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Interaction between Idea-generation and Idea-externalization Processes in Artistic Creation: Study of an Expert Breakdancer

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Abstract

This study develops a cognitive model to explain the process of artistic creation in a dance domain. Many researchers in the field of psychology and cognitive science have investigated the process of creativity and developed various theories that explain this process. Their efforts have mostly focused on higher cognitive functions of artists and scientists. However, in recent years, several studies that have highlighted the importance of the interaction between idea generation and idea externalization processes suggest that people can find and develop new aspects of images and ideas by perceiving and reflecting on the images and ideas they externalize. This study develops a cognitive model that explains this interaction process in dance creation by referring to a famous theory of motor learning, the closed-loop model. We also investigate dance creation of an expert breakdancer and check the validity of our proposed model.

Keywords: creativity, artistic creation, externalization of ideas, closed-loop model, performing arts, breakdance

Introduction

How do professional artists generate their original and fascinating expressions? In the psychology and cognitive science field, many researchers have investigated the process of creativity (e.g., Dunbar, 1993; Okada & Ishibashi, 2017; Wallas, 1926). For example, Finke, Ward, and Smith (1992) proposed the Geneplore model, which explains the process of idea generation, focusing on various cognitive functions. The Geneplore model suggests that people generate and explore their ideas under several task constraints by using cognitive functions such as long-term memory, mental rotation, and concept combination. Additionally, Wallas (1926) proposed the four-stage model based on anecdotal records of several artists. This model explains the creative process in four phases: preparation, incubation, illumination, and verification.

These traditional theories have focused mainly on the cognitive process of the creators. However, in artistic creation, the process of externalizing the creators' images and ideas is also important. Artists externalize their images and ideas in the end or middle of almost all their creations (Glăveanu, 2013). For example, in a dance creation, dancers externalize their images as physical movements, and in paintings, artists externalize their images to the outside as traces, using brushes, paints, and canvases. We propose that this externalization process and the perception or reflection of those externalized images and ideas facilitate the development of the images and ideas. However, previous studies of creation have regarded this externalization process as an implementation phase, and have thus paid it little attention (e.g., Zeng, Proctor, & Salvendy, 2011). In recent years, however, some researchers came to focus on this process of idea-externalization (Glăveanu, 2013). Based on these discussions, we highlight the importance of the interaction between the idea-generation process and the idea-externalization process in artistic creation, and we develop a model that explains the influence of this interaction.

Although these studies have highlighted the importance of the idea-externalization process and its interaction with the idea-generation process, they have not proposed a mechanism as to how this interaction facilitates the creation. Regarding this mechanism, Goldschmidt (1991, 1994) and Kirsh (2009, 2010) offered useful suggestions. Goldschmidt (1991, 1994) investigated the role of sketch in design and claimed that people cannot focus on all features of their images or ideas of expression while they are generating them. For example, when people consider several components that must be included in a design, they cannot focus on the relationships or blank spaces between these components. However, people can find and focus on these features of their images and ideas if they first externalize them as sketches. Furthermore, by focusing on these hidden features, they can develop their images and ideas from different aspects and generate original and fascinating ideas (see Fig. 1). Based on this discussion, Goldschmidt (1991, 1994) emphasized the importance of sketches in design (externalization of images and ideas) and perceiving or reflecting on them. She referred to this perception and/or reflection of sketches and the subsequent development of images and ideas as interactive imagery. Also, Kirsh (2009,

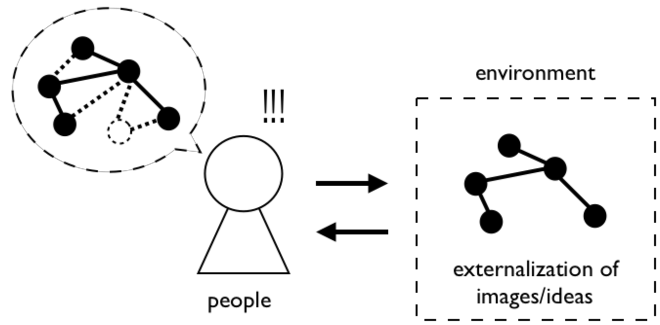

Fig. 1. Interaction between idea-generation process and idea-externalization process

