Acta Psychologica 144 (2013) 628–634

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/locate/actpsy

No anticipation without intention: Response–effect compatibility in effect-based and stimulus-based actions☆

Katharina Zwosta *, Hannes Ruge, Uta Wolfensteller

Technische Universität Dresden, Germany

A R T I C L E I N F O

Article history:
Received 15 May 2013
Received in revised form 25 July 2013
Accepted 25 September 2013
Available online 31 October 2013

PsycInfo Codes:
2300
2340

Keywords:
Goal-directed behavior
Stimulus-based behavior
Action control
Ideomotor theory
Response–effect compatibility
Instruction

A B S T R A C T

Goal-directed behavior is characterized by the anticipation of the resulting effect during response selection. Such anticipations can be contextualized in the sense that response–effect relationships in one stimulus context are inverted in another stimulus context. The primary study aim was to test the hypothesis that contextualized effect anticipation might depend on whether subjects adopt either an effect-based action control style or a stimulus-based control style. Importantly, we hypothesized that the choice of control styles depends on explicit instruction. Effect anticipation during response selection was determined by assessing the behavioral impact of spatial compatibility between the required response and an additional task-irrelevant spatial feature attached to the anticipated effect that would be produced by that response in a given context. In two experiments we found a compatibility effect exclusively in blocks with effect-based instruction but not in stimulus-based blocks. Furthermore, subjects could quickly switch between styles without one strategy dominating the others. Together, this shows that contextualized anticipation of distal visual effects is not an automatic process but depends on the intention to produce an effect.

1. Introduction

Goal-directed behavior requires knowledge about contingencies between situations, responses and the effects they produce, enabling flexible response selection in different situations according to the anticipated goal state. According to ideomotor theory this learning process leads to a bidirectional coupling between responses and effects, so that anticipatory activation of the effect representation automatically activates the corresponding response (Hommel, Musseler, Aschersleben, & Prinz, 2001; James, 1890). Thus, one critical characteristic of goal-directed behavior is the anticipation of the effect during response selection.

Indeed, Kunde (2001) demonstrated that responses are faster if the response location matches the location of (irrelevant) visual effects it produces. This means that the location of the effect must have been activated before the response was made so that the future event can interact with ongoing response selection. This effect is not restricted to spatial compatibility, but compatibility effects were also found for the duration of action effects (Kunde, 2003), effect intensity (Kunde, Koch, & Hoffmann, 2004) and verbal responses (Koch & Kunde, 2002).

Importantly, such compatibility effects also occurred if response–effect (R–E) contingencies were contextualized (Kiesel & Hoffmann, 2004). In reality, the effect that is produced by a certain action strongly depends on the context in which it is applied. One response can have different and even contradictory effects if applied in different situations leading to a hierarchical structure of response–effect relationships depending on the stimulus (Colwill & Rescorla, 1990). As an example, pushing or pulling a door can open or close the door depending on the side of the door where you are standing. So, pursuing the goal to open the door would lead to contrary actions when you are inside or outside the room. This means that R–E contingencies in one situation are reversed in the other situation so that effect anticipation is dependent on the context.

The goal of the present study was to investigate how this contextualized effect anticipation is affected by different action control styles. It was suggested that there are two fundamentally different ways in which people interact with the environment relying either on internal or external stimuli (Herwig, Prinz, & Waszak, 2007): People can either manipulate the environment in order to reach certain effects (effect-based action control style) or they can simply react to environmental stimuli (stimulus-based action control style).

Experimentally, these two action control styles are often induced by using free-choice vs. forced-choice tasks. However, to date there is only one study that compared these two task types specifically with regard to contextualized R–E mappings: Pfister, Kiesel, and Melcher (2010)

☆ This work was supported by the German Research Council (DFG, SFB 940 project A2). We would like to thank Tatjana Gackstatter, Carmen Schäuffele, Anne Dschietzig, Tina Rößler, Amal Kebir, Lydia Heilig and Paula Michels for data acquisition.

* Corresponding author at: Department of Psychology, Technische Universität Dresden, 01062 Dresden, Germany.

E-mail address: zwosta@psychologie.tu-dresden.de (K. Zwosta).

0001-6918/$ – see front matter © 2013 Published by Elsevier B.V.
http://dx.doi.org/10.1016/j.actpsy.2013.09.014

found that R–E anticipation during action selection (as indexed by the compatibility effect) occurred only if participants were choosing their responses freely but not if responses were spatially predetermined. This particular finding seems to suggest that effect-anticipation during response selection depends on an effect-based action control style. However, it stands to be argued whether the employed forced-choice task was a 'fair' stimulus-based control condition. In fact, subjects responded to spatial stimuli in a spatially compatible manner. Hence, the absence of R–E compatibility effects in this condition might simply reflect that when responses are directly (automatically) activated by a spatial stimulus, anticipated action effects might not have the time to affect behavior. In fact, by using different response cues implicating different S–R translation speeds due to dimensional overlap or non-overlap, we could show that the behavioral expression of learnt action–effect associations is prevented when actions are directly activated by highly over-learnt response cues (Wolfensteller & Ruge, submitted).

To avoid this problem, the present study aimed at manipulating the action control style differently while keeping a constant forced-choice setting. To this end, participants were instructed to choose their actions either according to the effect that should be produced or according to one of two pre-cued stimulus–response rules. Importantly, also under the pre-cued rule condition, correct responses were followed by effects according to exactly the same hierarchical scheme as in the effect-based condition. Hence, we used a pure manipulation of instruction while the hierarchical associative structure that could be used to guide response selection was identical.

