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# Embodiment of motor skills when observing expert and novice athletes

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If people are shown a dynamic movie of an action such as kicking a soccer ball or hitting a tennis ball, they will respond to it faster if it requires the same effector. This standard congruency effect was reported to reverse when participants viewed static images of famous athletes not actually performing an action. It was suggested that the congruent response was inhibited because of a social contrast effect, based on an implied action, whereby responders viewed themselves as comparatively worse than the professional athlete. The present study recorded hand and foot responses when identifying static images of both famous and novice athletes in soccer and tennis. The action was either explicit or implied. In Experiment 1, a standard congruency effect was found for all images. In Experiment 2, when a response was based on the identity of the athlete rather than their expertise, the standard congruency effect was enhanced for images of novice athletes, but was eliminated for experts, suggesting a social contrast effect. Our study is the first to show that embodiment effects can be seen for implied and explicit action images of both novices and experts, and that static images are capable of eliciting priming effects associated with sport-relevant effector pairings.

*Keywords*: Embodied cognition; Action perception; Compatibility effects; Expert; Novice.

An emerging viewpoint in cognitive psychology is that the mind's representation of objects and events is rooted in action (see for example, Beilock & Holt, 2007; Clark, 1999; Stanfield & Zwaan, 2001; Zwaan, 2004; Zwaan, Madden, Yaxley, & Aveyard, 2004). Di Pellegrino, Rafal, and Tipper (2005) exemplified this notion of action-embodiment in a study demonstrating that simply viewing the handle of a teacup facing to the left could activate motor programming for the left hand to facilitate grasping. Interestingly, the dichotomy between the neurological underpinnings of action and perception is at times blurred, with both being represented in similar locations of the brain. Indeed, it has been demonstrated that brain areas involved in both the

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production and representation of action are often shared (di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Fogassi et al., 2005; Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). For example, Kohler et al. (2002) found neurons in the monkey cortex that discharged when a monkey performed a certain action, but also on hearing that action's related sound. These same "mirror neurons" also discharged when the monkey viewed the action being performed by another.

There are a number of human examples that exemplify both the behavioural and the neurological consequences of observing an action. For example, when participants observed mouth, hand, and foot actions, corresponding activation was observed through functional magnetic resonance imaging (fMRI) in areas associated with these movements in the premotor cortex (Buccino et al., 2001). The authors interpreted these data to mean that when viewing an action, an internal representation of the action is generated, suggesting that the motor system is preparing to perform the same action. Similarly, Meister et al. (2004) observed bilateral frontoparietal activity involving premotor areas when musicians simply imagined playing the piano.

At the behavioural level, recent findings have shown that participants often respond more quickly and accurately to items that are related to some sort of previously presented action (e.g., action depicted in a sentence or picture). For example, Holt and Beilock (2006), based on a similar study by Stanfield and Zwaan (2001), investigated how expert and novice ice hockey and football players responded to sport-related objects and activities as compared to sport-unrelated objects and activities. Participants were required to read a sentence that described either an everyday or a sport-specific situation and then to make a judgement as to whether a subsequently presented picture was mentioned in the preceding sentence. Critically, the picture could either match the action depicted in the sentence or not. Participants were faster when the picture matched the action depicted in the sentence for everyday actions. However, only experts demonstrated this affordance for their sport-specific pictures and actions, suggesting that sensory-motor experience underpins this embodiment effect (see also Beilock, Lyons, Mattarella-Micke, Nusbaum, & Small, 2008).

There is also evidence that characteristic judgements about a performer of an action are affected by observed actions and response compatibility. For instance, Bach and Tipper (2007) found that when participants viewed dynamic videos of an actor either typing on a keyboard or kicking a soccer ball they were more fluent (i.e., faster and more accurate) when responding to the identity of the actor if the response type (hand or foot) matched the action being performed (typing or playing soccer, respectively). That is, although each actor was equally often seen typing or kicking, subsequent judgement of their personality was influenced by the participant's motor fluency. For example, an actor identified with a foot response was more fluently processed when seen kicking (compatible condition) than when viewed typing (incompatible condition). This participant's motor fluency influenced later assessment of the actor's personality, where they were considered to be more athletic. Interestingly, this effect was only found for movies and not for static images of the performers in the action. As the static images were designed so as to remove explicit action, it is possible that the presence of explicit action may play a key role in action embodiment effects. The findings of this experiment are important as they show action embodiment after viewing actions in dynamic films for both identity of the individual and judgements of the performer's personality.

