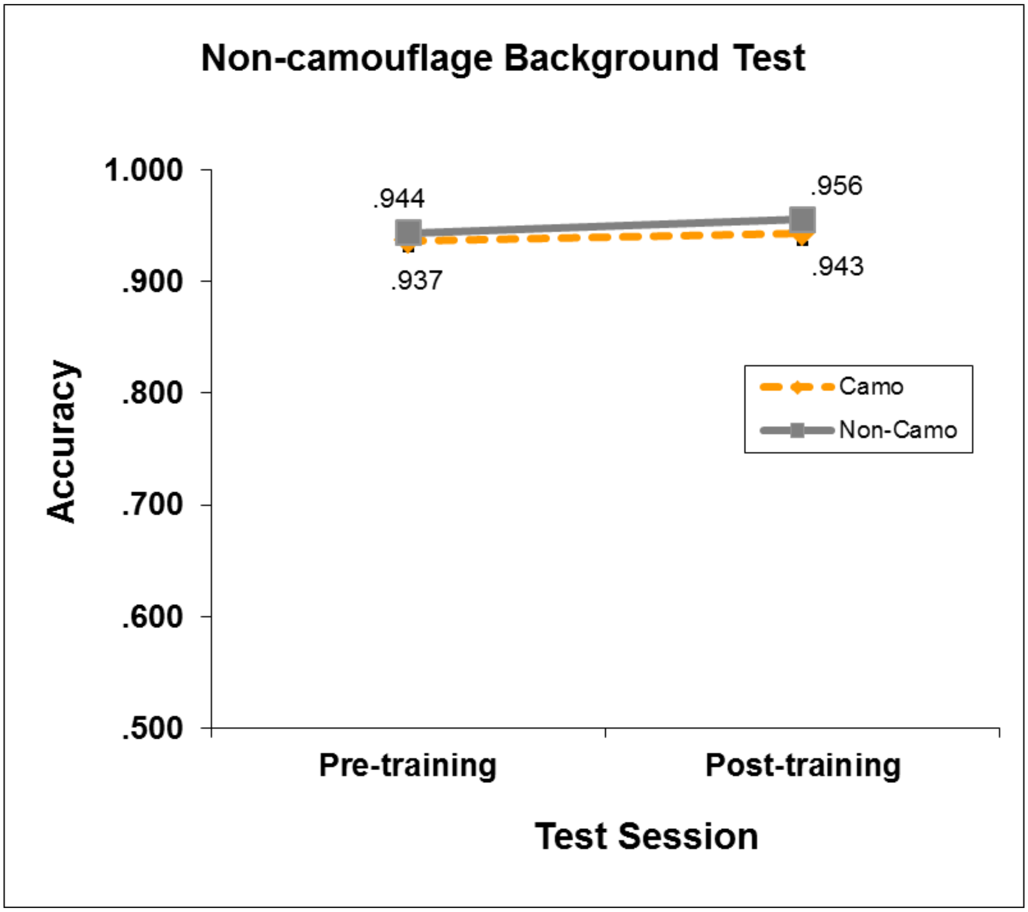


Figure 10: Mean Accuracy of the camouflage and non-camouflage training groups over the pre- and post-training non-camouflage background test sessions.

