The Effects of Time Limitations on Target Identification

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ABSTRACT

Motivation – Aiming at making image interpretation more efficient, we studied the effects of limiting exposure durations on performance.

Research approach – Two psychophysical experiments were performed examining the performance of 36 expert image analysts. The targets were presented at three image quality levels.

Findings– The results suggest that limiting the exposure duration of an image to four seconds does not impair the performance of the analysts, i.e., four seconds suffice for identification in an the image interpretation task, no matter what the quality of the image.

Research Implications– This finding suggests that limiting the exposure duration during actual image interpretation would be beneficial since it would shorten the total amount of time needed for interpretation while not lowering the probability of correct identification.

Take away message – Sometimes unlimited time is not necessary in order to obtain the best results. When someone is an expert at what s/he does, making a quick decision might yield equivalent outcomes

Keywords

Image interpretation, Identification, Limited exposure duration, Intuitive decision making.

INTRODUCTION

Normally image interpretation takes place without limiting the exposure duration. This approach makes sense if the interpretation process is viewed as a single task that can not be divided into subtasks. However, image interpretation can be seen to be composed of two distinct phases – a search phase and an identification phase. It can be argued that limiting the exposure duration of the search phase is not a good idea. However, limiting the exposure duration of the identification phase might increase overall efficiency, since it would decrease the total duration of the task.

Of course, it must be shown that limiting the exposure duration is not accompanied by less desirable effects, such as more misidentifications and/or more non-identifications. Actually there is some evidence that implies exactly the opposite. Namely, there is body of research that suggests that forcing a well practiced expert to make a decision in more intuitive manner, relying on more automatic processes, results in better performance (e.g., Beechler, Winterstein, Kamper, & Jeffrey, 1969; Dunning & Perretta, 2002; Dunning & Stern, 1994).

We assumed that limiting the exposure duration of the image would force the analysts to become more "intuitive" in their decision process, and this might lead to better outcomes. This notion is based on the theoretical concept of dual processing (Kahneman, 2003; Stanovich & West, 2000). These researchers suggested the existence of two parallel cognitive systems: One unconscious, intuitive, and automatic and the second conscious, reasoning based, and deliberating. The operations of first system resemble those of the perceptual system in that they are fast, automatic, effortless, associative, implicit, and often emotionally charged. This is the system that we tried to tap in this research.

The present research examined the hypothesis that limiting exposure duration of an image would not impair or perhaps even improve the performance of human analysts in a target identification task.

METHOD

Two experiments were conducted, examining the effect of two variables: the exposure duration of the image and the difficulty of the identification task.

Subjects: Thirty-six expert analysts from the Israeli Air Force, 18 in each experiment.

Stimuli: In order to create three levels of task difficulty we photographed models of six military vehicles from three different distances paralleling easy, medium and difficult images. These were photographed from four different angles (front, back, side and 45^0). We inserted these vehicles into photographs of terrain at the same angles of depression. We then utilized image processing techniques to get realistic aerial photos of those military vehicles in the field (see examples in figure 1).

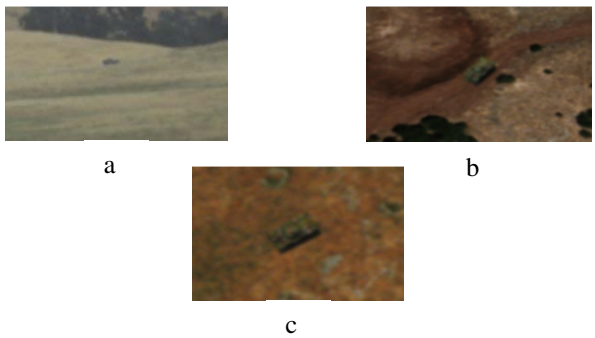

Figure 1: Examples of photos that were used in the experiment. A T-62 tank photographed from three distances (a, b, and c, reflect difficult, medium and easy images, respectively) and planted in terrains with the same angles.

