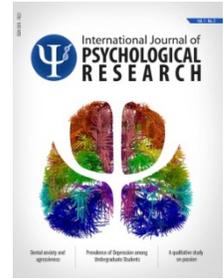




A Motor Imagery During Blind Action is Guided by the Same Foci of Attention as Actual Performance in a Sample Comprising Females

La Imagen Motora Durante una Acción a Ciegas es Guiada por los Mismos Focos de Atención del Desempeño Real en una Muestra Compuesta por Mujeres



Research

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ABSTRACT

There is strong evidence that focussing on the goal of an action improves performance relative to focussing on the concrete motor behaviours. The current study tests whether blind action guided by imagery relies on the same foci of attention. Thirty female participants took part in an experiment. In each condition there were 20 trials, they were asked to close their eyes and draw a straight line between two landmarks on a graphics tablet. We instructed them, in three conditions, to focus on (1) mental imagery of the goal landmark (external focus of attention), (2) drawing a straight line with the fingers (internal focus), or (3) without a specific focus of attention (control). We tested to what extent these attention instructions affected drawing performance, in terms of both deviations of the participants' lines from an ideal straight line, and the time it took to complete the line. The study revealed that the manipulation specifically affected the deviation measure and that an external focus of attention was better than an internal focus and the control condition. These findings reveal that that mental imagery during blind action relies on same processes as actual performance. These data give perceptual representations of a direct role in motor control. They will be related to current theories of action control (constrained action hypothesis, ideomotor theories, and dual task accounts).

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RESUMEN

Hay fuerte evidencia de que concentrar en la finalidad de una acción mejora el desempeño concerniente a la concentración en comportamientos motores concretos. El presente estudio evalúa si una acción a ciegas guiada por imágenes depende de los mismos focos de atención. 30 mujeres hicieron parte del experimento. En cada condición había 20 pruebas para un total de 60, se les pidió cerrar sus ojos y dibujar una línea recta entre dos puntos de referencia en una tableta digitalizadora. Se les instruyó en tres condiciones: concentrarse en (1) una imagen

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mental del punto de referencia que actuaba como meta (foco externo de atención), (2) dibujar una línea recta con los dedos hacia la referencia final (foco interno), o (3) realizar la actividad sin ningún foco específico de atención (control). Se evaluó hasta qué punto estas instrucciones de atención afectaron la ejecución del dibujo en cuanto a que tan rectas fueron las líneas de los participantes y el tiempo que tomaron para terminar la tarea. Este estudio reveló que la manipulación afectó específicamente el grado de desviación y que un foco externo de atención fue mejor que uno interno y que la condición de control. Tales hallazgos revelaron a su vez que la imagen mental durante la tarea depende del mismo proceso del desempeño real. Esta información da representaciones perceptuales de una función directa del control motor que serán relacionadas a las teorías actuales del control de la acción (hipótesis de la acción restringida, teorías ideo-motoras, y la explicación de la tarea doble)

Palabras clave: Foco de atención; tarea a ciegas; imagen mental; imagen motora; desempeño.

1. INTRODUCTION

A large number of studies have shown that an external focus of attention is better than an internal focus of attention when learning or executing motor skills (Freedman, Wulf & Robin, 2007; Salehian, GURSOY, Sen & Zadeh, 2012; Wulf, 1998; Wulf, 2007; Wulf, Dufek, Lozano & Pettigrew, 2010; Wulf, McNevin & Shea, 2001). For example, Wulf, McConnel, Gartner and Schwarz (2002) varied the focus of attention during golf performance. To create an internal focus of attention, the learners were asked to shift their weight from the back leg to front leg while hitting the ball. In the external focus of attention condition, the learners were asked to shift their weight toward the target. Performance was improved in the external condition.

In another example, Wulf, Zachry, Granados and Dufek (2007) tested participants' ability for high jumping. In the control condition, participants were asked to jump straight up and touch the highest rung vertically without attention. In the internal focus of attention condition, participants were asked to concentrate on the tip of their fingers during touch the highest rung. Finally, in the external focus of condition participants were asked to concentrate on the rung. Again, performance was best in the external focus of attention condition.

