



# Information processing under high and low distractions using eye tracking

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## Abstract

The previous studies found the differences of eye movements between systematic and heuristic processing were inconsistent. To bridge this gap, we manipulated both systematic and heuristic processings (using high vs. low distractions) and argument quality (using strong vs. weak), and measured both eye movements and self-reported attitude. The results suggested that low distraction induced larger differentiation of post-message attitude between strong and weak arguments compared to high distraction, indicating the successful operation of both processings. More importantly, low distraction enabled more fixations and shorter saccade lengths independent of argument quality. However, no differentiations were found involving fixation duration, regressions, and reading speed. In addition, argument quality influenced eye movements, i.e., less fixation and faster reading speed were found in strong arguments. Our results explain why distractions reduce the efficiency of information processing from an eye tracking perspective and why fixation duration results were inconsistent in the previous studies.

**Keywords** Persuasion · Eye tracking · Distraction · Systematic and heuristic processing

## Introduction

Persuasion plays a central role in most areas of life. Over the past decades, scholars have proposed many theories and models to explore underlying cognitive mechanisms and regularities. The most influential persuasion theory is a dual-process model: the elaboration likelihood model (ELM; Petty and Cacioppo 1986a). It proposes that when ability and motivation to process information are high, attitude is the result of systematic processing, whereas when motivation and ability are lower, attitude results from heuristics cues.

It is important to distinguish both processing patterns to elucidate the cognitive processes that underlie attitude formation. This is because both processing patterns may result

in similar attitudes, but the consequences and strength of similar attitudes differ between central and peripheral routes (Petty and Krosnick 2014). In particular, attitude via systematic processing is more likely to be permanent, resistant to counterpersuasion, and predictive of behavior. In contrast, heuristics processing tends to lead to an attitude, which is temporary, susceptible to counterpersuasion, and less predictive of behavior (Petty and Cacioppo 1986b).

Eye tracking can provide unobtrusive and objective measures of attentive behaviors during exposure to messages (Venkatraman et al. 2014; Wade and Tatler 2005). Exposure and visual attention to messages are important since they are the preconditions of attitude change when reading a persuasive content (McGuire 1981). It has been shown that fixation duration and fixation count, which are the main measurements in eye tracking research, are reliable indicators of the level or depth of information processing (Velichkovsky et al. 2002). That is, both fixation duration and the number of fixations increase with increasing required cognition efforts to process the message. Many researchers utilized eye tracking to investigate differences in visual attention between systematic and heuristic processing (Glöckner and Herbold 2011; Yang 2015). For example, Ares et al. (2014) evaluated differences of rational and intuitive thinking styles when consumers viewed yogurt labels.

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Their results showed that both fixation counts and duration of consumers who used a rational thinking style to evaluate nutritional information were more than those of consumers who relied on an intuitive style of thinking. In addition, Rubaltelli et al. (2012) reported that compared to a rating task, participants preferred to deliberately complete a pricing task. More importantly, the deliberative thinking processing required for the pricing task was related to increased pupil dilations, fixation duration, and fixation counts. Turner et al. (2014) also reported that participants with motivation to shop for healthful food products showed longer fixation duration when looking at all available nutrition information on food packages.

However, some studies reported different results in terms of fixation duration. Horstmann et al. (2009) compared decision processes with regard to underlying intuition and deliberation models, and found that instruction-induced deliberation resulted in a large number of fixation counts than those generated by intuition, while no differences were found for fixation duration. Additionally, Keller et al. (2014) reported a discrepancy between the number and duration of fixation. During the processing of two risk communication formats, mean fixation durations for percentage and pictograph were not significantly different between intuitive and deliberative decision conditions. However, deliberation resulted in a higher number of fixations. Research on online shopping by Yang (2015) also showed no difference in fixation duration between the high and low elaboration conditions.

As noted, some studies found that systematic processing induced longer fixation duration compared to heuristic processing. In contrast, some studies did not report such a difference. Given the inconsistent and ambiguous results reflected in the existing literature, as well as the importance of differentiating between systematic and heuristic processing, we used another variable to manipulate both processing types—high and low distractions—which have frequently been utilized in the previous persuasive studies (Lammers and Becker 1980; Petty et al. 1976). Distraction influences the capability to process information. Few previous eye tracking studies manipulated systematic and heuristic processing via different capability variables. Studies that used distraction found a consistent trend: Distraction enhances persuasion for a message that contains weak arguments due to the disruption of unfavorable thoughts; however, that distraction reduces persuasion for a message that contains strong arguments by disrupting favorable thoughts. In conclusion, distraction can affect the ability of a person to process a message, and further determine the systematic and heuristic processing.