Complementing the study described above, Bach and Tipper (2006) examined whether or not an observer simply represents the actions of an individual or whether the characteristics of the performer (e.g., well-known tennis player) activate the motor system in the absence of an explicit action. Using static images, participants responded to the identity of famous soccer and tennis players with either a foot or a finger response. Half of the photos depicted the athlete "in-context" (wearing athletic clothing in a sport environment), or "out-of-context" (in normal clothing, at a press conference, for example). None of the pictures depicted any explicit sport-related action, and therefore action was only implied. Therefore, if participants responded faster and more accurately when responding with an effector related to the athlete's sport (e.g., foot for soccer pictures), then this would be evidence for action embodiment in the absence of explicit action (i.e., simply by the knowledge of the athlete's profession). The athlete's profession did indeed have an effect on performance; however, it was opposite from what was expected. Participants responded faster and more accurately to incompatible sport-response mappings than to compatible mappings—what the authors referred to as a social contrast effect. The authors explained this counterintuitive finding as a form of social comparison, whereby the participants automatically inhibited the associated motor behaviour as a result of comparing their (inferior) skill level to that of the experts. They argued that these contrast effects are only seen when action characteristics are implied (implicit) as opposed to directly perceived (explicit).

Note that these counterintuitive and unexpected inhibition effects have since been replicated by Tipper and Bach (in press) and Candidi, Vicario, Abreu, and Aglioti (2010). Furthermore, similar effects have been seen for characteristics such as intelligence. For instance, priming participants with the name "Albert Einstein" led to impaired performance on intelligence tests, presumably due to the participants' feelings of inadequacy when compared to an exemplar of superior intelligence (Dijksterhuis et al., 1998; see Dijksterhuis & Bargh, 2001, for a review).

The results of Bach and Tipper (2006) are interesting in that they show evidence of action-system involvement in individual person identification, in the absence of perceived actions. However, this effector inhibition has only been shown for implied actions depicted on static slides and only with stimuli of expert athletes (see Bach & Tipper, 2007; but note an example by Bach, Peatfield, & Tipper, 2007, who showed congruency effects, but only when attention was explicitly oriented to the effector). Therefore, further research is needed to show that opposite (or null) effects occur with explicit action shown in static pictures and when novice performers are viewed acting in a sporting context. If implied action leads to a social contrast effect (due to the superior expertise of the performer), we would expect incompatible sport–response pairings to be responded to faster than compatible pairings only when a well-known athlete is viewed "out of action" (as seen by Bach & Tipper, 2006). No contrast effect would be expected for pictures of novices viewed "out of action". In this condition, participants are not expected to have a motor representation for these unknown athletes. However, if explicitly depicted actions shown on static images serve to prime the motor response associated with the effector, then facilitation effects should be observed for both expert and novice pictures. Because there is evidence that embodiment effects are only observed if attention capturing cues help to draw attention to the body parts (Bach et al., 2007), even in an explicit "in action" condition, there might also be reason not to see priming effects.

In summary, we extended the experimental protocols adopted by Bach and Tipper (2006, 2007) to include static images, depicting explicit action in addition to implied action, of both expert athletes and novice performers. These conditions allowed us to test whether the effector inhibition seen by Bach and Tipper (2006) was a result of a social contrast effect, due to the perceptions of athletes as being of superior motor skill. Participants were presented with pictures of both famous "expert" and unknown "novice" tennis and soccer players, either performing their sport's respective action ("in-action"), or simply in their athletic uniform and in a sport context ("out-of-action", e.g., on the tennis court; analogous to Bach & Tipper's, 2006, "in-context" condition).

## EXPERIMENT 1

### Method

***Participants***

Forty undergraduate students (20 female, average age 20.7 years, range 18–26 years) from the University of British Columbia participated in exchange for course credit. All reported normal hearing and normal or corrected-to-normal vision. Participants were randomly allocated to one of two possible groupings where both expert athletes were paired to either the foot or the hand (and vice versa for the novices).

### *Apparatus and stimuli*

Participants sat approximately 60 cm from a computer screen in a dimly lit and sound-attenuated testing room. The experiment was programmed and presented using E-prime software (Psychology Software Tools, Inc.). Responses were given with identical foot and hand pedals that were connected to the software via a custom-made serial port box.

