Automatic Preference Detection by Analyzing the Gaze 'Cascade Effect'

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Keywords
Preference detection, gaze 'cascade effect', two-alternative forced choice task

Introduction

The purpose of our work is to predict (visual) preference decisions of users in real-time, with the overall goal of designing systems that may recognize a user's choice of a particular visually presented stimulus in the presence of other stimuli, and respond accordingly. Our system, called *AutoSelect*, may automatically detect a user's visual preference solely based on eye movement data in a two-alternative forced choice (2AFC) setting. In a pilot study involving the selection of neckties, the system could correctly classify subjects' choice with an accuracy of 81%.

We believe that visual attention based interactive technology is of high relevance to various applications, including e-learning, future interfaces, as well as devices for handicapped people. In fact, many decisions of our daily life can be reduced to choices between several items, and cannot be easily explained in terms of overt reasoning on premises. In a restaurant, for instance, we choose between different types of dishes. Unless price or dietary considerations are of primary importance, our decision for a particular dish might be based on our taste, our expectation of a specific (eating) experience, or even our current mood.

The analysis of eye gaze patterns may provide an effective means to unveil non-conscious preference decisions of people. This paper describes our AutoSelect system that exploits the gaze 'cascade effect' and a recently conducted pilot study.

Gaze 'Cascade Effect'

When presenting pairs of human faces to subjects and giving the instruction to decide on their attractiveness, (Shimojo et al., 2003) observed a phenomenon they called gaze 'cascade effect'. This phenomenon involves the gradual gaze shift toward the face that was eventually chosen (as more attractive), while gaze bias was initially distributed evenly between the two presented faces. The results of the 2AFC task used in their study demonstrated a progressive bias in subjects' gaze toward the chosen stimulus (preference formation), which was measured by the gaze time spent on the selected stimulus. However, the strong correlation between choice and gaze duration occurred only in the last one and half seconds before the decision was made. A finding that (Shimojo et al., 2003) declared as surprising relates to the result that a larger cascade effect was found in the 'difficult' task, where the comparison between the attractiveness of faces was difficult, while intuitively, subjects were expected to more evenly distribute their gaze between stimuli in this case, in order to compare stimuli in as much detail as possible. The result was be explained by a theory claiming that gaze would significantly contribute to decision-making when cognitive bias is weak. The importance of this result for our research derives from the fact that a large number daily choices, e.g. regarding consumer products, are also deficient of a strong cognitive bias, and hence contributes to the importance of investigating non-conscious human decisions.

Pilot Study

A system that is able to automatically detect users' choices seems to break new ground. We therefore conducted an exploratory study using the AutoSelect system. Our first application is an automatic necktie selector, where subjects are shown a pair of ties and the AutoSelect system tries to detect the preferred tie. Subjects were given no instruction other than having to choose a tie for themselves or their friend for a graduation party.

We used faceLAB™ v4 from (Seeing Machines, 2005), a non-contact vision-based system with a sampling rate of 60 Hz. We implemented an algorithm based on the findings of (Shimojo et al., 2003), which detects visual preference in real-time.

Eight subjects (4 female, 4 male), all students or researchers from our institute, participated in our study. Subjects entered the experimental room individually and were provided written instructions about their task. Subjects were seated in front of a 20.1 inch display with attached infrared lights and their head and eyes were calibrated. This procedure had to be performed for each individual once, and took approximately 5 minutes. A session was initialized by subjects pressing a 'start' button in a web page based interface (see Fig. 1).