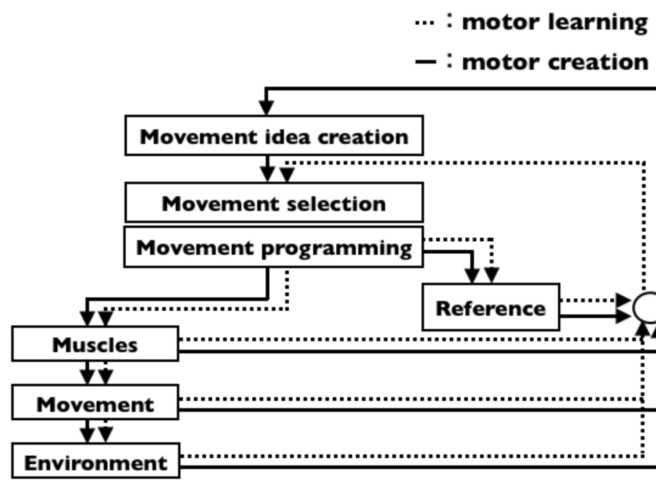

Fig. 2. Motor learning process of closed-loop model and motor creation process of our model. Dotted lines indicate the process of motor learning and solid lines indicate the process of motor creation.

2010) suggested that the idea-externalization process plays various roles in people's cognition. The process of externalization does not only save the internal memory but also facilitate the re-representation of images and the construction of the complex structure of images. He proposed that these processes facilitate the creation of artists.

Based on this discussion, this study explains how the interaction between the idea-generation process and the idea-externalization process facilitates artistic creation. To do so, we develop a cognitive model that explains the process of artistic creation in a dance domain. We also conduct a case study to investigate the creation process of an expert breakdancer and check the validity of our model.

Model development

This study develops a model to explain the influence of that interaction on creation. In particular, this study focuses on dance creation (the creation of breakdance) that existing studies have investigated over the past 10 years. The creation of breakdance is a suitable subject for this study because some fieldwork studies suggested the importance of externalizing images and ideas and perceiving or reflecting on them in breakdance (e.g., Shimizu & Okada, 2013).

To develop our model, we examined models of creation, such as the Geneplore model, reviewed discussions by Goldschmidt (1991, 1994), and referred to a famous theory of motor learning, the closed-loop model, which has been prominent in cognitive science and biomechanics. We consider that this theory provides a clear explanation about the influence of externalization of images and ideas, and the effect of perception and reflection on dance creation.

The closed-loop model emphasizes the importance of a movement-implementation process, especially the feedback error, which refers to a gap between somatosensory feedback derived from the movement and the prediction of that feedback, called efference copy, in the motor-learning process (Schmidt & Lee, 2011). This model explains the mechanism of motor learning (see dotted lines in Fig. 2), which we describe as follows: First, people perceive and identify a stimulus from their surroundings and select their reaction of movements in the cerebellum and primary motor area (movement selection). Then, to implement those movements, they send signals to the peripheral nerves in their muscles (movement programming) and conduct those movements (muscles, movement). Simultaneously, they send a copy of this motor program, called the efference copy, and generate a prediction of the somatosensory feedback derived from those movements (reference). People receive the gap between the somatosensory feedback and the prediction of that feedback, known as the feedback error, and in the next trial of movements, they refer to this error and correct their motor plan to get their movements as close to their goal (model) movements as possible (movement programming). The closed-loop model explains a mechanism as to how people improve and learn movements by these repetitive processes.