A total of 96 pictures were used. Half of these pictures depicted an expert soccer player (David Beckham) or an expert tennis player (Roger Federer) either actively performing a sport-related action (e.g., kicking a soccer ball or hitting a tennis ball, respectively), or not performing a sport-related action (e.g., standing on the soccer field or tennis court, respectively; see Figure 1). The experts were not the same people as those used in the original Bach and Tipper (2006) experiment, because of the bias to British sports athletes. Beckham and Federer were expected to be better known by an international/Canadian audience (corroborated by a postexperiment questionnaire where all participants recognized the famous athletes). There were an equal number of pictures for each condition and each athlete (e.g., 24 expert soccer pictures, half "in-action" and half "out-of-action"). All expert pictures were found on the Internet (www.images.google.com) and resized so as not to exceed 300 pixels either horizontally or vertically. An equal number of pictures of novice athletes were used (48). A novice soccer and tennis player were filmed while playing their respective sport


**Figure 1**. *Examples of experimental stimuli. Each cell has an in-action and out-of-action picture of each of the different athletes: expert soccer player (A), (left hand image courtesy of The Daily Sports Herald, right hand image courtesy of Raj Patel), expert tennis player (B), (left hand image courtesy of Charlie Cowins, right hand image courtesy of Boss Tweed), novice soccer player (C), novice tennis placer (D). To view a colour version of this figure, please see the online issue of the Journal.*

(Canon ZR10 digital video, DV, camera; 10× optical zoom, 200× digital zoom, image stabilizer, and 460K-CCD pixel level). The novices were instructed to change their clothes and were filmed in different settings (i.e., different tennis courts) so as to account for different clothes and backgrounds observed in the expert pictures. Still images were then made during video playback. These images had the same dimensions as those of the pictures of expert athletes.

### *Procedure*

Participants were instructed to respond as quickly and accurately as possible to the identity of the four athletes (two expert athletes and two novice athletes). Arbitrary, yet relatively common, names consisting of two syllables were given to the novice athletes (the expert athletes' names were not changed). Participants were allocated to one of the two possible stimuli–effector pairings. In Group 1 ($n = 20$), participants responded to both expert athletes with the foot pedal. In Group 2 ($n = 20$), participants responded to both expert athletes with the hand pedal. The novice athletes were responded to with the other response effector (hand or foot pedal, respectively). This allowed for a direct comparison between expert (or novice) pictures that were both incongruently and congruently mapped to the same effector (e.g., responses to expert tennis and soccer players with the hand pedal).

At the beginning of the experiment the participants were given a practice block (32 trials) that could be repeated if necessary. Only after the participant demonstrated that he or she was able to correctly match the athletes' name with the correct response were they allowed to continue in the experiment. The experiment then consisted of four blocks of 96 trials each, such that all pictures were presented once in each block. Each trial began with a fixation cross that was presented for 250 ms, after which a blank screen was presented for 500 ms, and finally the image was presented for 2,000 ms. The participants had to respond within these 2,000 ms, otherwise an error message was given. The experiment lasted approximately 30 min, including short breaks between blocks.

## Results

Reaction times (RTs) for correct responses as well as percentage accuracy data were submitted to a repeated measures analysis collapsed across effector for the two different groups. The three factors were action ("in-action" vs. "out-of-action" pictures), congruency (congruent vs. incongruent sport–response mappings), and picture expertise (expert vs. novice pictures). The means for this analysis are depicted in Figures 2A (expert stimuli) and 2B (novice stimuli).

The main effects of action and picture expertise were not significant (both $F$s $< 1$). The main effect of congruency was significant, $F(1, 39) = 6.50$, $p = .015$, $\eta_p^2 = .14$. Overall, participants responded faster to compatible (623 ms) than to incompatible (636 ms) sport–response mappings. Both the action by picture expertise, $F(1, 39) = 6.30$, $p = .017$, $\eta_p^2 = .14$, and the action by congruency, $F(1, 39) = 5.5$, $p = .024$, $\eta_p^2 = .12$, interactions were significant. For the identification of expert pictures, RTs were faster "in action" (627 ms) than "out of action" (633 ms). The reverse was true for novice stimuli (632 ms, "in action"; 625 ms, "out of action"; see Figure 2). The Action × Congruency interaction was due to a larger congruency effect (incongruent RT − congruent RT) for "in-action" pictures (638 ms vs. 621 ms, respectively; 17 ms facilitation) when compared with "out-of-action" pictures (633 ms vs. 626 ms, 7 ms facilitation). There was no evidence of a contrast effect nor a three-way interaction $F(1, 39) = 2.58$, $p = .12$, $\eta_p^2 = .06$, $1 - \beta = .35$. Thus, although action interacted with picture expertise, and with congruency, the failure to observe a three-way interaction meant that regardless of whether the action was explicit or implied, the congruency effect was the same for experts and novices.

