

Communication

# Psychological Pressure Distorts High Jumpers' Perception of the Height of the Bar

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Received: 23 April 2018; Accepted: 25 May 2018; Published: 26 May 2018



**Abstract:** The effects of psychological pressure on perceiving the height of a jump bar just before starting a high jump run was investigated. University students ( $n = 14$ ) training for a high jump event performed 15 trials (3 practice, 6 high-pressure, and 6 low-pressure) in counterbalanced order in their daily practice environment. The height of the bar was judged as significantly higher on high-pressure trials compared to low-pressure trials ( $p = 0.030$ ). A regression analysis indicated that participants who reported increased subjective perceived pressure tended to judge the bar to be higher ( $r = 0.468$ ,  $p = 0.091$ ). There was no significant difference between high-pressure and low-pressure trials for the performance index, defined as the success rate ( $p = 0.209$ ). This study provides the first evidence that environmental perceptions prior to executing a motor task under pressure may make performance of the task appear to be more difficult.

**Keywords:** action-specific perception; dynamic perception; high jump; psychological stress

## 1. Introduction

In competitive sport, the influence of psychological pressure on the performance of motor skills cannot be ignored. Pressure is defined as “any factor or combination of factors that increase the importance of performing well on a particular occasion (p.610)” [1]. Pressure is known to influence the performance outcome of several motor skills. The positive effect of pressure is the so-called clutch [2,3], whereas choking means performance decrement under pressure (i.e., negative effect) [1,4], which is a particularly acute problem for athletes. Therefore, how pressure influences the decrement of performance outcomes needs to be clarified.

Many previous studies have indicated that pressure alters performance outcome via changes in psychological (e.g., cognition, attention, and emotion), physiological (e.g., arousal and central nervous system), and behavioral (e.g., kinematics and muscular activity) domains [1,4,5]. In addition to these

factors, it is known that motor performance is related to several types of environmental perceptions. As a result, it is necessary to investigate perceptions and actions under pressure. However, only a few studies have considered the role of perceptions and actions in explaining the choking phenomena.

It would be effective to focus on subjective reports of athletes and link those reports with empirical data to gain a full understanding of this issue. This approach could enable us to focus on significant problems having a large impact on sports performance under pressure. One of these problems is subjective changes in perception of the environment reported by athletes during sports competitions [6]. These changes include alterations in spatial, temporal, and kinematic information about the opponent. For example, a badminton player recollected that she felt her own court to be larger, the net higher, and her opponent's body bigger when she experienced choking during a game. This evidence suggests that environmental perception *prior to* executing motor skills under pressure negatively distorts task performance, making it more difficult. However, there is no direct evidence of this in sports contexts. Further, a few studies have observed no pressure-induced changes in perception of distance, for example, distance to the hole in a golf-putting task [7] and distance to a knife-wielding opponent in a shooting situation [8].

The purpose of the present study was to investigate experimentally the effects of psychological pressure on judging the height of a jump bar immediately before starting a high jump run. It was predicted that most participants would perceive the bar as higher when in a high-pressure situation, and especially that individuals who felt greater subjective pressure would particularly perceive the bar to be higher. The relationship between changes in height perception and performance outcome of the high jump task under pressure was also examined.

## 2. Materials and Methods

### 2.1. Participants

Participants were 14 healthy university students (seven women and seven men, mean age = 20.14 years, standard deviation = 1.51, range = 18–23 years) in training for a high jump event. Eight participants (three women and five men) specialized in the high jump, and six participants (four women and two men) specialized in combined events. Written informed consent was obtained from all participants. A research ethics committee in the Mukogawa Women's University approved the experiment (approval No. 16-33; approval date 23 July 2016).

### 2.2. Procedure

The experiment was conducted in the participants' daily practice environment. Two participants participated as partners in each session. After they warmed up for approximately 30 min at their own pace, they performed three practice trials that familiarized them with the task. The height of the bar on practice trials was set to  $-28$ ,  $-24$ ,  $-20$  cm of each participant's personal best height. Following the practice trials, they performed six low-pressure and six high-pressure trials, with three trials in each of four test sessions. Eight participants (four pairs) performed four sessions in the following fixed order: low-pressure 1, high-pressure 1, low-pressure 2, and high-pressure 2 (i.e., A-B-A-B design). To prevent order effects, the other six participants (three pairs) performed the trials in this fixed order: high-pressure 1, low-pressure 1, high-pressure 2, and low-pressure 2 (i.e., B-A-B-A design). Two participants performed in an alternating sequence on all trials.