The above-mentioned process explains the mechanism of motor learning and refinement when people have a clear model of movement (i.e., a clear goal). But, how is the mechanism of motor creation achieved when people have no clear goal? In this process, people should first generate their model of movement (i.e., a goal) through cognitive functions proposed by traditional creative theory (such as the Geneplore model), and they should implement this movement plan as a movement. The roles of the feedback error in motor creation also differ from those in motor learning. In motor learning, the feedback error provides information that helps people to approximate their movements to those of the model. However, in motor creation, the feedback error provides information to find and focus on the hidden features (e.g., the relationships between components) of their proposed movement ideas (Goldschmidt, 1991, 1994). As a result, people should develop their images and ideas from various aspects and generate their original movements. In this manner, externalizing images and ideas and perceiving and/or

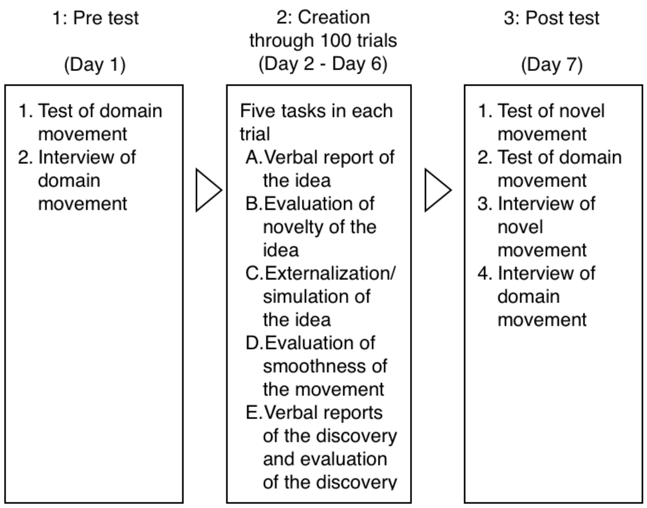

Fig. 3. Procedures of case study

reflecting on them will facilitate the creation of dance movements.

Based on these discussions, we developed a model of dance creation (solid lines in Fig. 2). This model explains the process of motor creation in dance as follows: First, people generate their ideas of movements through cognitive functions such as mental rotation and concept combination (movement idea creation). They generate these ideas by focusing on specific aspects of movements, and they send signals to implement these movements (movement programming) and conduct the movements (muscles, movement). After that, people receive the somatosensory feedback of the movements, compare those with their predictions of them (reference), and calculate the feedback error. Then, they develop and reconstruct their ideas of movements based on this feedback error and by shifting the aspects where they focus. This model thus explains the mechanism of how the interaction between the idea-generation process and the idea-externalization process facilitates dance creation. In particular, the model highlights the importance of the feedback error derived from the idea-externalization process. Notably, previous studies claimed that the feedback error plays an important role in various phenomena such as tickling (Blackmore et al., 1999) and phantom pain (Ramachandran & Ramachandran, 1996), not only in motor learning. We suppose that the feedback error has various functions in human movements.

Case study

Next, we check the validity of our proposed model by conducting a case study of an expert breakdancer's creation, and we verify whether the interaction between the idea-generation process and idea-externalization process facilitated the dance creation. We set two conditions. In the first condition, the dancer generated an original movement in an interactive condition (with the above-mentioned interaction), and in the second condition, the dancer generated an original movement in a non-interactive condition (without the interaction). We compare these two conditions and investigate the differences in the creation process. We also investigate how this interaction facilitates the dance creation by checking the creation process of the first condition in detail. With reference to these two results, we discuss the validity of our model.

Participant

An award-winning Japanese expert breakdancer with nine years' experience in breakdancing participated in our case study. He generated original dance movements over seven days in the two conditions.

Condition

The expert dancer developed original dance movements in the two conditions (interactive and non-interactive conditions). In the interactive condition, he developed his movements by repeating tasks to generate an idea (idea-generation process) and to externalize his idea as movement (idea-externalization process). In the non-interactive condition, he developed his movements by repeating tasks to generate an idea (idea-generation process) and to simulate his idea in his mind, without externalizing it as movement (idea-simulation process).