### *Accuracy data*

Participants were accurate, having an overall error rate of 2.9% (see Figures 3A and B). The same

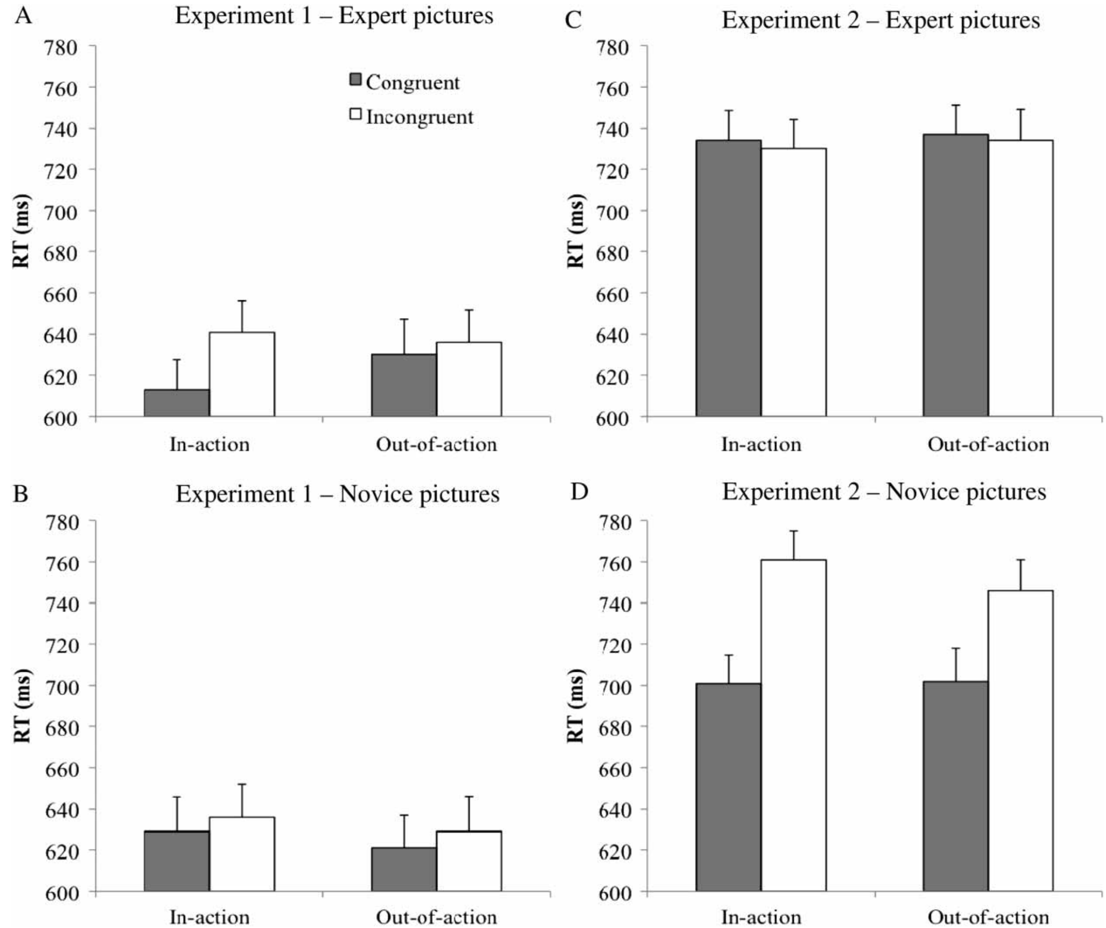


**Figure 2**. *Reaction time (RT; in ms) data (and standard error bars) as a function of congruency, action, and stimulus expertise level for Experiment 1 (A = expert athletes; B = novice athletes) and Experiment 2 (C = expert athletes; D = novice athletes).*

analysis of variance (ANOVA) with the within-participants' factors action, congruency, and expertise was carried out on the error data. None of the main effects (all $F$s $< 1$) or interactions were significant.

## Discussion

In Experiment 1 we addressed action embodiment with static images during person identification when an action was either shown explicitly or implied by the context. We were interested in how these judgements were mediated by the skill level of the person to be identified. Here, we extended previous studies (see Bach & Tipper, 2006, 2007) by not only comparing implied action of expert athletes, but by also comparing pictures of both experts and novices "in action" to examine whether perception of skill level only during an implied action leads to an inhibition of the sport-congruent response (a contrast effect).