Wulf (2007) proposed the constrained action hypothesis to explain why an external focus of attention is better than internal focus of attention. She noticed that participants, when trying to consciously control their movement, adopt an internal focus of attention. In contrast, when individuals try to do the task automatic or unconsciously they adopt external focus of attention. An external focus of attention might therefore promote automatic motor processes, relative to more controlled ones. Another explanation about why an external focus of attention is better than an

internal focus of attention is the theory of event coding (Hommel, Müssele, Aschersleben & Prinz, 2001). According to this theory, actions are activated by various forms of imagery, such as movement intentions. An external focus of attention – that is directed towards movement intentions – might therefore allow more effective control of motor processes.

Wulf, Shea & Park (2013) investigated about beneficial of attention type on retention for motor performance. Two experiments were used by balance task (stabilometer), the participants were asked to focus on their feet (external focus attention) or on two markers in front of they (internal focus attention). Both experiments took three days; during the first one, the participants switched their attention focus; on the second day, the participants were free to switch their attention focus any time; and during the third one, most participants chose an external focus that was more effective in retention than participants who preferred an internal focus.

The aim of this study is to find out whether blind action that relies on mental imagery of a visual goal is like normal performance. In the experiment there were three conditions: external, internal and control. Participants were asked to draw straight lines between a cross and a happy face with closed eyes and use imagery to guide his movements. In the external condition, the participant is asked to focus on the target "happy face" while in the internal condition, the participant is asked to focus on her fingers during draw a line from cross to the target. The control condition occurs without any instructions. If mental imagery during blind action relies on the same processes as normal performance, an external focus of attention should be better than an internal focus of attention.

2. METHOD

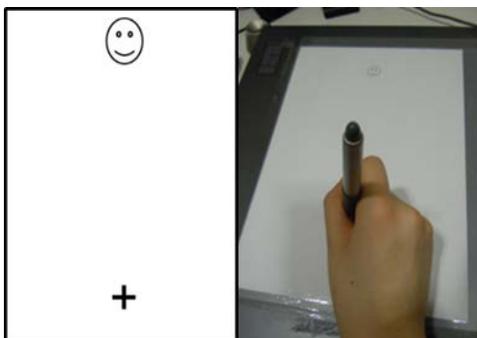
2.1. Participants

Thirty female students of Plymouth University (age range: 18-27) participated in the experiment. They satisfied all the requirements in volunteer screening and gave informed consent approved by the School of Psychology Ethics Committee at Plymouth University. Participants were paid either at a rate of £4/half hour or they received course credits. All participants were in good health, had no history of disease or medical treatment that might influence motor or visuomotor functions. Participants were excluded from the analysis when they carried out the task too fast or too slow (on average, under than 10 second or over than 30 second for each line drawing).

2.2. Material and Apparatus

The experiment was controlled by a standard PC. Line drawing was measured with a graphics tablet, version 0.5.0.0, Wacom Graphics Tablet Intuos 3 A4 extended addition, with an electronic pen. A piece of paper was placed on the tablet with two landmarks. The starting point was a cross at the bottom of the tablet, and the goal was indicated by a happy face at the top (see Figure 1). In addition, two sounds were played via an external loudspeaker system (sine wave of 1331Hz). The sounds lasted 100ms.

Figure 1. Illustration of the trial sequence.



2.3. Procedure and design

The participant was seated in a dimly lit room and was told to draw straight lines on a graphic tablet (from bottom to the top) during her eyes closed. There were 60 trials altogether that took roughly 30 minutes to complete. Between trials we asked participant to focus on different aspects of her drawing. In the *external focus of attention* condition, the participant

was instructed to imagine the target of the movement (the happy face) while drawing the line. In the *internal focus of attention* condition, the participant was instructed to focus on the movement of her hand (fingers) while drawing the line. In third *control condition* there was no specific instruction.

Each trial started with an attention instruction. In the *External Focus of Attention* instruction, the participant was told, before starting the trial, "Please place the pen on the start position (+). Try to imagine the straight line between the two start and end positions". The experimenter asked the participant to start the trial and gave instructions: "close your eyes. After a few seconds, you will hear a beep. This is the signal to start drawing." The participant was asked to keep her eyes closed but mentally focus her attention on the target ("Just imagine the cross (+)") and to focus by imagery on the target while moving the pen towards it slowly and in a straight line, while keeping the eyes closed. The next instruction was: "While drawing, picture where the pen is relative to the target. When it deviates from the straight course, please bring it back towards it." Participant heard another beep when she got to level with the target. Then, she could then open her eyes. The next trial started again as soon as they moved the pen back to the start position.