The height of the bar in high-pressure and low-pressure conditions was set to  $-25$ ,  $-22$ ,  $-19$ ,  $-16$ ,  $-13$ ,  $-10$  cm of each participant's personal best height. The height of six trials in both conditions was randomized for each participant. Before each trial, participants were blindfolded so that they were unable to observe the two experimenters who adjusted the height of the bar. After adjustment of the bar was completed, participants removed the blindfold. They were requested to verbally state the height of the bar in centimeters before they started their run according to their own timing. Participants

received feedback regarding the height of the bar after each practice trial. However, they did not receive any feedback after low-pressure or high-pressure trials.

The pressure condition included a combination of pressures, including reward, punishment, and social stress involving the partner. After the practice trials, participants were instructed that they would receive 2000 Japan Yen (about 20 United States Dollar) as a reward for participation. In addition, the following instruction was given prior to the high-pressure condition: “I will give you an extra 500 JPY per trial if you succeed in the high jump task. However, if you fail, both you and your partner will lose 500 JPY of the 2000 JPY participation reward.” Before the low-pressure condition, participants were instructed that they would receive 200 JPY per trial if they succeeded in the task, but there would be no penalty for either the participant or the partner for failing to perform the task.

### 2.3. Dependent Variables and Data Analysis

To examine psychological effects of the pressure manipulation, perceived pressure and mental effort required to succeed in the task were measured using Visual Analog Scales (VAS) immediately prior to judgment of the bar height on each low-pressure and high-pressure trial. Participants were asked to indicate his/her perceived pressure and the subjective mental effort to succeed in the following trial. In responding to two questions (i.e., perceived pressure and mental effort), they were required to draw vertical marks on 100 mm straight lines in which the left end indicated “not at all” and the right end indicated “extremely”.

As an index of height perception, the ratio (%) of the verbal statement of the height of the bar to the actual height was calculated. The bar was perceived as being higher than its actual height if this score was greater than zero, and height perception was lower if this score was less than zero. The performance index was the success rate on the six trials in the two conditions.

For all dependent variables, Wilcoxon signed-rank tests were used to analyze differences between low-pressure and high-pressure conditions. Variations from the low-pressure to high-pressure conditions were calculated for all dependent variables, in the form of the average of the six trials in the pressure condition minus that in the low-pressure condition. In order to test the relationships among these variations, Spearman rank-order correlation coefficients ( $n = 14$ ) were calculated for all relationships. After taking the sample size into consideration, it was decided to use non-parametric tests. The significance level for all analyses was 5% (two-tailed).

### 3. Results

Table 1 shows the means and standard errors for all dependent variables in the low-pressure and high-pressure conditions. There were significant increases in perceived pressure (7.42 mm; Wilcoxon  $Z = -2.17, p = 0.030$ ), mental effort (6.77 mm;  $Z = -2.29, p = 0.022$ ), and height perception of the bar (0.59%;  $Z = -2.17, p = 0.030$ ) from the low-pressure to high-pressure conditions. There was no significant difference between conditions for success rates on the task (4.76%;  $Z = -1.26, p = 0.209$ ).

**Table 1.** Means and standard errors of all dependent variables in the low-pressure and the high-pressure conditions.

Dependent Variables	Low-Pressure	High-Pressure
Perceived pressure (mm)	49.31 ± 5.36	56.73 ± 5.05 *
Mental effort (mm)	61.92 ± 3.69	68.69 ± 4.45 *
Height perception of the bar (%)	0.77 ± 1.23	1.36 ± 1.26 *
Success rate of the task (%)	69.05 ± 6.50	73.81 ± 7.76

Note: \*  $p < 0.05$ .

The correlation between changes in perceived pressure and height perception from the low-pressure to high-pressure conditions was approaching significant ( $r = 0.468, p = 0.091$ ), indicating that participants who reported greater perceived pressure in the pressure condition tended to judge

the bar to be higher. Given that this relationship might be moderated by participants' age, we also conducted an additional moderator analysis. However, there was no significant interaction effect (beta coefficient = 0.006, 95% confidence interval  $[-0.051, 0.063]$ ,  $t = 0.234$ ,  $p = 0.820$ ), which suggested that participants' age did not moderate the relationship between changes in perceived pressure and height perception in the high-pressure compared to the low-pressure condition.

For height perception, the correlation with mental effort was not significant ( $r = 0.424$ ,  $p = 0.131$ ). For success rate, there were no significant correlations (perceived pressure,  $r = -0.348$ ,  $p = 0.223$ ; mental effort,  $r = -0.229$ ,  $p = 0.430$ ; and height perception,  $r = -0.352$ ,  $p = 0.217$ ).

#### 4. Discussion

In the present study, the psychological effects of pressure were reflected in ratings of subjective pressure and mental effort on the VAS. Both scores increased from low-pressure to high-pressure conditions by approximately 7 mm. Therefore, the psychological effects of pressure manipulations used in this study were effective. The mean perceived height of the bar for all participants under high-pressure was significantly higher than in the low-pressure conditions, as we expected. In addition, participants who reported greater subjective pressure tended to judge the bar to be higher. Therefore, this study provides the first evidence that psychological pressure could distort environmental perceptions prior to executing a motor task, such that the task would appear to be more difficult.

