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# An Examination of the Gaze-cueing Effect Using Different Methods of Gathering Responses<sup>1</sup>

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**Abstract :** This study compared the gaze-cueing effect for two different response styles: detection method and localization method, using a relatively small number of trials in each experiment. The effect of the stimulus onset asynchronies (SOAs) was found to be similar to a previous study by Friesen & Kingstone (1998). The experiment using the localization method yielded the gaze-cueing effect, but the experiment using the detection method did not. Error exclusion rates, but not latency exclusion rates differed between these response methods; the localization method produced significantly more errors than the detection method. However the present findings suggest that for a smaller number of trials the detection method may fail to clearly identify the gaze-cueing effect.

**Keywords :** gaze-cueing effect, attention, response errors

Human gaze has been regarded as one of the most powerful tools for communication in face-to-face interactions. Psychologists have long been interested in investigating the effects of human gaze in social and/or cognitive spheres. One of the phenomenon investigated by Friesen & Kingstone (Friesen & Kingstone, 1998) was called the gaze-cueing effect. This phenomenon shows that our perception of another's gaze direction evokes covert and overt shifts of attention towards the corresponding direction, which occurs reflectively. This gaze-cueing effect is very robust and arises reliably and thereby influences our behaviours (Frischen, Bayliss, & Tipper, 2007).

To examine the effect of gaze-cueing, the participant is asked to respond to a target that appears either to the left or to the right of a facial image with varying stimulus onset asynchronies (SOAs) where the eye gaze of the facial image is directed to either the left or the right side. The participant

responds by either detecting the appearance of the target or by indicating the target's location. When the target appears in a congruent location to the direction of the facial image's eye gaze (i.e. valid trial), then the participant's response is significantly faster than when the target appears in an incongruent location.

Although the gaze-cueing effect is robust and reliable, the experiments used to test this effect may not be so straightforward for participants, especially when testing younger subjects because the detection of this effect generally includes a few hundred trials. As this effect has made a tremendous contribution to our understanding of the perception of the face and gaze-following behaviours in different populations, it is crucial to consider what trial size is sufficient to elicit valid measurements.

In the systematic investigations into the gaze-cueing paradigm, Friesen & Kingstone tested the effect of three different methods of gathering responses: *detection*, *localization* and *identification* of the target and they found significant differences in error rates between the methods of responses requested from the participants. However,

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the gaze-cueing effect, in which the responses to the cued-target trials were faster than those of the neutral or uncued-target trials, was found for all response methods. These findings suggest that any of the three response methods can be used in an experiment. Thus a more practical consideration would be what error rates could we accept in an experiment. A lower error rate could mean that the number of trials could be minimized (and the detection method has the lowest error rate). This would be very useful when the experiment is administered to younger subjects. However, the previous study's experiments used 500 trials for each experiment; therefore it is not clear how many trials is sufficient in order to observe the gaze-cueing effect.

The aim of the present study is to examine the gaze-cueing effect using different response methods and a much smaller number of trials in each experiment. In this experiment, the detection method and localization method were of particular interest as these methods could be adopted for a younger age population. If the experiment using the simplest method, which is the detection method in which 'any key' press responses together with a smaller number of trials, could reliably identify the gaze-cueing effect, then this method would be better for younger people.

## Method

*Participants.* Eight female university students participated in the experiment (age range=20-21 years, mean age=20.1 years, SD=1.0 year). The participants had normal or corrected-to-normal vision.

*Stimuli.* Photos of a female actor expressing happiness, anger, sadness, or a neutral expression, and each facial expression had a version with both a straight and averted gaze directions, were selected from the ATR Facial Expression Image Database (DB99). Mirror images of these photos were used for the alternate averted gaze direction. In all, there are 12 different images. The facial images were 6.8 cm wide and 9.1 cm high and the images luminance and brightness were adjusted to

be identical using Adobe photoshop CS4. The facial image was presented in the center of a 13-inch laptop computer screen (Apple MacbookPro). The target reaction signal was a 1.8 cm circle and was located horizontally at 15.5 cm away from the center of the face image.

*Experimental design and procedure.* Each participant was seated facing the monitor at a distance of 40 cm. A single trial consisted of a series of the following events. Following a 1000 msec of inter-stimuli interval, a fixation point (+) appeared at the center of the computer screen for 600 msec. Then a face stimuli with straight gaze appeared at the center of the screen for 1500 msec, which was followed by an averted-gaze face for either 100 or 300 msec (SOA), before the target circle appears at the either right or left of the facial image stimulus. The target circle was presented until a response was made or 1500 msec had elapsed. There were two types of response methods. For the localization method, the right-left response keys were assigned, and the participant was instructed to press a key 'm' for a right and 'z' for a left response. Whereas for the detection method, a single key response style was used, the participants were instructed to press any key to make a response. The participants were also instructed to look at the center of the screen until the target circle appears and to press the appropriate key as soon as they saw the target. Each of the facial stimuli had a straight gaze which was automatically followed by one of the two directional averted gazes (right or left), two target locations (circle on the right or the left), two SOAs (100 or 300 msec) and four facial expressions (happy, angry, sad, and neutral), totaling of 32 different types of stimuli. The stimuli presentation was randomized within a block of 32, and each block was repeated 4 times, making a total of 128 trials for each experiment. There was a short break between every two blocks of trials. The participants completed two experiments, one for each response method; the order of the experiments was counterbalanced.