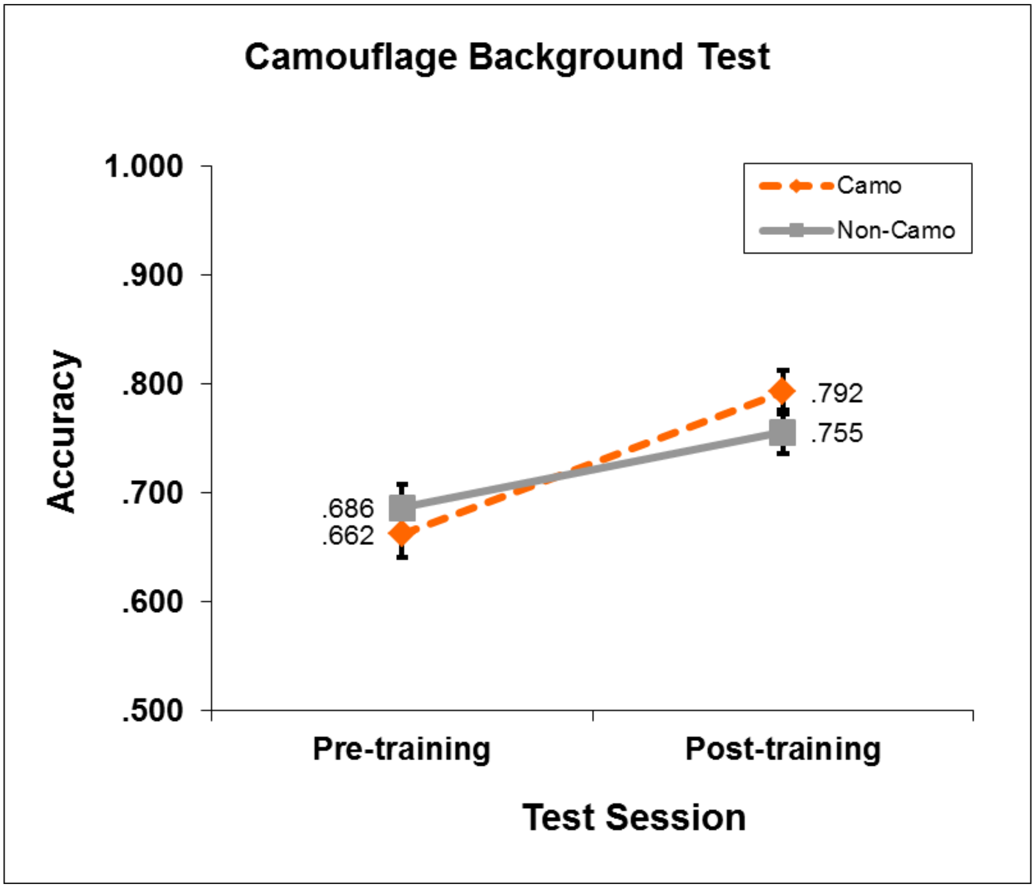


Figure 11: Mean Accuracy of the camouflage and non-camouflage training groups over the pre- and post-training camouflage background test sessions.