At first glance, this approach resembles previous studies investigating intention–response compatibility. For example, Ansorge (2002) found that spatial R–E compatibility effects only occurred if participants were instructed to produce a specific spatial effect throughout the experiment while no R–E compatibility effects occurred if participants were instructed to respond according to stimulus–response rules (see also Shin & Proctor, 2012). However, these experiments included an overlap between the code of the intention and the response as both were spatial. For example, the stimulus indicated that it should be moved to the left and this facilitated left key presses vs. right key presses. The problem with this type of R–E compatibility effect is that it could potentially be due to interference between overlapping semantic codes (i.e., the stimulus would activate "left" while the required response would activate "right") but not between the anticipated effect (left stimulus movement) and the right response.

This latter potential problem was avoided in the present study as the spatial component of the effect was task-irrelevant. If the instructions induce different action control styles, then only in the effect-based action control style, when subjects are instructed to produce certain effects (e.g., colors), the action effects (including task-irrelevant features, e.g., the spatial location) should become integrated into response selection. Importantly, then it should not be necessary for the intention to dimensionally overlap with the response. Rather, having a specific effect-related intention (to produce a certain color) alone should be sufficient to induce an intentional action control style leading to measurable effect anticipation.

2. Experiment 1

We used a novel paradigm where R–E contingencies in one context were inverted in the other context so that general R–E associations were absent (see Fig. 1). Responding to stimulus 1 by pressing the left key led to an effect on the left side while pressing the right key led to an effect on the right side. For stimulus 2 this was inverted: Pressing the left key led to a right effect, pressing right to a left effect. We compared three different conditions: In the effect-based condition the instruction was to produce a certain color which was contingent on a certain (task-irrelevant) location. A second stimulus-based condition only differed in terms of the cue that preceded the stimulus. Responses to certain stimuli were also contingently followed by certain effects but the instruction was given in terms of stimulus–response rules not including any aspect of the effect. Finally, we added a control condition with a stimulus-based instruction but random effects, thus making effect anticipation impossible. The critical variable was the difference in response times towards stimuli with response–effect compatible and response–effect incompatible mappings as this indicates that effects were anticipated before they actually appeared. We hypothesized that if being in an effect-based action control mode alone is sufficient to induce effect anticipation during response selection then the spatial component of the future event, even though not explicitly included in the intention, should interact with the spatial response. Furthermore, if R–E anticipation is dependent on an effect-based action control style then R–E compatibility effects should be absent in the stimulus-based condition even though there is a perfect contingency between stimuli, responses and effects.

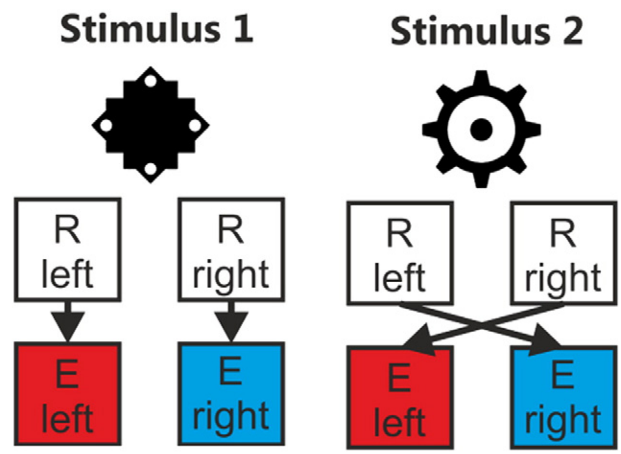

Fig. 1. Example of a compatible (left) and incompatible (right) stimulus–response–effect mapping. Effect colors were contingent on task-irrelevant locations. For both effect-based and stimulus-based conditions responding to one stimulus led to spatially compatible effects while responding to the other stimulus led to incompatible effects.

2.1. Methods

2.1.1. Subjects

Twenty subjects participated at the Technische Universität Dresden. One had to be excluded due to an exceptionally high error rate (36%). Of the remaining 19 participants 13 were female and mean age was 24 years (range: 19–29). All subjects were right-handed and had normal or corrected-to-normal vision. The participants were compensated with 5€ or received course credit.

2.1.2. Apparatus and stimuli

Stimuli were presented on a 17" monitor on light background. The experiment was controlled by E-Prime 2.0. Two cues, two stimuli and two effect colors were assigned to each condition. There were three pairs of genuine black-and-white stimuli that were taken from the Creative Symbol Collection of Matton Images. Accordingly, there were also three pairs of effect colors (red–blue, green–purple, orange–pink). In the effect-based condition the cue consisted of a colored octagon frame that indicated the effect color that was to be produced. In the stimulus-based condition and the control condition the cue frames were black or white indicating the rule to be applied. In one of the conditions the frames were circles and in the other one they were squares. Effects were color filled octagons that appeared on the right or left side of the cue and stimulus. Responses were made with the keyboard, pressing the key "D" with the left index finger or the key "K" with the right index finger.

For each subject stimuli and effect colors were independently randomly assigned to the three conditions. Then, within effect-based and stimulus-based conditions, cues were randomly assigned to effect colors and stimuli to R–E compatibility.