*Data analysis.* Reaction latencies from the presentation of the target circle to the press of the key

were analyzed. Incorrect responses and time-outs were classified as errors and excluded from the final analyses. Reaction latencies that deviated from the individual participants' mean  $\pm 2$  SD were also excluded from the final analyses.

## Results

The proportion of trials excluded from the final analyses was examined first. Those trials excluded from the analyses were examined for response errors and for latency outliers, separately. The means and standard deviations for the proportion of each of the exclusion trials are summarised in Table 1.

To compare the exclusion rates between response types, (response types: two-key, any-key) and exclusion types (error, latency) an ANOVA was conducted. There were significant exclusion effects:  $F(1, 7)=30.33, p<.01, \eta^2=.81$ , and response type effects:  $F(1, 7)=5.73, p<.05, \eta^2=.45$ , but no interaction between these variables was found. The latency exclusion rate was significantly greater than the error exclusion rate. There was a greater exclusion rate for the two-key response in comparison with the any-key response.

To examine these effects as a function of SOAs, 2 (response types: two-key, any-key) x 2 (SOAs: 300 msec, 100 msec) ANOVAs were conducted on the rate of error exclusion and latency exclusion, respectively. There was a significant main effect of response type for error exclusion:  $F(1, 7)=9.32, p=.019, \eta^2=.57$ , suggesting that there were more error exclusions in the two-key response types

than any-key responses. On the other hand, latency exclusion did not differ between two response types:  $F(1, 7)=0.00, p=1, \eta^2=0$ . Neither SOA effects nor interactions were found to be significant for both error exclusion and latency exclusion [SOA:  $F(1, 7)=3.97, p>.05, \eta^2=.36$ , for error exclusion, and  $F(1, 7)=.956, p>.1, \eta^2=.12$  for latency exclusion, interactions between response type and SOAs:  $F(1, 7)=3.73, p>.05, \eta^2=.35$  for error exclusion, and  $F(1, 7)=2.54, p>.1, \eta^2=.266$ , for latency exclusion].

To examine the gaze-cueing effect for the response types, a 2 (SOA: 100 msec, 300 msec) x 2 (response styles: two-keys, any-key) x 2 (validity: valid, invalid) ANOVA on latency as a dependent variable was conducted. Mean response latencies as function of SOAs, Validity, and Response styles are summarized in Figures 1 and 2. There were significant main effects for SOA:  $F(1, 7)=9.9, p=.016$ , and Validity:  $F(1, 7)=32.3, p=.001$ . The latency of the trials with 300 msec SOA was significantly shorter than the trials with 100 msec SOA, and the latency of the valid trials was significantly shorter to the invalid trials. There was no effect for Response styles:  $F(1, 7)=3.5, p>.10$ . However, there was a significant three-way interaction:  $F(1, 7)=9.3, p=.019$  and a significant interaction between Response styles and Validity:  $F(1, 7)=40.3, p<.001$ .

Follow-up analyses of the three-way interaction were conducted at the levels of the SOA and Response styles, respectively. On the levels of the SOAs, there was a significant interaction between

Table 1. Means and standard deviations for the percentage of trials excluded from the analyses for response due to response error and latency.

	Localization method (two-key response)		Detection method (any-key response)	
	M	SD	M	SD
SOA 300 msec				
Error exclusion	1.95	1.82	0.2	0.55
Latency exclusion	2.93	2.28	4.69	3.44
SOA 100 msec				
Error exclusion	0.78	1.18	0	0
Latency exclusion	3.71	0.81	1.95	2.17

## Two keys / Localisation method

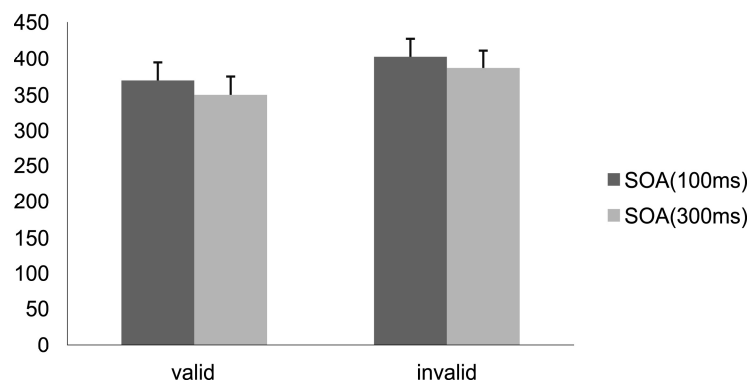


Figure 1. Mean latencies (msec) as a function of SOA and Validity when the two-key responses were used.