There are several possible reasons for the perceptual changes found in this study. First, attentional changes under pressure may have distorted environmental perception. Choking under pressure is caused by conscious processing [4] and distraction [9] during task execution. Gray and Cañal-Bruland [10] found that choking in a golf-putting task led to changes in size perception of the hole (i.e., it appeared smaller), and participants who choked showed enhanced conscious processing of putting movements. Participants in this study may also have engaged in conscious processing or experienced distraction prior to the run under pressure, and such attentional changes may have affected their height perception.

However, attentional changes may not be the sole reason that perception changed prior to task performance. Increased anxiety and fear and decreased confidence in task performance may also have been related to the perceptual changes. In previous studies, increases in slant estimation [11] and in distance estimation [12] have been observed for participants in an elevated location. Similarly, psychological aspects under pressure may have caused greater height perception before task performance.

Finally, physiological states under pressure, including arousal [10] and muscular activities [5], may have affected perception. Psychological and physiological effort required for motor tasks have been shown to distort perception in the direction of wasted energy costs. For example, distance and slant estimates increase when a heavy backpack is carried and in the absence of optic flow [13,14]. Given that mental effort increased under pressure in the present study, physiological arousal and muscular activities may have also been enhanced under pressure. These physiological changes under pressure may have led to a change in height perception in the direction of greater behavioral energy demand for the task (i.e., a higher bar).

Although height perception was distorted under pressure, success rates of the high jump task did not change from low-pressure to high-pressure conditions. Moreover, variations in height perception and success rate in the low- and high-pressure conditions were not significantly correlated. It has been suggested that perceptual distortions are misperceptions resulting from performance decrements, or that perceptual distortions play a functional role in maintaining performance [15]. Although the perceptual distortion observed in this study could be regarded as playing a functional role in task performance, it is difficult to eliminate the possibility that the distortion might lead to a performance decrement if a stronger level of stress, similar to an actual athletic competition, were to be induced under pressure. Moreover, the performance index measured in this study was crude, and recorded only the success or the failure in the task. Therefore, in future studies, more precise performance and kinematic indices could be assessed by using motion analysis.

The results of this study suggested that the perception of the environment is distorted before performing a motor skill, depending on the degree of psychological stress caused by pressure. According to Witt [16], action-specific perception is when “people perceive the surrounding environment in terms of their ability to act in it (p. 201).” A series of studies on this topic has reported that the skill level [17], daily performance [18,19], and task difficulty [20,21] influence the perception of the environment. It would, therefore, be interesting to clarify perceptual distortions under pressure by taking interactions among psychological stress and variables related to action-specific perception into consideration.

Finally, certain limitations of this study should be mentioned. The first limitation is the small sample size and number of trials. The height perception of the bar significantly increased under pressure despite the small sample size and the number of trials. However, the performance outcome and the relations between these variables did not change significantly under pressure. If a large sample size and more trials were used, significant differences in these variables might be observed. The second limitation is that the results of this study might be affected by the other moderators such as the skill level, years of experience with the task, and the initial mental state before participating in the experiment. Therefore, it is suggested that future research take the effects of these moderator variables into consideration.

## 5. Conclusions

Athletes need to maintain optimal perception and action even when they are under pressure during sports competitions. A key finding of this study is that prior to executing motor skills in competitive situations, perceptions about the environment, such as spatial information, could be biased in the direction of increasing the difficulty of motor skills. This tendency would increase for athletes that experience increased state anxiety under pressure. It is suggested that the underlying mechanisms of this phenomenon should be examined from the perspective of cognition, emotion, and physiological states in future research. Moreover, detailed studies on the effects of perceptual biases on motor behavior that include kinematics and performance outcomes would be useful. Stern et al. [22] indicated that reducing anxiety under pressure by using an implementation intention strategy led to performance improvements along with compensation for the distance perception bias in golf-putting and dart-throwing tasks. This suggests that psychological skills for reducing state anxiety might play a key role in developing optimal perception and action under high pressure.

**Author Contributions:** Y.T. conceived and designed the experiments; Y.T., J.S., and K.K. performed the experiments; Y.T. analyzed the data; Y.T., J.S., K.K., K.G., Y.M.T., and T.M. wrote the paper.

**Acknowledgments:** This work was supported by a Grant-in-Aid for Scientific Research (C) (No. 16K01686) from Japan Society for the promotion of Science (JSPS) KAKENHI.

**Conflicts of Interest:** The authors declare no conflict of interest.

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