In the *Internal Focus of Attention* condition, the participant was told "Please place the pen on the start position (+)". The experimenter then asked participant to close her eyes. After a few seconds, the participant heard a beep. This was the signal to start drawing. The participant was asked to continue to mentally focus her attention on her fingers holding the pen and imagines her hand draw straight line. Participant was told "Focus on your fingers while you move your hand towards the target in a straight line. Please move your hand slowly and keep your eyes closed".

The third condition was the *Control Condition*. The participant was told "Please place the pen on the start position". The experimenter told the participant to start the trial and ask her to close her eyes and to do not use her imagery. After a few seconds, the participant heard a beep; this was the signal to start drawing. Participant was told to keep her eyes closed and to move the pen upwards in a straight line; later she was asked to move slowly and to keep the eyes closed". As before, the participant heard another beep when she was level with the target. After that, the participant opened her eyes. The next trial started again as soon as participant moved the pen back to the start position.

2.4. Analysis

The analysis aimed to assess whether mental imagery with external and internal attention affected participants' ability to do the three conditions. Mean of deviance (left and right) and drawing time were the dependent variables. Deviance was calculated as the absolute distance (i.e. in either direction) of the participants' hands relative to an ideal line connecting the starting and end points. Drawing time was calculated as the difference between the first beep (marking the start of a trial) and the second beep (marking arrival of the pen at the goal position). Trials were excluded if participants did the task too fast (under 10 second each trail or over than 30 second), if they started drawing before hearing the starting beep. Eleven participants were excluded because they were not able to fulfill these criteria in the majority of trials.

3. RESULTS

Deviance and drawing time were analyzed with separate a one factor ANOVAs with three levels (control, internal of focus attention and external of focus attention). The ANOVA for Deviance (Figure 2) revealed a highly significant main effect, $F(1,19) = 8.83$, $p < 0.001$. Pairwise comparisons showed that performance in the external focus of attention

condition was better than in the control condition, $F(1,19) = 3.51$, $p < 0.001$, and the internal focus of attention condition, $F(1,19) = 3.3$, $p = 0.005$. In contrast, performance in the control condition and the internal focus of attention condition did not differ, $F(1,19) = 1.03$, $p = 0.31$. The ANOVA performed on the drawing time measure revealed no significant effect, $F(1,19) = 1.0$, $p = 0.3$ (see Figure 3).

Figure 2. Descriptive statistics of deviation.

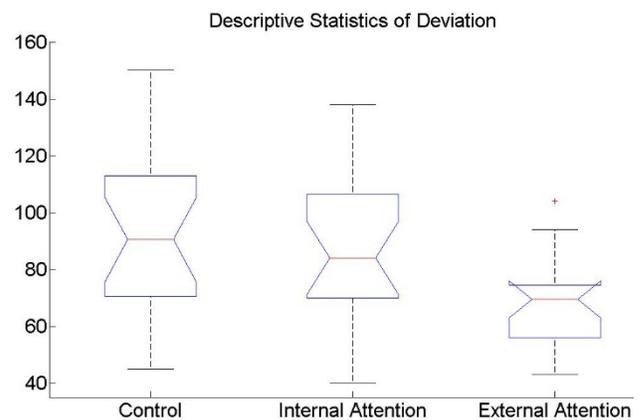
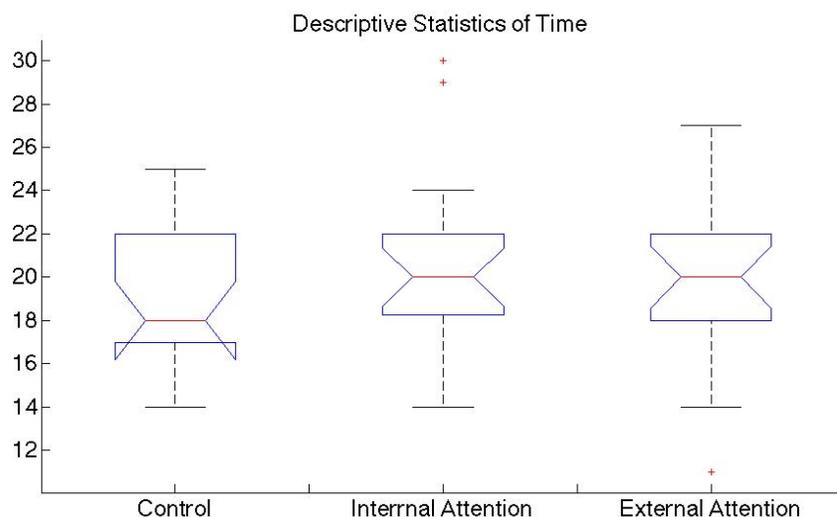