According to the cognitive load theory (CLT), humans have a limited capacity to process all available information; therefore, only limited information can be processed concurrently (Sweller 1988). Consequently, issues regarding both

allocation and control of cognitive resources have become a theoretical focus (Day et al. 2009). Cognitive resources are more likely to be consumed by high distraction tasks compared to low distraction tasks. As a result, highly distracted individuals do not have sufficient cognitive resources to process persuasive information. When an individual suffers from overly abundant cognitive load, insufficient capacity remains to process a persuasive message. Thus, we expected low distraction to lead to a broader (more fixations), deeper (longer fixation duration), better organized (less regressions and shorter saccade lengths), and faster reading process compared to high distraction.

The aim of the current study was to investigate differences in eye movements between systematic and heuristic processing, which were manipulated by low and high distraction tasks. Furthermore, we varied argument quality (high vs. low) following the classic paradigm of persuasive research. Apart from fixation count and duration, saccade length, regression, and reading speed were recorded and included into the subsequent analyses. We hypothesized that participants with a low distraction task should generate more fixations, longer fixation duration, shorter saccade lengths, smaller regression proportions, and faster reading speed compared to those with a high distraction task.

## Methods

### Participants and design

Eighty male undergraduates with medicine major were recruited for the current study ( $M_{\text{age}} = 21.53$ ,  $SD = 0.54$ ). The design utilized a 2 (distraction: high, low)  $\times$  2 (argument quality: strong, weak) factorial design between participants. Eight participants had to be excluded due to invalid calibration (mean deviation on  $X$  or  $Y$  axes larger than  $1.5^\circ$ ), a tracking ratio below 70% (Keller et al. 2014), or incorrect responses for the distraction task. Finally, the remaining 72 valid cases were entered for statistical analysis. Low distraction condition includes 35 cases, and high distraction condition has 37 cases. All participants provided written formal consent after having received a detailed explanation of the study procedures and received a financial compensation for the inconvenience of participating in each phase of the study. The protocol of the experiment was approved by the Ethics Committee of The Fourth Military Medical University.

### Materials

The participants read a persuasive message that either contained five strong (with a length of 872 words) or five weak arguments (with a length of 882 words) in favor of transgenic technology. We conducted a pretest to confirm that the

strong arguments were cogent and compelling and that the weak arguments were specious. Fifty-nine first-year undergraduates randomly received one of the two versions of a message advocating transgenic technology. This message consisted of either five strong or five weak arguments. The results revealed that strong arguments ( $M=5.05$ ,  $SD=0.77$ ) instigated a more favorable attitude than weak arguments ( $M=4.25$ ,  $SD=0.97$ ),  $t(57)=3.50$ ,  $p<0.01$ , indicating the validity of the persuasive material.

For the strong version of the message, one argument focused on the fact that transgenic technology potentially increases yield. In contrast, the weak version of the argument also supported transgenic technology, but did not provide a compelling reason for this support. In the weak argument condition, one argument conveyed that although the safety of transgenic technology is controversial, this technology must be developed to promote our country's status in the world.

## Procedures

Participants entered the laboratory alone. Prior the final experiment, participants completed the pre-message measure. Participants were asked to report their attitudes regarding several social hot topics. Among the 10 evaluated items, the sixth one was used to measure the participants' initial attitude regarding transgenic technology.

The utilized explanation was that the aim of the experiment was to study reading habits from a computer screen; therefore, participants had to sit at a specific distance of 65 cm from the monitor and move as little as possible to ensure the experimental effect. After calibrating and validating the eye tracker, the formal experiment commenced.