There were two main findings. First, we extended Bach and Tipper's (2007) results of action embodiment, as evidenced by facilitation of responses to sport–effector congruent pairings, to static images depicting action. To the best of our knowledge, this is the first demonstration of this priming. Second, and contrary to Bach and

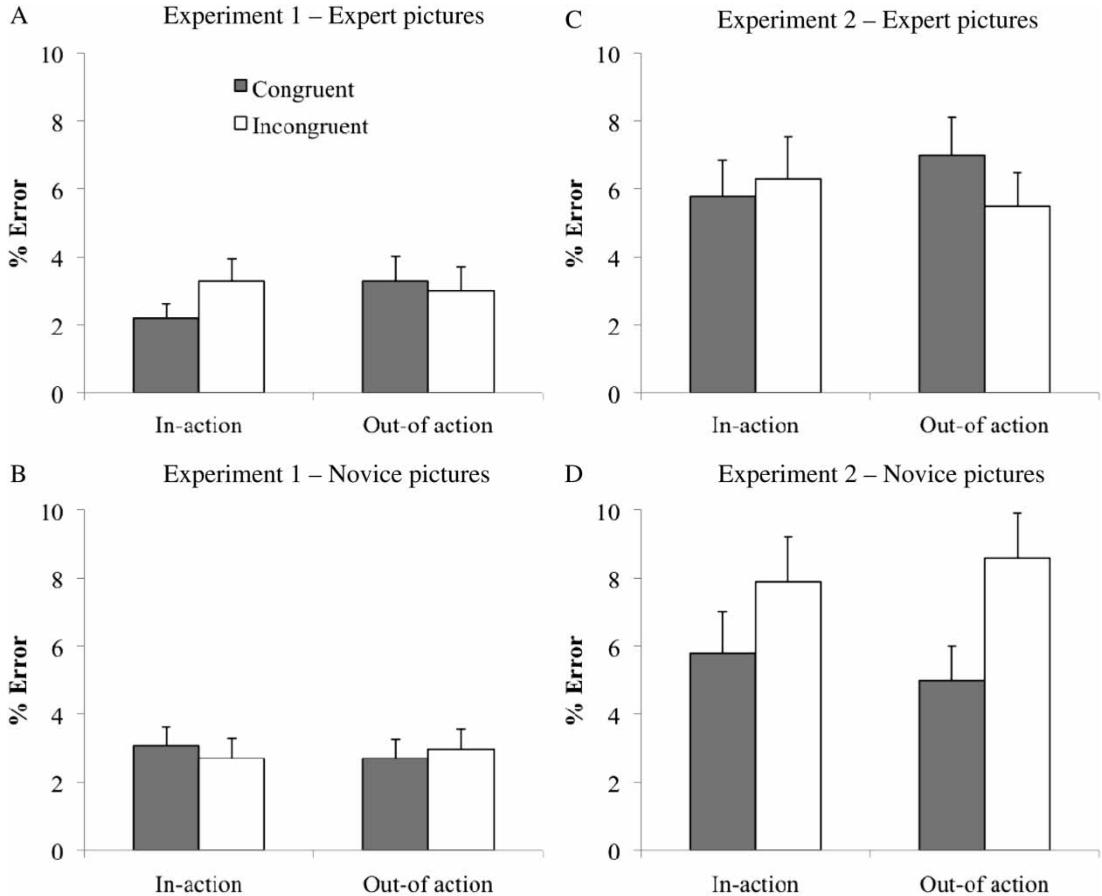


**Figure 3**. *Percentage errors (and standard error bars) as a function of congruency, action, and stimulus expertise level for Experiment 1 (A = expert athletes; B = novice athletes) and Experiment 2 (C = expert athletes; D = novice athletes).*

Tipper (2006), Candidi et al. (2010), and Tipper and Bach (in press), there was no evidence of a contrast effect where incongruent sport–response mappings were responded to faster than congruent mappings during recognition judgements of famous athletes.