Figure 3. Descriptive statistics of time.



4. DISCUSSION

A large number of attempts have been made to understand the role of mental imagery in motor control (for review see, Farah, Hammond, Levine & Calvanio, 1988; Jeannerod, 2001; Kosslyn, Ganis & Thompson, 2006), and how these processes are affected by attention (Klein, 2009; Lohse, Jones, Healy & Sherwood, 2014; Taylor, 2006). Most studies have found that an external focus of attention is better than an internal focus of attention during actual performance (for review see, Carpenter, Lohse, Healy, Bourne & Clegg, 2013; Hagh, Sadeghi & Daneshfar, 2013; Wühr & Müssele, 2002; Schlesinger, Porter & Russell, 2012; Wulf et al., 2010). Relative little attention has been paid to motor processes during blind action that cannot draw on visual feedback (cf. Souman, Frissen, Sreenivasa & Ernst, 2009). Wulf et al. (2013). It was found that external focus attention is more beneficial for motor skills and learning than an internal focus attention; also external focus of attention is more effective retention performance than internal focus of attention.

In this study, we manipulated attention foci during blind action with motor imagery. It revealed that an external focus of attention during blind action with motor imagery is better than an internal focus of attention.

These findings during blind action are similar to many studies that reported that an external focus of attention is better than internal a focus of attention in visually guided motor performance (e.g. See Chiviawsky, Wulf & Wally, 2010; Wulf, 2007). External mental imagery promotes the utilization of reflexive, unconscious and fast processes (Wulf et al., 2001). In contrast, an internal focus of attention during motor imagery triggers conscious control over on-going movement. Another reason is that an external focus seems to facilitate energy conservation (see Schlesinger, Porter, & Russell, 2012). It may be that an external focus of attention promotes muscle activation more than internal focus of attention. (see Guillot et al., 2007; Jeannerod & Frak, 1999; Hale, 2003; Rodrigues et al., 2010). Based on findings of study the ideomotor theory is a good idea to explain that external focus of attention is a better than internal focus of attention, motor imagery triggers action during imagining or intention to do action.

Because motor imagery triggers action, merely seeing – or imagining – the goal of an action will activate the associated muscles and this makes the task easier and automatic. This is in sharp contrast to classic assumptions that effective motor performance

requires tight cognitive control of movement (not goal) parameters. Indeed, the current study found that an external focus of attention is better than internal focus of attention. Blind action guided by imagery is therefore like normal performance with eyes open. Similarly, Wulf (2007) proposed the constrained action hypotheses to explain why external focus of attention is better than internal focus of attention. She assumed that when a person concentrates her attention on the body site during task, automatic motor processes will be constrained. Finally, to explain the difference between external and internal foci of attention, cognitive load should be considered. An internal focus of attention requires participants to split attention between two things: the goal of the action and the body site. An internal focus of attention therefore requires a division of labor: attention to the body part and goal achievement. In contrast, an external focus of attention allows one to disregard body sites or movement and may therefore free cognitive resources. It does not require such distribution of attention, allowing focus only on goal achievement.

In sum, an external focus of attention during blind action with motor imagery is better than an internal focus of attention, at least in this female centric sample tested here. These findings give strong evidence that motor imagery during blind action is like actual performance. These findings give perceptual presentation a real role in the link between perception and action.

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