Instructions on the screen informed the participants that they would see messages about transgenic technology. A fixation cross was presented on the center of the screen for 1000 ms. Then, the fixation cross was replaced by five pictures either containing five strong arguments or five weak arguments. The participants were permitted to look at the message as long as required. A fixation cross did not reappear between each picture. When the participants were reading the information, they were told that they had to conduct a second task simultaneously. The second task (i.e., distraction) was that participants should count the number of specific audible sounds. We varied both frequency and complexity of the target sounds to manipulate the level of presented distraction (Martin et al. 2007). For high distraction tasks, participants were told to count the high-pitched sounds only, while ignoring lower-pitched sounds. All sounds in the high distraction task were played randomly. In contrast, for the low distraction task, we required participants to simply count the number of all sounds they heard. Based on the reading time and the number of sounds that participants reported, we

excluded participants from the final analyses who provided the wrong number of sounds.

After reading the message, participants completed pencil-and-paper post-message attitude measures, information recall task, and manipulation checks. After completion of these measures, the participants received thanks and were paid 20 CNY as a reward.

## Eye tracking measures

Participants' eye movements were tracked and recorded with a Tobii eye tracker (Stockholm, Sweden) at a sampling rate of 60 Hz. The persuasive material was presented on a 17-inch thin-film monitor of the eye tracker with a  $1280 \times 1024$  pixel resolution. Initial eye position data were recorded via Tobii Studio software. The fixation count and mean fixation duration were directly generated by Tobii Studio software. The analyses of saccade lengths, regressions, and distribution of fixation duration were created using MATLAB software.

The two basic components of eye movements when people read a message are the movements themselves (called saccades) and fixations (the period of time when the eyes remain fairly still) (Rayner 2009). Generally, no new information is acquired during saccades due to the quick eyes movement across the visual stimulus. The human brain does not encode new information during a saccade; therefore, cognitive processing happens during fixations rather than saccades (Irwin 1998; Irwin and Carlson-Radvansky 1996). When the eyes are fixated on a certain area for an extended time period, the individual is processing information. Eye movements are categorized based on the velocity of the directional shifts of the eye (Salvucci and Goddberg 2000). If the velocity exceeds 30 visual degrees per second, the eye movement belongs to a saccade, whereas if it falls below this threshold it is regarded as a fixation.

Fixation count represents the total number of times that a participant fixates his gaze on the whole persuasive message. The mean fixation duration is the mean duration of all these fixations within the whole persuasive messages. In addition, we used letters rather than visual angles to represent saccade length which was measured as a Euclidean distance between the coordinates of the first and last point in a sequence of continuous eye position samples (Morrison and Rayner 1981). Return sweeps were excluded from the analyses of saccade lengths. Reading speed was calculated by dividing the number of total words by the whole reading time. Rayner (2009) suggested that the regression analysis should distinguish between return sweeps, because these are right-to-left saccades that range from the end of one line to the beginning of the next line rather than really representing information encoding processes. In the current study, we divided the next saccadic direction into four directions. If the

subsequent fixation located in the bottom left corner (using the current fixation location as center), and if the distance between previous and current fixation locations was more than half of one line, we regarded these types of saccades as return sweeps and excluded them from further regression analysis.

## Measures and results

### Personal relevance

As noted above, both motivation and ability to consider the persuasive message can decide the domination of information processing patterns between systematic and heuristic processing. In the current research, two processing patterns were operated by the distraction which influenced the ability to process information, so we measured the personal relevance of message to exclude the interference of motivation. Participants answered: “How relevant do you believe transgenic food is to you?” (1 = *not at all relevant to me*, to 7 = *very relevant to me*). A  $2 \times 2$  (distraction  $\times$  argument quality) ANOVA found no any significant effects,  $F_s < 1$ , indicating motivation did not affect experimental manipulations. Additionally, one-sample  $t$  test showed the relevance was higher than the scale midpoint of 4,  $t(71) = 5.74$ ,  $p < 0.001$ . This result reveals that participants were relevant to transgenic food ( $M = 4.85$ ,  $SD = 1.25$ ).