Although these data do not support Bach and Tipper's (2006) social comparison account of their results, due to the lack of evidence that participants (negatively) compared themselves to the expertise of the athletes leading to an inhibition of an action-related response, there were additional significant procedural differences that could account for these effects. First, our famous athletes were different to those chosen by Bach and Tipper (2006), although they were considered highly recognizable and successful in their respective sports, and all participants reported that they were familiar with both athletes in a postexperiment questionnaire. Second, participants in Experiment 1 probably responded by classifying images either as expert or novice rather than making a decision based on the identity of the athlete. The design used by Bach and Tipper (2006) required judgements to be made on the identity of this athlete. That our participants responded about 100 ms faster than those in Bach and Tipper (2006) agrees with the likelihood that our participants were making a response based on a superficial categorical level (expert vs. novice) rather than a deeper exemplar of that category level (person-identification). Experiment 2 replicated Experiment 1, but this time we ensured that participants made a response decision based on person identification (i.e., within category) by mixing skill level across effectors.

## EXPERIMENT 2

In the present design, both a novice and an expert were paired with a foot response and a hand response. Therefore, a decision to respond with either the hand or foot could not be made on the basis of skill level or sport alone.

### Method

#### *Participants*

There were 40 new participants (24 female, average age 21.5 years, range 18–31 years) who were allocated to one of two possible athlete–response pairings. Participants in each group had both an expert and a novice athlete (different sports) associated with each response effector. One group of participants responded to the expert soccer player and novice tennis player with the foot pedal (and the expert tennis player and novice soccer player with the hand pedal), while the other group used the hand pedal to respond to the expert soccer player and novice tennis player (and the expert tennis player and novice soccer player with the foot pedal). All other procedures were maintained as detailed in Experiment 1.

### Results

The same repeated measures ANOVA as that conducted in Experiment 1, after collapsing across response type, was used. The means for this analysis are depicted in Figures 2C (expert stimuli) and 2D (novice stimuli). Note that overall RTs are about 100 ms slower than those in Experiment 1, and in line with those of Bach and Tipper (2006), consistent with the notion that our participants were now executing a response according to the identity of the person in the image. The three factors were action ("in-action" vs. "out-of-action" pictures), congruency (congruent vs. incongruent sport–response mappings), and picture expertise (expert vs. novice pictures). Replicating the findings of Experiment 1, the main effects of action and expertise were not significant (both $F$s $< 1$) but the main effect of congruency was significant, $F(1, 39) = 9.66$, $p = .004$, $\eta_p^2 = .2$. Overall, participants responded faster to compatible (719 ms) than to incompatible (743 ms) sport–response mappings. The action by picture expertise interaction was marginally significant, $F(1, 39) = 3.4$, $p = .073$, $\eta_p^2 = .08$. This was due to faster responses to implied or what we termed "out-of-action" novice pictures (724 ms) than to "out-of-action" expert pictures (736 ms), whereas there was virtually no difference between response latencies to novice and expert "in-action" pictures (732 ms and 731 ms, respectively). Unlike Experiment 1, the action by congruency effect was not significant, $F(1, 39) = 2.5$, $p = .122$, $\eta_p^2 = .06$. The predicted Expertise × Congruency interaction was significant, $F(1, 39) = 39.5$, $p < .001$, $\eta_p^2 = .5$, highlighted in Figure 2C and 2D, showing large congruency effects for novice pictures. Most importantly, the critical three-way interaction was not significant, $F(1, 39) = 1.57$, $p = .218$, $\eta_p^2 = .04$, $1 - \beta = .77$.

#### *Accuracy data*

Participants had an overall error rate of 6.5% (see Figures 3C and 3D). The pattern of data was comparable to that seen for the RT data. There was no main effect for action, $F < 1$, or picture expertise, $F(1, 39) = 1.07$, $p = .308$, $\eta_p^2 = .03$, and the congruency effect was not significant, $F(1, 39) = 2.48$, $p = .123$, $\eta_p^2 = .06$, despite the trend for congruent pairings to be responded to faster than incongruent pairings. Although none of the other interaction effects were significant, there was the expected three-way interaction of action, picture expertise, and congruency, $F(1, 39) = 4.86$, $p = .034$, $\eta_p^2 = .11$. For novice pictures there was a congruency effect both "in action" and "out of action". In contrast, for expert pictures, despite a trend for congruency effects "in action" the predicted contrast effect was seen "out of action" with incongruent stimuli being responded to more accurately than congruent stimuli.

### Discussion

Consistent with our hypothesis that participants in Experiment 1 were making a rapid decision that was based on skill level rather than the identity of the individual, RT performance in the present study—where a response based on identity was ensured—was about 100 ms slower than before, dovetailing with the response latencies observed in Bach and Tipper (2006). Interestingly, this had a major impact on the congruency effect observed for novices. That is, while responses with the congruent effector were faster than the incongruent effector across experiments, participants in Experiment 2 had a much larger congruency effect overall, which did not vary with in- versus out-of-action images (see panels B and D in Figures 2 and 3). This suggests that any facilitatory effect when responding to novice pictures with the same effector is enhanced when judgements are restricted to the identity of the individual.