The following procedure was then iterated for 62 pairs of ties. First, a center located 'dot' was shown on the screen for 2.5 s in order to eliminate any initial gaze bias. Next, a pair of ties was presented, located to the left and to the right on the screen. In order to guarantee that subjects actually compare the ties, automatic selection was suppressed within the first 2.5 s. This value was based on the empirically determined decision time of 4 s in (Shimojo et al., 2003). After the system decision, the selected tie was presented and subjects were asked to indicate whether the system choice is correct by clicking on a 'yes' or 'no' button. Then the next iteration started with the initial view of a center dot. One initial set of 32 tie pairs was prepared, and the chosen ties were put back into the tie pool, which was used to create the subsequent set of 16 pairs, and so on. Eventually, subjects were shown a single pair of ties they presumably liked best. Hence, subjects were exposed to 63 pairs and performed 62 decisions in total. In the initial set of tie pairs, two partitions were created with 13 pairs each. One partition contained pairs of 'different' type ties, i.e. formal (decent) vs. 'entertainment' (adventurous) style ties, whereas the other partition contained 'similar' type ties that differed only in color or had a slightly different pattern but the same color. The motivation of this grouping was to investigate differences in subjects' decision behavior for presumably 'easy' vs. 'hard' decisions. All sessions were logged and lasted for about 10 minutes.

Results

The primary result concerns the classification accuracy of the AutoSelect system. In our study, the system was able to detect subjects' choices correctly in 81% of the cases. The worst recognition rate was 68%. Given a chance level of 50%, the system performed very well. (One subject was excluded from the analysis because of distorted values due to starting a conversation during the experiment.) We wanted to investigate the users' interactive experience with a running system, which can reveal e.g. issues related to the latency between user decision and system decision. Informal comments on the system indeed indicated that subjects were surprised about the system's reliability to timely identify which tie they liked more. Some of the misclassifications were related to a design problem, i.e. when subjects moved their face out of the camera range. The next version of AutoSelect should alert subjects in those situations. Furthermore we were particularly interested in results comparable to the 'difficult' vs. 'easy' choice finding reported in (Shimojo et al., 2003).

We hence compared recognition rates and decision times for 'different' vs. 'similar' tie pairs. Recognition rates were 75% (different ties) and 81% (similar ties); decision times were 6.8 s (different ties) and 7.65 s (similar ties) In line with (Shimojo et al., 2003), the decision time for similar ties was significantly longer than for different ties ($t(180) = -1.66$; $p = 0.049$). A one-tailed t-test assuming unequal variances was used in our analysis. This result supports the hypothesis that a choice between unlike items relies on (time consuming) cognitive processing, whereas similar items might be chosen based on non-conscious ('intuitive') preference. We also note that the system calculated the choice between similar ties more accurately.

Conclusion

We conducted a pilot study to test whether the AutoSelect system can correctly predict the choice of a user. The accuracy of the system with a limited number of subjects (seven) is reasonably high (81%). Future research needs in our case are two-fold: (1) We plan to improve the experimental design. In the current study, subjects are asked to confirm (or not confirm) the system choice, which involves the risk to receive 'polite' rather than 'truthful' answers (whether the system chose the preferrered tie correctly). Although this goes along with a situation that occurs i.e. in sales talks with vendors, we will obtain preference decisions predicted by AutoSelect and subjects' decisions independently in an upcoming study. In this way, the accuracy of the AutoSelect system can be estimated on a more solid basis. (2) A larger number of subjects will be included in the follow-up study.

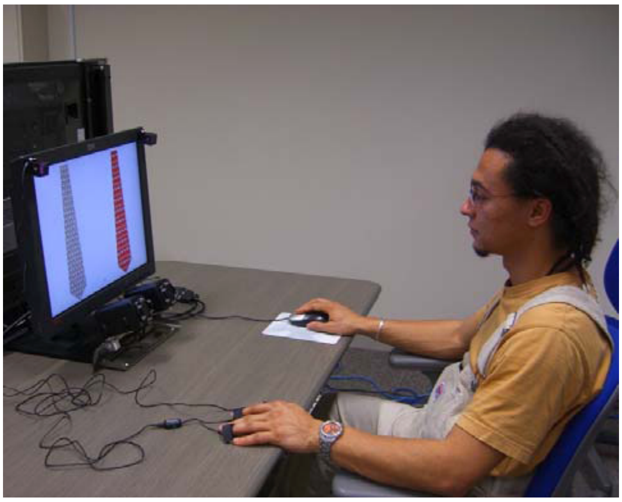

Figure 1: Experimental setup

References

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