### Manipulation check

To assess the effectiveness of the utilized manipulation of message quality, participants received the following question: “How would you rate the quality of the arguments used by the materials to support transgenic technology?” The evaluation used the following measures: 1 = *not at all convincing*; 7 = *very convincing*. A  $2 \times 2$  ANOVA showed a robust main effect of argument quality,  $F(1,68) = 42.32$ ,  $p < 0.001$ ,  $\eta^2 = 0.37$ , indicating that strong arguments ( $M = 5.79$ ,  $SD = 0.81$ ) were viewed as more convincing than weak arguments ( $M = 4.16$ ,  $SD = 1.31$ ). A main effect of the provided distraction was not significant,  $F(1,68) < 1$ . Additionally, the interaction effect was significant,  $F(1,68) = 5.09$ ,  $p < 0.05$ ,  $\eta^2 = 0.04$ . That is, for both low and high distraction participants, those who received the strong arguments had significantly more convincing feelings toward the arguments ( $M_{low} = 6.06$ ,  $SD = 0.66$ ;  $M_{high} = 5.53$ ,  $SD = 0.87$ ) than those who received the weak arguments ( $M_{low} = 3.83$ ,  $SD = 1.25$ ;  $M_{high} = 4.45$ ,  $SD = 1.32$ ),  $F_{low}(1, 69) = 38.04$ ,  $p < 0.001$ ,  $\eta^2 = 0.33$ ;  $F_{high}(1, 69) = 9.36$ ,  $p < 0.01$ ,  $\eta^2 = 0.08$ . However, the impact of argument quality on the manipulation

check of message quality was greater under low distraction than under high. Thus, argument quality was successfully manipulated.

Participants received the following question: “How much distraction did you suffer when reading the message?” The evaluation used the following measures: 1 = *not at all*; 7 = *very much*. The aim of this procedure was to subjectively assess the extent of influence by the distractive task. A two-way ANOVA test was conducted. A significant main effect of distraction manipulation was found,  $F(1,68) = 9.89$ ,  $p < 0.01$ ,  $\eta^2 = 0.12$ , indicating that participants with low distraction had lower interference ( $M = 4.31$ ,  $SD = 1.13$ ) compared to participants with high distraction ( $M = 4.97$ ,  $SD = 0.64$ ). No other effects were significant. In sum, the manipulation of distraction was successful.

### Attitude

A pre-message attitude test revealed that participants held slightly positive pre-message attitudes toward transgenic technology ( $M = 4.19$ ,  $SD = 0.80$ , which was higher than the scale midpoint of 4,  $t(71) = 2.07$ ,  $p < 0.05$ ). Therefore, the transgenic technology message was pro-attitudinal. Initial attitudes were equivalent across all  $2 \times 2$  conditions (all  $F_s < 1$ ).

Participants were asked to report their post-message attitude toward transgenic technology via four measures. The first measure was “do you agree with the current popularizing of transgenic technology?” (1 = *strongly disagree* to 7 = *strongly agree*). The remaining three items used a 7-point semantic differential scale. The endpoints of the scales were *bad-good*, *foolish-wise*, and *harmful-beneficial*. Responses to these four measures were averaged, thus forming an attitude index (Cronbach’s  $\alpha = .854$ ).

A  $2 \times 2$  (distraction  $\times$  argument quality) analysis of variance (ANOVA) was used to analyze the post-message attitude index. The results showed a significant two-way interaction between distraction and argument quality,  $F(1,68) = 4.46$ ,  $p < 0.05$ ,  $\eta^2 = 0.05$ . During conditions of low distraction, participants who received strong arguments had significantly more favorable attitudes toward the proposal ( $M = 5.53$ ,  $SD = 0.64$ ) than those who received weak arguments ( $M = 4.33$ ,  $SD = 1.86$ ),  $F(1, 69) = 14.40$ ,  $p < 0.001$ ,  $\eta^2 = 0.17$ . However, for the condition with high distraction, participants who received strong arguments did not significantly differ in attitude ( $M = 4.82$ ,  $SD = 0.75$ ) compared to those who received weak arguments ( $M = 4.55$ ,  $SD = 1.00$ ),  $F < 1$ . In addition, a significant main effect was found for argument quality,  $F(1, 68) = 11.31$ ,  $p < 0.01$ ,  $\eta^2 = 0.13$ . The attitude differences between high and low distractions indicated successful manipulations of both systematic and heuristic processings.