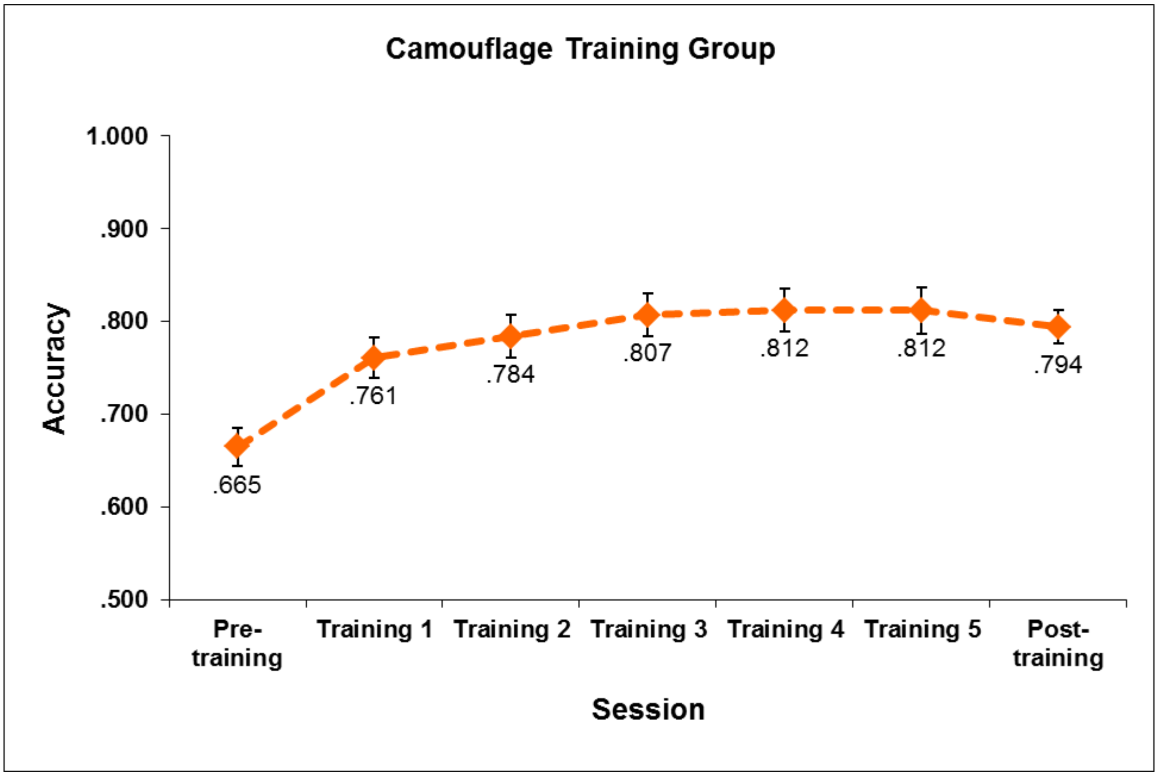


Figure 12: Mean accuracy of the camouflage background search task for the camouflage training group over pre-training, training and post-training sessions.

Table 1: Age and gender information

		Training Group					
		Camo			Non-camo		
		Mean	Standard Deviation	Count	Mean	Standard Deviation	Count
Age		22	3		21	3	
Gender	**F**			13			15
	M			11			9

Table 2: Four combinations of test sequence

Training Group	Pre-training Sessions	Training Sessions 1, 2, 3, 4, 5	Post-training Sessions
Camo	Non-camo , camo	Camo	Camo , Non-camo
Camo	Camo , Non-camo	Camo	Non-camo , camo
Non-camo	Non-camo , camo	Non-camo	Camo , Non-camo
Non-camo	Camo , Non-camo	Non-camo	Non-camo , camo

APPENDIX B: INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Office of the Vice Chancellor for Research
Institutional Review Board
528 East Green Street
Suite 203
Champaign, IL 61820

December 15, 2010

Arthur Kramer
Psychology
2247 Beckman Institute
405 N Mathews Ave
M/C 251

RE: *Object and Space-Based Mechanisms of Visual Attention*
IRB Protocol Number: 95044

Dear Arthur:

This letter authorizes the use of human subjects in your continuing project entitled *Object and Space-Based Mechanisms of Visual Attention*. The University of Illinois at Urbana-Champaign Institutional Review Board (IRB) approved the protocol as described in your IRB-1 application, by expedited continuing review. The expiration date for this protocol, UIUC number 95044, is 12/12/2011. The risk designation applied to your project is *no more than minimal risk*. Certification of approval is available upon request.

Copies of the enclosed date-stamped consent forms must be used in obtaining informed consent. If there is a need to revise or alter the consent form(s), please submit the revised form(s) for IRB review, approval, and date-stamping prior to use.

Under applicable regulations, no changes to procedures involving human subjects may be made without prior IRB review and approval. The regulations also require that you promptly notify the IRB of any problems involving human subjects, including unanticipated side effects, adverse reactions, and any injuries or complications that arise during the project.

If you have any questions about the IRB process, or if you need assistance at any time, please feel free to contact me or the IRB Office, or visit our Web site at http://www.irb.illinois.edu.

Sincerely,

Sue Keehn, Director, Institutional Review Board

Enclosures

telephone (217) 333-2670 • *fax* (217) 333-0405 • *email* IRB@illinois.edu