In breakdancing, dancers generate original movements by focusing on and developing specific movements in the domain (Shimizu & Okada, 2013, 2018). Therefore, in our case study, we asked the dancer to generate an original movement by developing a specific domain movement. We used different domain movements in each condition[1].

Procedure

In each condition, the dancer generated original movements through 100 trials over seven days. Fig. 3 shows the procedures. The dancer followed the same procedures in both conditions, except for task C on days 2–6 (externalization/simulation of the idea).

On days 1 and 7, we tested the domain movement (10 trials each day) using the video camera and motion capture system described in the next section. We also conducted interviews about the domain movement. We conducted further tests (3 trials) and interviews of the dancer's original movements on day 7.

On days 2–6, the dancer generated original dance movements through 20 trials per day. In each trial, he conducted five tasks. First, he generated the idea of movement, and reported its content (task A). Second, he evaluated the novelty of the idea on a one hundred-point scale using a Visual Analog Scale (VAS) (task B). Third, the dancer externalized his idea as a movement in the

[1] We used different domain movements in each condition to exclude the strong influence of the first-time creation on the second-time creation. However, we needed to be careful when interpreting the results of this study because of the different features of the domain movements in each condition.

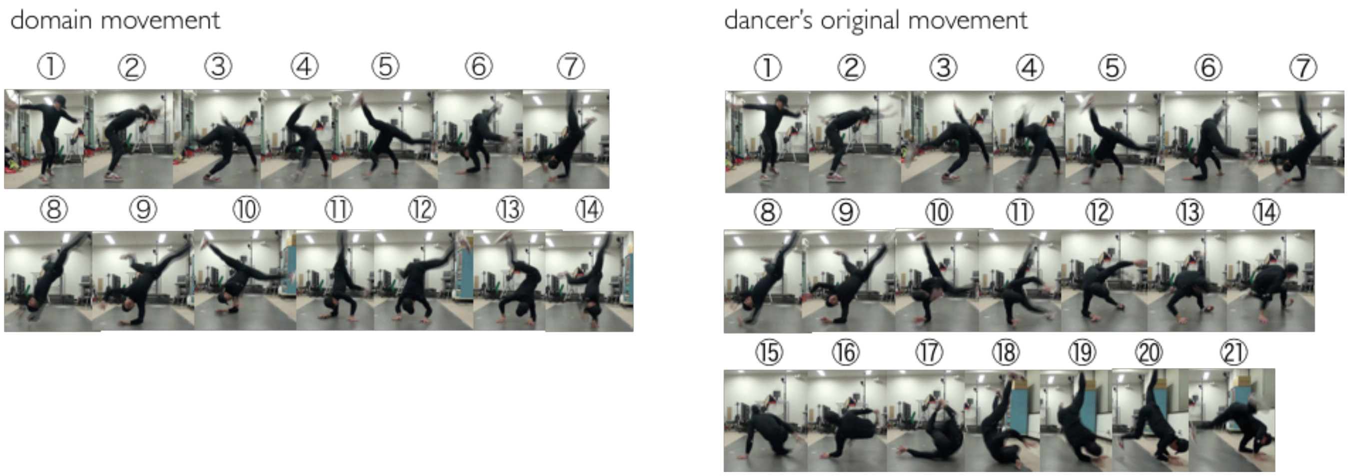

Fig. 4. Domain movement and dancer's original movement in the interactive condition. After the action of picture 14, the dancer goes into the action of picture 7 again, and repeats the rotation in domain movement (left side). In original movement, he goes into the action of picture 7 again after the action of picture 21, and repeats the rotation (right side).

interactive condition and simulated his idea in the non-interactive condition (task C). In the interactive condition, we recorded the movement using a video camera and motion capture system. Fourth, the dancer evaluated the smoothness of the movement using VAS (task D). Fifth, he reported his discovery brought by the idea-externalization and simulation tasks and evaluated the degree of that discovery using VAS (task E). The dancer repeated these five tasks a hundred times to generate his original movement. We set these tasks based on the creation process of expert dancers observed in the fieldwork study (Shimizu & Okada, 2018). We focused on tasks A (verbal report of the idea), C (externalization/simulation of the idea), and E (verbal report of the discovery) in this study because these data include the important information on the idea-generation and idea-externalization processes.