## Recall of message arguments

Participants with low distraction should recall more of the information to which they are exposed than participants with high distraction. This hypothesis stems from the fact that if people are thinking about and elaborating on information, then they should remember this information better than if they are not devoting much cognitive effort to process it ( Craik and Lockhart 1972). Participants were asked to list as many of the message arguments as they could remember. Two judges independently determined the number of arguments each participants correctly recalled. Judges were unaware of the experimental hypotheses and any participant's level of distraction, though of course judges knew whether they were scoring recall from the strong or the weak version of the message. An item listed by a participant was counted correctly recalled if it expressed one of the five arguments contained in the appropriate message. Arguments listed twice by a participant were counted only once. The interrater reliability was 0.91, and the judges' counts were averaged prior to analyses to derive the index of message recall.

A two-way ANOVA was conducted. The results showed that the main effect of distraction was significant,  $F(1,68) = 5.83$ ,  $p < 0.05$ ,  $\eta^2 = 0.08$ , indicating participants with low distraction recalled more arguments ( $M = 4.10$ ,  $SD = 0.68$ ) compared to participants with high distraction ( $M = 3.57$ ,  $SD = 1.13$ ). However, the main effect of argument quality and the interaction effect did not reach significance,  $F_s < 1$ .

## Eye tracking measures

We conducted a 2 (distraction)  $\times$  2 (argument quality) ANOVA with the number of fixation, fixation duration, saccade lengths, regressions, or reading speed as the dependent variables. The results revealed significant main effects of argument quality when fixation counts and reading speed were used as dependent variables, indicating that the reading of strong arguments induced less fixations and faster reading speed in participants (Table 1). Significant main effects were found for distraction with fixation counts and saccade lengths as dependent variables. Additionally, no significant interaction effects were observed.

Simple effect analyses were conducted to analyze the differences of eye movements between low and high distractions. As depicted in Table 2, low distraction generated more fixations and shorter saccade lengths regardless of argument quality. Here, the number of fixation was marginally significant when arguments were weak. With respect to fixation duration, regression, and reading speed, no significant differences were found between low and high distractions. Consistent eye movement patterns were found during different

**Table 1** Results of each ANOVA

	Source of variation	<i>F</i> value	$\eta^2$
Fixation counts	Distraction	8.82***	0.11
	Argument quality	6.17**	0.07
	Interaction effect	0.02	0.00
Fixation duration (ms)	Distraction	0.03	0.00
	Argument quality	0.50	0.01
	Interaction effect	1.20	0.02
Saccade lengths	Distraction	9.35**	0.12
	Argument quality	0.28	0.00
	Interaction effect	0.06	0.00
Regressions (%)	Distraction	0.11	0.00
	Argument quality	0.02	0.00
	Interaction effect	1.30	0.01
Reading speed	Distraction	2.86*	0.04
	Argument quality	6.37**	0.08
	Interaction effect	0.14	0.00

\*\*\* $p < 0.01$ ; \*\* $p < 0.05$ ; \* $p < 0.1$

materials reading (strong and weak arguments), which indicates that our results are robust and convincing.

To investigate fixation durations in more detail, Horstmann et al. (2009) fixation durations were subdivided as short ( $< 150$  ms), medium ( $\geq 150$  and  $< 500$  ms), and long ( $\geq 500$  ms). They did not find a difference between intuitive and deliberate decision modes with regard to the observed distribution of short, medium, and long fixations. Following their methods, we analyzed the overall proportions of short, medium, and long fixations. One fixation duration was categorized as short ( $< 150$  ms), medium ( $\geq 150$  and  $\leq 500$  ms), and long ( $> 500$  ms). Then, we separately calculated  $\chi^2$  tests of distraction and fixation duration for strong and weak argument. For strong arguments, distraction did not influence the distribution of single fixation duration,  $\chi^2 = 0.62$ ,  $p > 0.05$ . Furthermore, no significant influence was found for the distraction on the distribution observed for weak arguments,  $\chi^2 = 0.45$ ,  $p > 0.05$  (Fig. 1). These results further confirmed that distraction did not affect duration.

