

---

# Negative Emotion, Positive Performance? A Glimpse into Emotional Influences on Moving Target Selection

**Jin Huang**

Institute of Software, CAS  
School of Artificial Intelligence,  
UCAS  
huangjin@iscas.ac.cn

**Xiaolan Peng\***

Institute of Software, CAS  
School of Computer Science and  
Technology, UCAS  
xiaolan@iscas.ac.cn  
Corresponding author

**Rui Chen****Shengcai Duan**

ShenZhen Institute of Advanced  
Technology, CAS  
School of Computer Science and  
Technology, UCAS  
{rui.chen1, sc.duan}@siat.ac.cn

**Feng Tian**

Institute of Software, CAS  
School of Artificial Intelligence,  
UCAS  
tianfeng@iscas.ac.cn

**Hongan Wang**

Institute of Software, CAS  
School of Computer Science and  
Technology, UCAS  
hongan@iscas.ac.cn

**Abstract**

Moving target selection is one of the most fundamental interaction tasks in user interfaces involving dynamic content. In such kind of systems, many stimuli will cause individual positive or negative emotions. Users need to make the selection with the influences of these emotions, such as waving a stick to hit a fast-moving spider. In this study, we explored the effects of induced emotion on user performances in a time-constrained moving target selection task. We found that participants tended to select the targets faster but make more mistakes in positive emotion condition, while they select the targets slower with fewer mistakes in negative emotion condition. We discussed future research directions on this topic and how it could potentially help the design in user interfaces with dynamic content.

**Author Keywords**

Moving Target Selection; Emotion; User Performance

**CCS Concepts**

•Human-centered computing → Pointing; User studies;

**Introduction**

Nowadays, an increased number of interactive systems try to introduce natural interaction elements such as dynamic contents and emotional factors into user interfaces. Taking a horror virtual reality (VR) shooting game as an example,

---

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).  
*CHI '20 Extended Abstracts, April 25–30, 2020, Honolulu, HI, USA.*  
© 2020 Copyright is held by the author/owner(s).  
ACM ISBN 978-1-4503-6819-3/20/04.  
<http://dx.doi.org/10.1145/3334480.3382874>

virtual enemies appear in the form of dynamic targets. Players have to overcome the emotions of tension and fear and shoot the enemies at the same time. The task of “shooting the enemies” here, is a case of moving target selection in HCI research, that is, a user acquires a target with a certain width and moving speed [7]. As dynamic contents are becoming ubiquitous nowadays, moving target selection is considered to be one of the most fundamental tasks in modern user interfaces [5, 7, 12].

Considering the impact of emotions on varied human activities [13, 10, 4], the potential influence of user emotions on moving target selection has attracted our attention. However, in contrast to the extensive technical approaches to improve user performances on selecting moving targets, we found much less existing work attempting to explore the effects of user-side factors such as emotion on user performances in this area. Although several psychological studies have investigated the influence of emotion on the reaction time of human push-pull movements [2, 16], their findings can hardly be applied to the user interfaces involving dynamic content characterized fundamentally by moving target selection.

To explore how emotion affects user performances in moving target selection, we designed and conducted an experiment involving 24 participants testing the different effects of induced positive and negative emotions on their pointing performances. Error rate and movement time were recorded in a moving target selection task after participants had been exposed to positive or negative emotional videos. We observed that with the influence of positive emotion, the participants selected the targets faster, but prone to make more errors; while with the influence of negative emotion, the participants’ movement was slower with an improvement in pointing accuracy.

## Related Work

Moving target acquisition, as a fundamental interaction task in animation interfaces, has recently attracted more and more attention in HCI community [5, 7, 8, 6, 12]. The first study in moving target acquisition that has influenced HCI research goes back to the model proposed by Jagacinski et al. in 1980 [9]. The Jagacinski’s model extended Fitts’ law [3] to predict movement time (MT) in moving target selection by taking an additional factor of target speed into account. Based on the guidance of this model, some practical techniques such as Comet and Ghost [5] have been proposed to improve interaction efficiency in user interfaces involving dynamic content. Distinguished from building and applying the MT model, a recent research trend attempts to model the selection endpoints and uses it to predict error rate [7, 12] and assist target selection [8]. Attributes of the task, such as target size and speed, were considered as the main factors affecting user performances in these works. In contrast, the potential influences of user-side characteristics such as user emotion on the performances of moving target selection have so far received little attention.