Apparatus

In this study, we used a motion capture system (OQUS 300, Optical motion capture system, QUALISYS co.) to measure the features of the movements in the creation process in the interactive condition. The dancer wore a suit for the system, attached fourteen markers to his body, and worked on the creation. We did not measure the movements in the non-interactive condition because the dancer did not conduct any movements during the creation process; however, for consistency, the dancer wore the suit and attached markers in the non-interactive condition.

Results and Discussion

Outline of the Original Movements First, we explain the outline of the movement that the dancer generated in each condition. In the interactive condition, the dancer generated the movement shown on the right side of Fig. 4 (we also show the domain movement in the left). In this original movement, the dancer stops the rotation of the domain movement by landing on his right leg, and he uses the momentum of rotation for the inverse rotation. He described this action as canceling the rotation, and he generated this original movement by developing this concept. He and another expert dancer confirmed that this was an original movement that they had never seen in the breakdance domain.

In the non-interactive condition, the dancer generated an original movement based on the domain movement called Drill. In this domain movement, the dancer lands on the ground with his head and rotates his whole body (we abbreviate the figure because of space limitations). In the original movement, the dancer lands on the ground on his back after the rotation, and then jumps up and rotates in the different direction (this rotation is similar to another domain movement called Trax). Although mixing the two domain movements seemed interesting, he was not convinced of its originality.

Verbal Report of the Idea In the following sections, we compare the creation process in each condition. First, we investigate the verbal report of the idea that the dancer mentioned in each trial. In the analysis, we checked and counted the frequencies of the following three aspects because the dancer mentioned them many times in his reports: (1) specific body parts (e.g., head, right arm, left arm, right leg); (2) abstract concepts of the domain movement (words such as "direction," "speed," and "axis" of the rotation); and (3) other movements in the breakdance domain (e.g., Trax, Baby Windmill, and Ninety). We summed the total frequency of each aspect in each day, divided them by the total frequency of all three aspects, and calculated the relative frequencies of these aspects for each day. These frequencies indicated which aspects the dancer focused on each day.

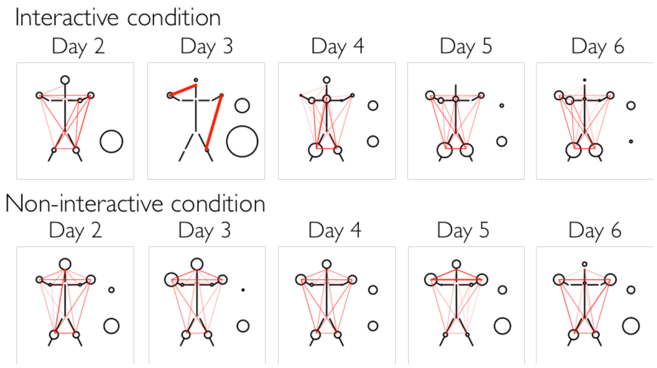

Fig. 5. Results of verbal reports of the idea. Two circles drawn to the right side indicates the frequencies of second aspect (abstract concepts of the domain movement, upper side) and third aspect (other movements in breakdance domain, lower side).