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Procedure: On each trial the analysts were presented with an image similar to one of the three in figure 1. Their task was to identify the vehicle and give their answer in the next screen where the six possibilities were listed.

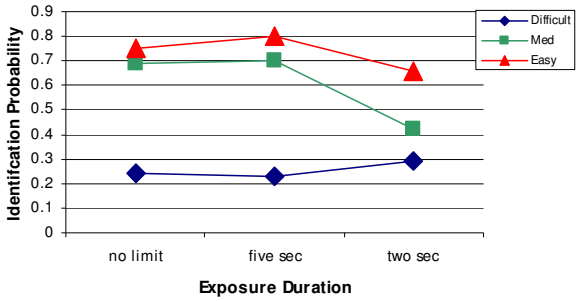
Three exposure durations were presented, in separate blocks, in the first experiment – no time limit, five seconds, and two seconds. The second experiment was designed to explore the intermediate durations, namely five, four, and three seconds. Each experimental block consisted of 24 different randomly chosen images. In the unlimited time condition the analysts hit the space bar key to move on to the answer screen. In the limited time conditions the answer screen appeared after the exposure duration had elapsed.

RESULTS

The dependent variable was identification probability (IP). An analysis of variance (ANOVA) was performed as a function of the task difficulty and exposure duration, and Post Hoc Duncan tests ($p<0.05$) were performed when the ANOVA yielded a significant effect.

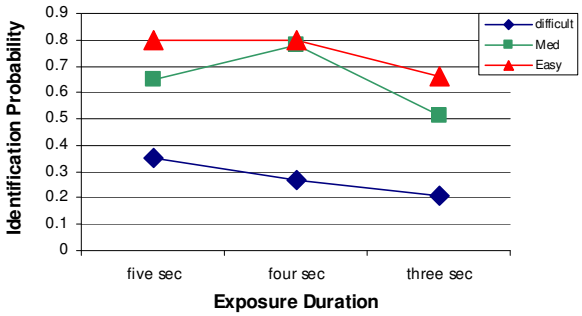
Experiment 1: A significant interaction of task difficulty and exposure duration was found, $F(4, 34)=6.08$, $p<0.0003$. The interaction results from the different pattern of IP in the difficult condition. The IP in the easy and medium conditions was no poorer in five seconds condition as compared to no limit condition, and decreased significantly in the two seconds condition. On the other hand, the exposure duration did not influence the IP in the difficult condition. The small increase at the 2 sec duration, reminiscent of an "intuition" effect, was not significant. (see Graph No 1).

Graph No. 1: Exp 1 -Identification probability as a function of task difficulty and exposure duration



Experiment 2: A significant interaction of task difficulty and exposure duration was found, $F(4, 34)=4.32$, $p<0.0003$. The interaction results from the different pattern of IP in the medium difficulty condition. In the easy and difficult conditions the IP decreased significantly in the three seconds condition compared to the two other conditions. In the medium condition there were significant differences between the three exposure durations: at four seconds IP was higher than five seconds, but at three seconds it was considerably lower (see Graph No 2).

Graph No. 2: Exp 2 - Identification probability as a function of task difficulty and exposure duration



DISCUSSION

The results of the two experiments together suggest that limiting the exposure duration of an image to four seconds will not impair performance. On the other hand, reducing the exposure duration to three seconds impairs performance in some of the task difficulty conditions. We suggest that it would be beneficial to limit the exposure duration to four seconds. The overall process will take less time and yet the IP will not be affected.

Some theoretical implications include the conclusion that unlimited time is not always the best way to do things. On some occasions forcing somebody to make a decision based on limited exposure time can be beneficial, because It saves time and does not impair performance. In the present study the analysts had to choose among six possible targets, while in real life the number of possible targets might at times be greater. Will our findings generalize to larger target populations? Further research is needed to determine this, and whether these finding generalize to other domains such as medical imagery.

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