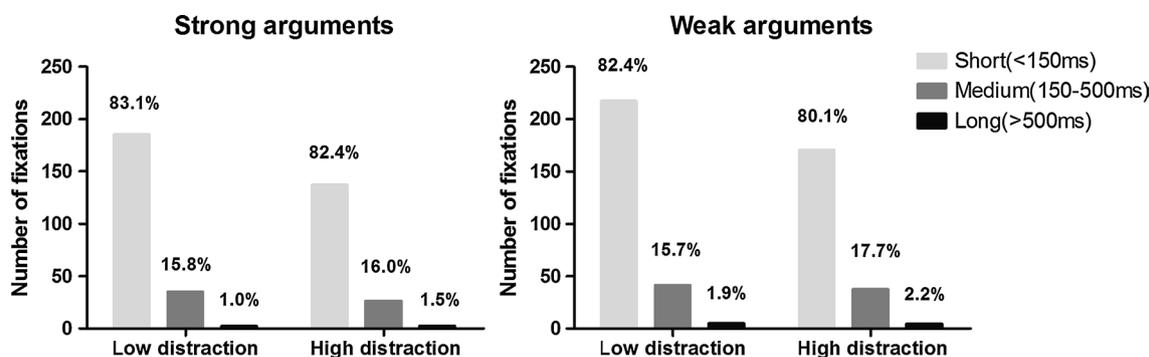
## Discussion

Eye tracking was used as the objective measurement in the current study to evaluate the differences of information processing patterns between systematic and heuristic processing. These two different processes were manipulated via a distraction task (low vs. high), which has previously been confirmed as a successful operational method (Petty et al. 1976). Our results showed that the low distraction resulted in more attitudinal differentiation between strong and weak arguments than high distraction. This indicates

**Table 2** Means and standard deviations of dependent variables and results of simple effect analyses

	Argument Quality	Low distraction		High distraction		F value	$\eta^2$
		M	SD	M	SD		
Fixation counts	Strong	222.88	76.24	166.71	103.81	4.24**	0.06
	Weak	265.50	38.82	214.05	75.70	3.63*	0.05
Fixation duration (ms)	Strong	177.65	24.37	167.06	34.42	0.78	0.01
	Weak	174.44	30.53	182.00	45.49	0.48	0.01
Saccade lengths	Strong	5.15	0.58	5.72	1.03	3.39**	0.07
	Weak	5.09	0.75	5.59	0.53	0.26**	0.05
Regressions (%)	Strong	0.15	0.02	0.14	0.04	5.21	0.00
	Weak	0.14	0.04	0.15	0.03	4.17	0.00
Reading speed	Strong	16.39	6.42	18.36	9.28	0.77	0.01
	Weak	12.07	2.01	15.15	5.61	1.84	0.03

\*\*\* $p < 0.01$ ; \*\* $p < 0.05$ ; \* $p < 0.1$



**Fig. 1** Number of short, medium, and long fixations averaged across participants with either high or low distractions. Bar labels indicate the proportion of fixations for each category

that participants with low distraction systematically thought about the persuasive information, while highly distracted participants heuristically processed the information, confirming our manipulation of different levels of elaborate processing.

Although using two types of persuasive materials (strong and weak), we still received consistent results. That is, compared to participants who received high distractions, participants with low distractions had more fixations and shorter saccade lengths when reading the messages. In contrast, no evident differences were found regarding fixation duration, regressions, and reading speed. It is therefore clear that a divergence phenomenon exists between fixation counts and duration. Jacob and Karn (2003) suggested eye movements to represent two high-level characteristics: the gathering of important information and the processing intensity. The former characteristic is used to locate important information, while the latter characteristic is used to determine how much resources should be allocated per piece of information once it is located. Explorative factor analysis (EFA) introduced in the study by Huang and Kuo (2011) also suggested two different components: the overall attention distribution and

the depth of information processing. Fixation duration in particular belongs to the processing depth, whereas fixations concern the global aspect of attention distribution. In the current study, low distraction generated more fixations but fixation duration, indicating that a distractive task only influenced the selection of attention rather than depth of processing. The attention distribution relates to the encoding of the arguments. If the participants do not process the arguments at all, this would be reflected in a difference in argument recalls between high and low distraction. In contrast, a depth of processing difference would be demonstrated by showing similar recall in high and low distraction, but differential attitudes. Our results showed that participants with low distraction recalled more arguments than those with high distraction, which further confirmed that distraction affected the arguments encoding rather than the processing depth.