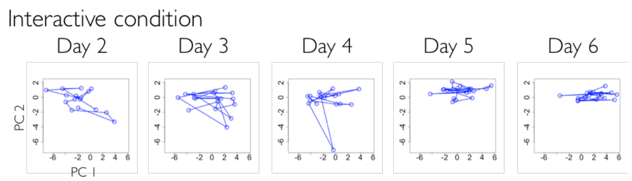

Fig. 6. Scores of PC 1 and PC 2 of the movement

We show these frequencies as sizes of circles in Fig. 5. This figure shows that, in the interactive condition, the dancer changed the aspects of his movement actively between days 2 and 4. Then, on days 5 and 6, he focused on specific aspects such as the right leg when attempting to generate the original movement (the right leg has an important role in his original movement: to stop the rotation of the domain movement). On the other hand, in the non-interactive condition, the dancer did not actively change the aspects of his movement during his creation.

Features of the Movement (Externalized Idea) Next, we investigate the features of the movement (externalized ideas) generated in the interactive condition. We calculated the kinematics data (joint angles and joint angular velocities in each segment) from the time-series position data of 14 markers using the inverse kinematics technique (Hirashima et al., 2008). Then, we conducted principal component analysis and extracted two components that had high contributions (proportions of variance) for explaining these movements (see Kadone & Nakamura, 2007), which we called PC 1 and PC 2. PC 1 and PC 2 are reduced dimensions that explain important features of the movement.

Fig. 6 shows that the scores of PC 1 and PC 2 had various values (PC 1: -7.06~3.84, PC 2: -7.10~1.34) on days 2–4. However, on days 5–6, these scores, especially scores of PC 2 converged at specific values (PC 1: -4.30~5.64, PC 2: -0.61~2.13). These results suggest that, in the interactive

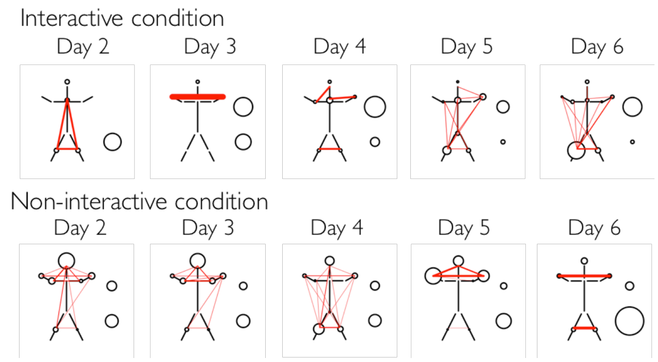

Fig. 7. Results of verbal reports of the discovery. Two circles drawn to the right side indicates the same aspects as those of Fig. 5.

condition, the dancer generated various kinds of movements that had various features in the first half of the creation. The dancer also focused on a particular movement that had a specific feature (the movement which involved stopping the rotation with his right leg) in the second half of the creation.

Verbal Report of the Discovery We investigated the discovery that the dancer mentioned when he externalized and simulated his idea. We examined the verbal report of the discovery and conducted the same analysis of the verbal report of the idea.

Fig. 7 shows that on days 2–4, the dancer actively reported his discovery in various aspects in the interactive condition. On days 5–6, however, he focused on specific aspects such as the right leg and the abstract concept, and he frequently reported his discovery of these aspects. By contrast, in the non-interactive condition, the dancer did not focus on various aspects from days 2–4. He focused on similar aspects to those on days 2–4, and he came to focus on various aspects in his discovery report on day 5.

These results of three analyses indicate that in the interactive condition, the dancer actively changed the aspects on which he focused in the early part of the creation, and in the late part, he focused on the specific aspects and on refining his idea. A retrospective interview conducted on day 7 supports this claim. The dancer mentioned that he found the idea of the original movement around trial 50, and subsequently focused on refining that movement. By externalizing his idea as movement and reconstructing his idea using the feedback error derived from that externalization, he was able to find and focus on the various and hidden aspects of his idea and generate an original movement.