Evidence showed that emotion affects both human cognitive and physical activities. Due to the mutual neurobiology interaction between emotion and cognition [15], emotion has been considered to have more explicit impacts on the user’s cognitive activities. For instance, positive emotions were observed to promote learning efficiency in multimedia learning [13], while the emotion of anger was proved to have a negative effect on driving performances [10]. For physical behaviors, human body movements such as posture control [17] and gait [11] were also found to be influenced by the subjects’ emotion. More relevant to this paper, the reaction time of “pull” and “push” movements of the subjects’ hands have significant differences when operating



**Figure 1:** The experimental apparatus.



**Figure 2:** Two example video clips in CEFSD. (a) "Better And Better" - Positive/Joy; (b) "Bodyguards and Assassins" - Negative/Sadness.

different emotional stimuli. Specifically, subjects responded faster to pull positive stimuli than a negative one, while they acted faster to push negative stimuli than positive one [2, 16]. In addition, given the correlation between emotion and the physical behaviors, researchers were motivated to predict emotional states through physical behaviors such as touch-screen gestures [4]. However, none of the aforementioned studies have directly explored how emotions shape the user performances in the task of moving target selection, which we will try to figure out through this work.

## Experiment

We conducted an experiment to investigate the effects of user emotion on pointing accuracy in a time-constrained moving target selection task. Participants were asked to take a moving target selection task after they had been exposed to positive and negative emotion-inducing materials.

### Participants and Apparatus

Twenty-four participants (12 males and 12 females, with an average age of 23.1) from the local college were recruited. Each participant was paid \$15. The experiment was conducted on an HP Zhan 66 Pro G1 laptop computer, with an Intel Core i7-8550U CPU and a 23-inch (533.2×312mm) LED display at 1,920×1,080 resolution. The pointing device was a Dell WM118 mouse with 1000 dpi, and a high-fidelity headset was used in the experiment (see Figure 1).

### Emotion-inducing Materials

We choose to use video clips to induce the emotion of the subjects. Three positive and three negative video clips were selected from the Chinese Emotional Film Standardization Database (CEFSD) [14] as stimuli. Figure 2 showed examples of positive and negative video clips in CEFSD. We slightly modified the interception time of the selected clips to meet our experimental requirements. Table 1 showed

the details for all selected video clips. Emotion types of the video clips were determined according to the previous work [14], and a SAM (self-assessment manikin) scale [1] was used to measure pre-test and post-test emotional states (valence and arousal) of the participants. The emotional state of dominant was excluded for simplicity.

### Design

The experiment had two independent factors including a within-subject factor *Emotion Type* and a between-subject factor *Task Difficulty*. The *Emotion Type* is divided by categorizing the six video clips (Table 1) in to positive (Joy, Tenderness and Amusement) and negative (Disgust, Sadness) emotions. The *Task Difficulty* is designed by setting two combinations of target speed and size with *Hard*: size = 24 px, speed = 288 px/sec, and *Easy*: size = 48 px, speed = 288 px/sec. The setting of the factor of *Task Difficulty* was set by referring to Huang et al.'s work [7].

### Procedure

The experiment contained two blocks of tests corresponding to positive and negative *Emotion Type*, respectively. Here, we will first describe the process for each block, and then introduce the whole experimental procedure. In a block of tests, a participant watched three randomly ordered video clips in an *Emotion Type* and performed a follow-up pointing test immediately after each video clip was finished. Specifically, after the video clip ended, the computer screen switched to a grey canvas, and the participant performed a 30-second pointing test in the canvas (Figure 3). During the pointing test, a blue circular target appeared at a randomized location on the screen and started moving to a randomized direction with fixed speed. The participant needed to click the target with the mouse as accurately and as quickly as possible. No matter hit or miss, a new target regenerated 500 ms after last click. The participant was en-

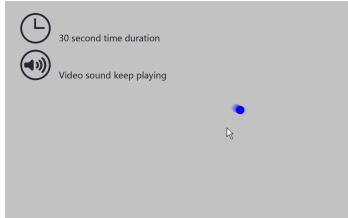


Figure 4: The pointing test.

	Emotion	Film Name	Length(sec)	Clip Content
Positive	Joy	Better And Better	144	The Spring Festival party of a village
	Tenderness	Hear Me	169	The hero rides the motorcycle and carries the heroine
	Amusement	Love on Delivery	148	The dogshit is patted to a bad man's face
Negative	Disgust	Farewell My oncubine	200	The hero suffers assault by an old eunuch
	Sadness	Bodyguards and Assassins	173	A father finds his son is dead
	Sadness	Changjiang qi hao	210	A little boy is sad because of his father's death

Table 1: Selected video clips and their details.