As mentioned above, some studies found longer fixation durations for systematic versus heuristic processing. However, some research found similar fixation durations between such processing. We suggest that the main reason for these inconsistent results may originate from the different cognitive processing. Based on the level of elaboration,

information processing could be divided into systematic and heuristic processing. From the perspective of cognitive processing, information processing relates to two representations: the coding of arguments which could be measured by fixation count and the depth of processing which could be reflected by fixation duration. Either of two representations can influence the extent of elaboration, and further affect the argument recalls and attitude change. For example, individuals both under high and low distractions would recall the same number of arguments, though their attitudes differ. This would suggest that the arguments are encoded to the same extent both under high and low distractions because of the similar level of recall, but the arguments are processed deeper when distraction is low, resulting in the attitude differences. Thus, the same level of elaboration in information processing may have a difference of fixation duration. In contrast, the different levels of elaboration may demonstrate same fixation duration.

It is possible in the current study that the distraction task makes information processing more difficult, so whether the difficulty of processing also interferes with the depth of process? In other words, participants could achieve the same level of processing both under high and low distractions, but it is just more difficult to do so when distraction is high. If so, the difficulty of processing can affect the fixation duration. It is the difficulty of processing that takes participants much more time to process the information, resulting in longer fixation duration. However, this pattern does not necessarily lead to deeper processing; therefore, the interference of the difficulty of processing should be eliminated. The attitude differences observed in the current research can argue against this interference. If participants achieved the same depth of processing, but only with more difficulty, the impact of argument quality on attitudes would have been the same under high and low distraction. Our results did not show this pattern, so the idea that distraction affected the difficulty of processing alone was not supported.

In the present research, the reading speed between low and high distraction remained the same, which contrasted our expectations as well as common sense. Theoretically, longer fixation duration, more fixations, and longer lengths are all related with decreasing reading speed. Judging from the results of the current study, we can see that distraction neither influences fixation duration nor reading speed. In low distraction conditions, participants used more fixations and shorter saccade lengths; in high distraction conditions, participants used less fixations and longer saccade lengths. Thus, the complementation of fixation counts and saccade lengths resulted in the same reading speeds between low and high distractions. This finding also indicates that the eye movement mechanisms involve how distractions reduce the information processing efficiency. One reason could be that distractions lower fixations, which induces less attention

selection, while a further reason suggests that distractions generate longer saccades, which are invalid for information encoding.

Most eye tracking studies used only one type of stimulus material, which may increase the variability of results. Therefore, the current study followed the traditional research methods used throughout the persuasion literature, and employed two types of stimuli (strong and weak arguments). Consistent results for both strong and weak arguments across the utilized types of stimuli would render our findings more convincing and enable a more generalized interpretation. Fortunately, we obtained such consistent results between strong and weak arguments. Although the words of strong or weak arguments were almost identical, strong arguments induced less fixations and a faster reading speed. One possibility is that the meaning of the persuasive message also influenced eye movements. In the current study, participants retained slightly positive initial attitudes. Thus, when reading strong arguments (cogent and compelling), participants identified more with what the line of arguments, thus generating less fixation counts and faster reading. Although both strong and weak arguments supported transgenic technology, when receiving weak arguments (specious), participants tended to increase argument scrutiny to confirm the accuracy of the specious arguments, which led to more fixations and slower reading speed. This finding also suggests that the effect of persuasive stimuli should be fully considered in the future research.

One implication of our findings is a preliminary to explain the inconsistent results for fixation duration in earlier studies. We suggest that the cognitive processing when reading message includes two aspects: the encoding of arguments and the depth of processing. One of them can influence the level of message elaboration. Another implication is a direct investigation of attention processes via eye tracking in persuasive context. In previous studies, systematic and heuristic processes were not investigated in a detailed or direct way, but were either indirectly or subjectively measured or argument quality was manipulated. Thus, our eye movement data provide direct investigations into the cognitive processes and compensate past behavioral studies of attitude.

There were caveats in the current study. As an exploratory study of eye tracking in the persuasion domain, this study only analyzed common metrics such as fixation duration, number of fixations, and saccades. To increase our understanding of the cognitive processing involved in attitude formation, more eye movement metrics (e.g., both path and pattern of eye movement) should be analyzed in the future studies. In addition, the distraction task only relates to individuals' ability to process information. Compared to the ability, motivational variables (e.g., the personal relevance of the message) also influence the likelihood of message elaboration. In the future, it is necessary to investigate the

differences in eye tracking measures between motivation and ability in terms of information processing.

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### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the local research committee at Fourth Military Medical University and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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