Overall Picture of the Creation in Interactive Condition Finally, we provide an overall picture of the dancer's creation in the interactive condition. Before finding the idea for an original movement (stopping the rotation of the domain movement with his right leg) at around trial 50, the

Table 1. Examples of dancer's discovery reports

"I jumped and rotated in the vertical direction higher than I expected. I was surprised by it." (Discovery report in trial 32)
"This time, I tried to bend both knees when I conducted EAT. This made me jump lower in the horizontal direction than I expected. Though it did not change the final position of EAT, it increased the rotation speed horizontally. I was confused by that." (Discovery report in trial 34)

dancer explored various ideas. Fig. 5 shows that he focused on each body part on day 2, and he said that he found an important aspect of the domain movement (rotation) on day 3, which he then focused on (Fig. 7 also supports this claim). The dancer found this aspect by externalizing his idea as movement and perceiving or reflecting on the feedback error derived from that externalization. In the dancer's verbal reports of the discovery on day 3 (in trials 32 and 34), he mentioned that he was surprised at the gap between the somatosensory feedback derived from the movement and his prediction of that, and became interested in the hidden aspect of his idea: the rotation (see Table 1). After this finding, the dancer focused on this aspect, the rotation, and attempted to generate an original movement by making various changes to it. Finally, the breakdancer developed his idea for an original movement, which involved stopping the rotation with his right leg, at around trial 50. The interaction between the idea-generation process and idea-externalization process led to the findings of the hidden aspect of his idea and facilitated the generation of his original dance movement. These results suggest that the process explained by our model occurred in the expert breakdancer's dance creation.

General discussion

This study developed a model to explain the process of artistic creation in the dance domain. We also conducted a case study that investigated the creation process of an expert breakdancer and verified the validity of our proposed model. Fig. 2 shows that the model developed herein proposes the importance of interactions between the idea-generation process and the idea-externalization process in dance creation based on the closed-loop model (Shmidt & Lee, 2011), the Geneplore model (Finke et al., 1992), and discussions by Goldschmidt (1991, 1994) and Kirsh (2009, 2010). The closed-loop model shows the importance of somatosensory feedback and its error derived from the movement in motor learning. We extended the roles of the feedback error and applied them to the creation of a novel dance movement. By externalizing their idea as a movement and focusing on the feedback error derived from that movement, dancers can find new and hidden aspects of the movement and develop their idea actively. Traditional theories of creation in psychology and cognitive science paid little attention to the importance of interaction between the idea-generation process and the idea-externalization process because the creation of a novel image or idea was considered to be achieved in people's cognitive processes. On the other hand, this study highlights the importance of the interaction between idea-generation and externalization and identified the mechanism of that interaction. We suggest that the processes of idea generation and idea externalization are highly connected, and this connection has a strong influence on creation.

However, we need to consider the generalizability of the influence of this interaction with caution. Based on the hands-on nature of an artistic creation, interactions between the idea-generation process and the idea-externalization process are important in almost all artistic domains. Goldschmidt (1991, 1994) and Glăveanu (2013) proposed the importance of interactions between imagination and externalization in artistic creation. However, there are critical differences between dance creation and other kinds of artistic creation. In particular, media that artists use for externalizing their images and ideas and the feedback they receive from this externalization process are different. In dance creation, dancers externalize their images and ideas as movements through their bodies, and they mainly receive somatosensory feedback from their movements. In paintings, however, artists externalize their images and ideas as traces by using various tools such as brushes, paints, and canvases in addition to their bodies, and they mainly receive visual feedback from their paintings. We thus need to consider these similarities and differences among various artistic domains when discussing the generalizability of our model.

Our model has other limitations. As this study verified the validity of the model by investigating the creation process of only one expert dancer, we should collect data from more expert dancers. Additionally, we should set various domain movements as the base movements and take a counterbalance of those movements between the two conditions. However, to investigate the creation process of experts takes considerable time and effort. We therefore need to develop a method to investigate the creation process of many experts efficiently in more natural field situations.

Acknowledgments

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