A very different result was found for the expert images in Experiment 2. Here, and for the first time in either experiment, we found that the congruency effect was eliminated. Thus when responses were made on identity rather than skill level, there was evidence for a social contrast effect—insofar as the standard congruency effect was eliminated for experts. However, unlike Bach and Tipper (2006), we did not see a significant reversal in the congruency effect nor did it matter whether the images were in-action or out-of-action. An alternative account for this result, and one that does not rely on a social contrast interpretation, might be that the saliency of the expert athlete and his perceived fame resulted in participants ignoring, or at least downplaying, the action or sport, which in turn negated any RT-related response priming effects. The error data in Experiment 2, however, would seem to favour the social contrast explanation, as there was a now significant and selective reversal in the congruency effect for experts that were out-of-action, with more errors being made by the congruent than by the incongruent effector. This agrees with the interpretation that a social contrast effect was operating for the in-action and out-of-action expert images in Experiment 2, and that this contrast effect was accentuated by an implied action in the expert images.

To compare the RT effects across experiments, we combined the data from Experiments 1 and 2 and conducted an ANOVA as before, but now with experiment as a between-subject factor. We expected an Experiment × Expertise × Congruency interaction, but given that the Action × Congruency interaction was significant in Experiment 1 and not in Experiment 2, a four-way interaction was additionally expected. The three-way interaction was marginally significant, $F(1, 78) = 3.62$, $p = .061$, $\eta_p^2 = .044$, due to the abolition of any congruency effect in Experiment 2 for expert images (732 ms vs. 736 ms; a 4-ms contrast effect), while the four-way interaction did reach conventional levels of significance, $F(1, 78) = 5.61$, $p = .02$, $\eta_p^2 = .067$ (as was the three-way interaction between Action × Congruency × Experiment), $F(1, 78) = 4.71$, $p = .033$, $\eta_p^2 = .057$. These findings reinforce our conclusion that responses are inhibited when individuals see actions depicted either explicitly or implicitly by experts under conditions where deep processing of the individual is required (as in Experiment 2; see also Bach & Tipper, 2006; Candidi et al., 2010).

## GENERAL DISCUSSION

In two experiments we showed that sport–effector compatibility mediates stimulus identification. We show for the first time action-related congruency effects for static images depicting action. This was observed for images where actions were explicitly depicted and when they were implied by context. However, the congruency effect observed in Experiment 1 for pictures of expert athletes was moderated in Experiment 2 when judgements were made at the level of the individual actor rather than across skill levels. Rather than any advantage for congruent response pairings, there was a slight advantage for incongruent sport–response pairings. Coupled with the improved accuracy for incongruent sport–response pairings these findings provide at least partial support for Bach and Tipper (2006) who showed a similar accuracy effect, yet a larger RT advantage for incongruent pairings for pictures of expert athletes. In the Bach and Tipper experiment the contrast effect was said to be a result of implied action. Although this was true when we examined the accuracy data in our experiment, the absence of the congruency effect and a trend towards faster RTs for incongruent stimuli was seen for both implied and explicitly portrayed actions.

The presence of faster congruency responses in Experiment 1 for both novices and experts, and the lack of congruency effects in Experiment 2 for expert pictures, suggests that participants across the two experiments were using different response strategies. In Experiment 1, it appears that participants used a response strategy that allowed them to respond at a categorical level as to whether an athlete was an expert or novice. In Experiment 2, response decisions had to be based on identity, and while a positive congruency effect persisted and was in fact larger for novice images, this congruency effect was abolished for expert images. In the experiment by Bach and Tipper (2006), similar identity judgements would have also been fostered by their design where participants were required to differentiate across skill level and sport within an effector. In view of the increased similarity in findings of their study with Experiment 2, it appears that this aspect of the design was a critical component for bringing about contrast effects, or at least negating standard congruency effects in RT. Further evidence that the response decision shifted from a fast skill-based decision to a slower identity-based decision was that our Experiment 1 RTs were about 100 ms faster than Experiment 2 RTs, and our slower Experiment 2 RTs were in line with those reported by Bach and Tipper (2006).