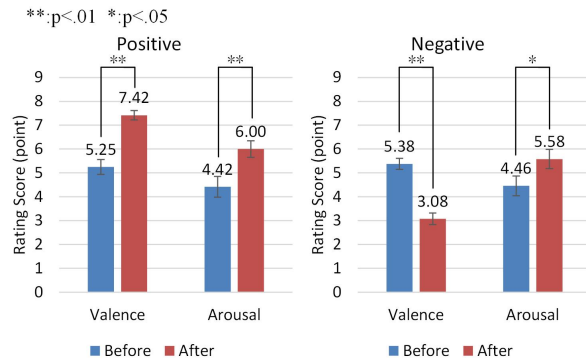


Figure 3: Valence and arousal before and after the tests. Error bars indicated stander errors.

couraged to acquire as many targets as they can. To further enhance the emotional stimulation, the sound of the video kept playing during the pointing test.

Before each block of tests, the participant was asked to sit still, calming down for at least 30 seconds, followed by two simple mathematical calculation exercises to get a neutral emotional state. Then the participant filled a 9-point Likert SAM scale to mark a pre-test emotional state. After the

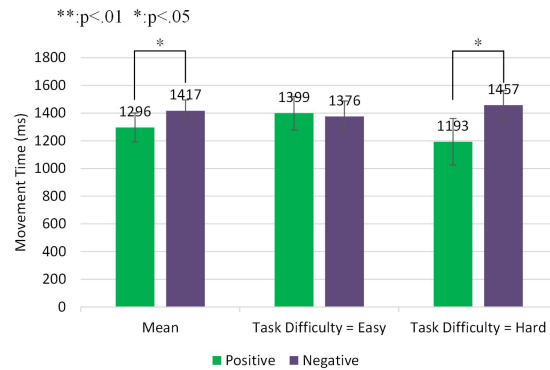
participant finished the block, he/she filled the scale again to provide a post-test emotional state. Each block of tests was completed by the participant alone in a separate room, guided by an experiment program. A 10-minute mandatory break was required between the two blocks of tests, and the experiment took about 40 minutes to finish. The order of the two blocks was counterbalanced within participants.

## Results

We first used a Generalized Linear Model to report the differences between participants' pre-test and post-test emotion states to verify our emotional induction. Then, a Non-parametric Wilcoxon signed-rank test [18] was used to analyze the effects of *Emotion Type* on movement time and pointing accuracy as they were not normally distributed.

### Emotion States

Results showed that participants' perceived valence and arousal changed significantly before and after the tests (all  $p < .05$ ). As shown in Figure 4, In the positive emotion test, the average of valence score increased from 5.25 (SD=1.53) to 7.42 (SD=0.95), and the average of arousal score increased from 4.42 (SD=2.12) to 6.00 (SD=1.71). In the negative emotion test, the average of valence score reduced from 5.38 (SD=1.15) to 3.08 (SD=1.19), and the



**Figure 5:** Effects of *Emotion Type* on movement time.

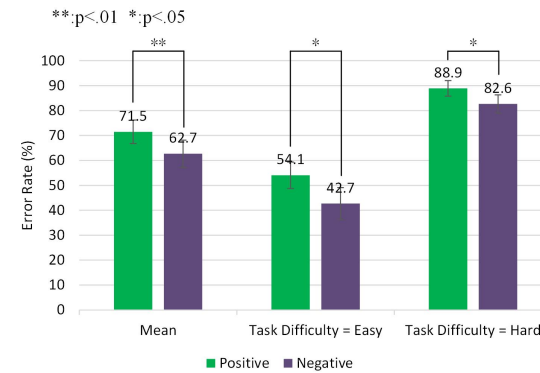
average of arousal score increased from 4.46 (SD=2.02) to 5.58 (SD=1.98). These results indicated that our emotional stimulus materials successfully induced participants' emotions.

#### *Movement Time*

Results showed a significant effect of *Emotion Type* on movement time ( $z = -2.400, p = .016$ ). The average of movement time in positive emotion was 1296ms (SD=519ms), while the average of movement time in negative emotion was 1417ms (SD=383ms). By separating the two levels of *Task Difficulty*, we found that this effect only existed in the Hard difficulty condition ( $z = -2.510, p = .012$ ). We observed a 1193ms (SD=411ms) less average of movement time in the positive emotion than 1457ms (SD=402ms) in the negative emotion.