## Any key / Detection method

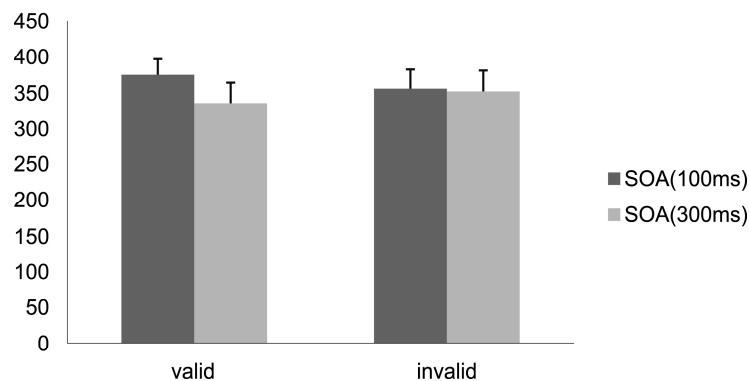


Figure 2. Mean latencies (msec) as function of SOA and Validity when the any-key responses were used.

Response styles and Validity in the SOA (100 msec) condition:  $F(1, 7)=7.2$ ,  $p<.001$  but not in the SOA (300 msec) condition. This significant interaction was due to a significantly longer latency in invalid trials compared to the valid trials, in the two-key response condition, whereas a reverse trend was found, in the any-key response condition. To elicit gaze-cueing effect, the latency for the invalid trials should be significantly greater than for the valid trials. In this respect, performance using the any-key response failed to observe the gaze-cueing effect.

On the level of the Response style factor, there was a significant interaction between SOA and Validity for the any-key response only:  $F(1, 7)=5.6$ ,  $p=.05$ . This significant interaction was due to a significantly longer latency for the valid trials compared to the invalid trials for the SOA (100 msec), whereas no difference was found in the SOA (300 msec) conditions. To observe the gaze-cueing

effect, the response to the invalid stimuli should be longer than that to the valid stimuli. Neither of the SOA conditions meet this assumption. In this respect, the current trend for latency difference suggests that the gaze-cueing effect was not observed for the any-key response.

### Discussion

The present study examined the gaze-cueing effect for two different response styles, together with the use of a relatively small number of trials. In this investigation, both the error and latency exclusion trials that were excluded from the final analyses, were examined.

For the error rate, the current finding also confirmed the previous studies in that significantly many more errors were made when using the localization method where two assigned-key presses were used in comparison to the detection method that required an any-key response. This larger

error exclusion was expected, and this necessitates one to include a relatively larger number of trials to compensate for possible response errors. However, a large number of trials may not be suitable for younger participants as their concentration may decrease.

Another interest of this investigation was the latency exclusions. There was no effect for SOA or response methods. However, more importantly latency exclusions were significantly larger than error exclusions, suggesting that latency exclusion rate may be more susceptible to a trial size. Although the latency exclusion criteria is not limited to the mean  $\pm 2$  SD, a larger trial size may yield a wider latency variance due to several possible causes (e.g. tiredness), thereby creating a larger inclusion range.

The gaze-cueing effect, whereby the latency of cued-trials should be shorter than uncued-trials, was examined for the detection method (i.e. any-key response) and the localization method (i.e. two-key response) conditions. For the effect of SOA, the latency to the trials with 300 msec was significantly shorter than the trials with 100 msec. This result confirmed previous findings (Friesen & Kingstone, 1998) that the latency became shorter as the SOA increased up to 600 msec. However, when the response types were compared, gaze-cueing effect was confirmed for the two-key response only. The investigation with an any-key response failed to find a gaze-cueing effect. The any-key response to the latency of the stimuli with 100 msec SOA actually yielded a reverse effect.

These results suggest that the detection method (i.e. any-key response) with a smaller number of trials may not elicit a reliable gaze-cueing effect. Friesen & Kingstone used 10 blocks of 48 trials for each of the response conditions. This large number of trials might help find the gaze-cueing effect with the detection method. When one hopes to be able to use the detection response with a smaller number of trials, it should be noted that the reliability of the effect might be an issue.

Nevertheless, the present study observed reliably the gaze-cueing effect using a relatively small number of trials when the localization (i.e. two-key response) method was used. As lengthy experimental trials may not be suitable for a certain groups of people, the present finding suggests that, when the localization method is used, one could reduce the trial size. The detection method, on the other hand, may be relatively error free, however to reliably find the gaze-cueing effect may require a large number of trials to be used.

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# Gaze-cueing Effect 測定パラダイムにおける反応収集方法の検討

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要 旨

本研究は、2種類のキー押し反応において、gaze-cueingの効果の現れ方の違いを検討した。Stimulus onset asynchronies (SOAs) 要因を変化させることによる効果は、SOA 先行研究 Friesen & Kingstone (1998) と同様の結果が得られたものの、キー押し要因(単一キー押し/割当てキー押し)の効果については、その限りではなかった。単一キー押しについては、gaze-cueing がみられなかったが、割当てキー押しについては gaze-cueing がみられた。本実験では、従来の実験よりも少ない試行数での効果について検討したことから、試行数を少なくして実験を行う場合については、単一キー押し方法を用いると必ずしも、gaze-cueing がみられるとは限らないことが示唆された。

キーワード：gaze-cueing、注意、誤反応