Differential results depending on whether participants were primed with a category (e.g., skill) or a specific exemplar of that category (e.g., identity) have been shown by Dijksterhuis et al. (1998). When the category of intelligence was primed, responses to general knowledge questions were better than when primed with a specific exemplar of intelligence (i.e., “Albert Einstein”). In the latter case, there was evidence that responses were inhibited. As exemplified in Figure 2, our data are in line with these findings. That is, although a contrast effect in RTs in Experiment 2 for expert pictures was not observed, it is noteworthy that the robust facilitation effects seen for all images in Experiment 1, and for novice images in Experiment 2, were selectively eliminated. In addition, the error data demonstrated a social contrast effect for expert out-of-action images. These findings support the idea that person identification is modified by the nature of the stimuli, in this case the skill level of the individual, but that this modification is dependent on deep processing of identity.

Nevertheless, because we saw congruency effects among novices, even when actions were only implied by context, we cannot conclude that judgements were based (solely) on the character of the individual (as suggested by Bach & Tipper, 2006). Rather, it seems that contextual cues, such as the background image of the tennis court or soccer field and sport-specific equipment (i.e., tennis racquet, soccer ball) were mostly responsible for the priming effects. Because congruency effects were suppressed when person identity was required in Experiment 2 for expert stimuli, it is likely that two competing processes were activated, leading to the absence of effects (see also Candidi et al., 2010, for a similar conclusion). That is, the contextual cues served to facilitate congruent actions, but in keeping with the social contrast phenomenon, identifying someone famous acted to suppress the sport-specific effector, resulting in a lack of difference between the congruent and incongruent conditions, at least for RT. Because contextual cues were low or absent in Bach and Tipper (2006), where only the top half of the athlete was shown, and inhibition (contrast) effects were strongest in the “out of context” condition, this interpretation would be supported. It would be informative in future work to look at conditions where the famous athlete is seen in a sporting context different to the sport where he is known—for example, Beckham playing tennis. This would allow us to look at the relative importance of context and stimuli characteristics in priming or inhibiting responses. We would expect significant context-related facilitation effects in this situation due to the priming of the sport (e.g., priming of the hand due to tennis) coupled with the inhibition of the foot, resulting from perceptions of a skilled soccer player.

We had expected that standard congruency effects would only be seen when actions were explicitly portrayed, and there was also reason to believe that congruency effects might be absent when static rather than dynamic pictures were used to portray the actions. However, in these experiments, large congruency effects were seen for novice pictures both "in-" and "out-of-action" in Experiment 2, and under all conditions for Experiment 1, especially for expert "in-action" pictures. Therefore, priming as a result of action embodiment is not limited to dynamic presentations (cf., Bach & Tipper, 2007), and neither is it limited to the explicit portrayal of actions. Indeed, Bach et al. (2007) have also suggested that embodiment effects are only observed if cues are present that draw attention to relevant body parts, yet in these experiments congruency effects were observed even in the absence of any such cues, beyond contextual information implying action.

It is important to view these results as an extension of Bach and Tipper's (2006, 2007) investigations as the procedural differences between the experiments could have contributed to the differences in findings. We mixed both novice and expert pictures depicting, or not, action, within the same experimental block. Bach and Tipper did mix "in-" and "out-of-context" pictures in the same block, but they did not have any pictures depicting explicit action or novices. It is possible that having famous and nonfamous athletes within the same experimental block could have muted the "contrast" effect as a result of seeing someone famous next to an obvious novice. Similarly, seeing action depicted in some pictures might have negated any contrast effects as a result of implicit action priming. Additionally, participants would have been more able to associate the person with the sport in the absence of action.

A future avenue for research would be to compare both skilled and novice performers as observers, in order to find out how they respond to pictures of other similarly skilled athletes "in-" or "out-of-action". This would perhaps provide a stronger test of the social contrast effect due to the increased importance of the sport for the observer and the relative perceptions of expertise. It would be necessary to have participants of the same perceived skill level as the expert stimuli, perhaps players from the same sporting league, to determine whether inhibitory effects are eliminated when the stimuli are no longer perceived as more skilled.

In summary, the present study showed evidence of action embodiment irrespective of whether an action was explicitly depicted or whether the person performing the action was skilled in the sport. The overall findings suggest that embodiment effects can be seen for implicit and explicit action images of both novices and experts and that static images are capable of eliciting priming effects associated with sport-relevant effector pairings. However, it appears that only when judgements are directly based on identification of the individual, and hence arguably more deeply encoded, is there any evidence of social contrast effects when an observer responds to a picture of an expert performer.

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