#### *Error Rate*

Results showed a significant effect of *Emotion Type* on error rate ( $z = -3.072, p = .002$ ). The average of error rate



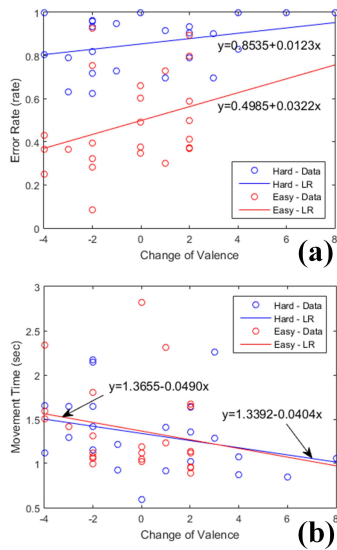
**Figure 6:** Effects of *Emotion Type* on error rate.

in positive emotion was 71.4% (SD=23.0%), while the average of movement time in negative emotion was 62.6% (SD=26.9%). In both of the two levels of *Task Difficulty*, we found participants made significantly more errors in the positive emotion than in the negative emotion (all <.05).

These results indicated that under the influence of positive emotion, the participants selected the targets faster, but more prone to make mistakes; while under the influence of negative emotion, the participants' movement was slower, and their selection accuracy was higher.

#### *Exploratory Analysis of Factors' Relationships*

To further investigate the relationships between emotional states and user performances, we calculated the changes of emotional valence and arousal pre- and post-test, and conducted correlation analysis among them and user performances. Results showed a significant positive Pearson correlation ( $\rho = .300, p = .038$ ) between change of emotional valence and error rate, and a marginal signifi-



**Figure 7:** Linear regressions of (a) Change of Valence vs. Movement Time, and (b) Change of Valence vs. Error Rate. Red and blue represented Easy and Hard conditions.

cant negative correlation ( $\rho = -.258, p = .077$ ) between change of emotional valence and movement time. Other correlations were not significant.

Figure 7 showed results of linear regression (LR) reflecting the above two relationships. We can see clearly that, in both levels of difficulty, when participants' emotional valence was increased (became more positive), they tended to make more mistakes (Figure 7 (a)) and use less time (Figure 7 (b)) in pointing moving targets. Compared to the Task Difficult of Easy, the error rates were higher in the Hard condition, but the slope of regression line in Easy condition was steeper than that in the Hard condition. Regression lines for movement time in the two levels of Task Difficult were very close, indicating a similar impact trend.

## Discussion and Future Work

In this paper, we studied the potential influences of positive and negative emotions on user performances in moving target selection. We argued that emotion is a non-negligible factor affecting user performances in moving target selection. We found that users with positive emotion selected moving targets faster but made more mistakes, while with negative emotion they selected moving targets slower with higher accuracy. Results of factors relationship analysis also indicated that users tend to use more time and perform more accurately as their emotion become more negative.

However, this work was limited in at least the following three aspects. First, the current measurement of emotional state is based on subjective scale, individual differences are relatively large, it is very difficult for us to quantitatively analyze the impact of emotion on user performances based on this data. Second, as a preliminary work in this direction, the types of emotions used in this work are inadequate. Even in the same emotional disposition (i.e., positive or nega-

tive), some emotion types such as anger and sadness may cause users to behave very differently. Third, we only considered the more commonly used experimental paradigm with induced emotion, the emotional stimulus were blocked after starting the pointing test. We don't know how things will change when emotional stimulation and pointing test are carried out simultaneously.

In the future, we will consider using physiological signals such as heart rate to provide real-time evaluation for the emotion states. This data may help to conduct quantitatively analysis of emotional inferences in selecting moving targets. We are also interested in studying influences of synchronous emotional stimulation on moving target selection in VR environments. Finally, more comprehensive emotional stimulation experiments involving more subjects will be carried out to obtain a fine-grained emotional influence spectrum on moving target selection.

An in-depth understanding of such emotional influences will help optimize the user interfaces with dynamic content in the future. For example, it may help to explain user behaviors in video games. The performance when a player is calmly sniping at a target is very likely to be different from when fighting with a terrible monster jumps out of his back. It can also provide guidance on the design of safety critical target selection interfaces. For example, serious or even daunting design may be more suitable for such systems than exciting user interface, as it may make users operate more patiently and accurately.

## ACKNOWLEDGMENTS

This work was supported by the National Key R&D Program of China (Grant No. 2017YFB1002805), the National Natural Science Foundation of China (Grant No. 61802379) and Youth Innovation Promotion Association CAS.

## REFERENCES

- [1] Margaret M Bradley and Peter J Lang. 1994. MEASURING EMOTION: THE SELF-ASSESSMENT MANIKIN AND THE SEMANTIC DIFFERENTIAL. *Journal of Behavior Therapy and Experimental Psychiatry* 25, 1 (1994), 49–59.
- [2] Kimberly L Duckworth, John A Bargh, Magda Teresa Garcia, and Shelly Chaiken. 2002. The Automatic Evaluation of Novel Stimuli. *Psychological Science* 13, 6 (2002), 513–519.
- [3] Paul M Fitts. 1954. The information capacity of the human motor system in controlling the amplitude of movement. *Journal of Experimental Psychology* 47, 6 (1954), 381–391.
- [4] Yuan Gao, Nadia Bianchibberthouze, and Hongying Meng. 2012. What Does Touch Tell Us about Emotions in Touchscreen-Based Gameplay? *ACM Transactions on Computer-Human Interaction* 19, 4 (2012), 31.
- [5] Khalad Hasan, Tovi Grossman, and Pourang Irani. 2011. Comet and target ghost: techniques for selecting moving targets. (2011), 839–848.
- [6] Jin Huang, Xiaolan Peng, Feng Tian, Hongan Wang, and Guozhong Dai. 2018a. Modeling a target-selection motion by leveraging an optimal feedback control mechanism. *Science in China Series F: Information Sciences* 61, 4 (2018), 044101.
- [7] Jin Huang, Feng Tian, Xiangmin Fan, Xiaolong Zhang, and Shumin Zhai. 2018b. Understanding the Uncertainty in 1D Unidirectional Moving Target Selection. (2018), 237.
- [8] Jin Huang, Feng Tian, Nianlong Li, and Xiangmin Fan. 2019. Modeling the Uncertainty in 2D Moving Target Selection. (2019), 1031–1043.
- [9] Richard J Jagacinski, D W Repperger, Sharon L Ward, and Martin S Moran. 1980. A Test of Fitts' Law with Moving Targets. *Human Factors* 22, 2 (1980), 225–233.
- [10] Myoungsoon Jeon, Bruce N Walker, and Jungbin Yim. 2014. Effects of specific emotions on subjective judgment, driving performance, and perceived workload. *Transportation Research Part F-traffic Psychology and Behaviour* 24 (2014), 197–209.
- [11] Gu Eon Kang and M Melissa Gross. 2016. The effect of emotion on movement smoothness during gait in healthy young adults. *Journal of Biomechanics* 49, 16 (2016), 4022–4027.
- [12] Byungjoo Lee, Sunjun Kim, Antti Oulasvirta, Jongin Lee, and Eunji Park. 2018. Moving Target Selection: A Cue Integration Model. (2018), 230.
- [13] Tze Wei Liew and Sumae Tan. 2016. The Effects of Positive and Negative Mood on Cognition and Motivation in Multimedia Learning Environment. *Educational Technology & Society* 19, 2 (2016), 104–115.
- [14] Yongjin Liu, Minjing Yu, Guozhen Zhao, Jinjing Song, Yan Ge, and Yuanchun Shi. 2018. Real-Time Movie-Induced Discrete Emotion Recognition from EEG Signals. *IEEE Transactions on Affective Computing* 9, 4 (2018), 550–562.
- [15] Hadas Okonsinger, Talma Hendler, Luiz Pessoa, and Alexander J Shackman. 2015. The neurobiology of emotion-cognition interactions: fundamental questions and strategies for future research. *Frontiers in Human Neuroscience* 9 (2015), 58–58.

[16] Andrew K Solarz. 1960. Latency of instrumental responses as a function of compatibility with the meaning of eliciting verbal signs. *Journal of Experimental Psychology* 59, 4 (1960), 239–245.

[17] John F Stins and Peter J Beek. 2007. Effects of affective picture viewing on postural control. *BMC Neuroscience* 8, 1 (2007), 83–83.

[18] Frank Wilcoxon. 1945. Individual Comparisons by Ranking Methods. *Biometrics* 1, 6 (1945), 196–202.