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Correspondence effects with torches: Grasping affordance or visual feature asymmetry?

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Three experiments were conducted to determine whether an object-based correspondence effect for torch (flashlight) stimuli reported by Pellicano et al. [(2010). Simon-like and functional affordance effects with tools: The effects of object perceptual discrimination and object action state. *Quarterly Journal of Experimental Psychology*, *63*, 2190–2201] is due to a grasping affordance provided by the handle or asymmetry of feature markings on the torch. In Experiment 1 the stimuli were the same as those from Pellicano et al.'s Experiment 2, whereas in Experiments 2 and 3 the stimuli were modified versions with the graspable handle removed. Participants in all experiments performed upright/inverted orientation judgements on the torch stimuli. The results of Experiment 1 replicated those of Pellicano et al.: A small but significant object-based correspondence effect was evident, mainly when the torch was in an active state. With the handle of the torch removed in Experiment 2, making the barrel markings more asymmetric in the display, the correspondence effect was larger. Experiment 3 directly demonstrated an effect of barrel-marking asymmetry on the correspondence effect: When only the half of the markings nearest the light end of the torch was included, the correspondence effect reversed to favour the light end. The results are in agreement with a visual feature-asymmetry account and are difficult to reconcile with a grasping-affordance account.

Keywords: Grasping; Functional affordance; Simon effect; Spatial coding; Stimulus–response compatibility.

When participants make left and right key-press responses to a nonlocation stimulus feature, with the stimuli occurring in left and right locations, performance is better when the stimulus and response locations correspond than when they do not. This phenomenon, known as the Simon effect (Lu & Proctor, 1995; Simon, 1990), has attracted considerable interest because it indicates that stimulus location is processed automatically when the task goal includes selecting one out of two spatially distinct responses (e.g., Hommel, 2011; Proctor, 2011).

Simon-type correspondence effects of an irrelevant stimulus feature with a response have been obtained for many dimensions (e.g., affective valence, Eder & Rothermund, 2010), with unique explanations offered for some of the variants. One such variant is the object-based correspondence effect, initially shown by Tucker and Ellis (1998). In their study, participants made upright or

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inverted judgements to pictures of objects, presented in the middle of a display screen, which had graspable handles on the left or right side. Key-press responses made with the left and right index fingers yielded shorter reaction time (RT) when the handle was to the side of the responding hand than when it was to the opposite side. Another experiment showed only marginal indication of the correspondence effect when the responses were made with different fingers on the same hand, leading Tucker and Ellis to conclude that their results were not just due to spatial correspondence. Instead, they attributed them to a grasping affordance, according to which the handle of the object automatically activates a tendency to grasp it with the corresponding hand.

Subsequent studies have shown that key-press responses do not yield object-based correspondence effects for all judgements of stimulus properties, particularly when the objects are centred such that the graspable part does not vary in distinct left and right locations from trial to trial (Bub & Masson, 2010; Cho & Proctor, 2011, 2013). Of most concern for the present study is evidence that the correspondence effects are obtained only when the required judgements involve a stimulus attribute related to grasping. Tipper, Paul, and Hayes (2006) had participants make left and right key-press responses to pictures of door handles, which were coloured green or blue and of round or square shape, pointing to the left or right (in a horizontal, passive state or a 45°-downward, active state). Participants who made colour judgements showed no correspondence effect of handle direction with key-press response. However, those who made shape judgements showed an effect, with it being larger when the handle was in the active state (35 ms) rather than in the passive state (14 ms).

Pellicano, Iani, Borghi, Rubichi, and Nicoletti (2010) obtained similar results with pictures of torches (flashlights) oriented horizontally so that they had a graspable handle at the left or right end and the light end (head) at the other (see Figure 1A). They varied active (switched on) versus passive (switched off) state by depicting light coming from the torch for the former but not for the latter. In their Experiment 1, participants made red versus blue colour discriminations with left and right key-presses, and no evidence for a grasping affordance was evident. In Experiment 2, participants made discriminations as to whether the torch was oriented upright (switch to top and handle sloped inward to enable easy grasping) versus inverted (switch to bottom and handle sloped outward). For this situation, the active-state stimuli showed a 10-ms object-based correspondence effect favouring the handle end, whereas the passive-state stimuli did not. Pellicano et al. concluded that their results were consistent with those of Tipper et al. (2006), saying "These results also suggest that affordances do not appear to be automatic but, rather, seem to depend on the extent to which the task requires detailed processing of shape. Furthermore, they are selectively activated if the functional meaning of tools is made very salient" (p. 2200).

The apparent finding of the Tipper et al. (2006) and Pellicano et al. (2010) studies, that a grasping affordance is activated for key-press responses only when the task requires judgements related to grasping, implies that there must be an appropriate task set. Because of the importance of this finding, Cho and Proctor (2013) conducted six experiments using the door-handle stimuli of Tipper et al. Despite the stimuli being the same, Cho and Proctor's results showed no object-based correspondence effect for shape judgements. For colour judgements, there was a correspondence effect, but it was relative to the location of the handle base (which changed left–right position from trial to trial). Upright/inverted orientation judgements, which like shape judgements can be regarded as relevant to grasping, also showed no correspondence effect. Cho and Proctor's results provide little evidence for a grasping affordance influencing judgements with the door-handle stimuli. Instead, they are in better agreement with a spatial-coding account for which shape and orientation judgements are based on integral processing of the stimulus dimensions and colour judgements on separable processing of colour and object elements.

Given that the door-handle stimuli show little evidence of grasping affordances influencing shape or orientation judgements, the question

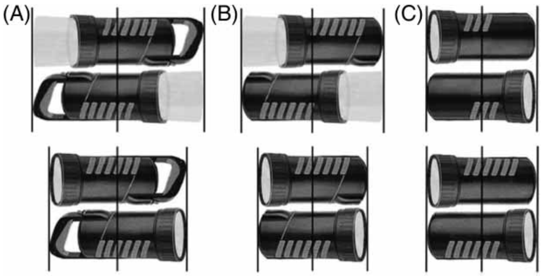

Figure 1. *(A) The torch stimuli used in Pellicano et al.'s (2010) Experiment 2 (orientation judgements) and the present Experiment 1. (B) The torch stimuli with handle removed used in our Experiment 2. (C) The torch stimuli with the switch removed used in our Experiment 3. The top four stimuli in columns A and B are in the active state, whereas the bottom four stimuli are in the passive state. All stimuli in column C are in the passive state, with the top two having three strips and the bottom two having six strips. Upright orientations are illustrated in rows 2 and 4 and inverted orientations in rows 1 and 3. The vertical lines were not part of the stimuli and are included to illustrate points about asymmetry of the grey strips discussed in the text.*

remains as to why Pellicano et al. (2010) obtained results consistent with the affordance account for upright/inverted judgements of the torch stimuli. Cho and Proctor (2013) noted that Pellicano et al.'s stimuli contained several additional asymmetric visual features that could have been the source of their results, focusing on the strips located at the bottom of the upright torch. For the orientation-judgement experiment, the torch was in an upright orientation on half of the trials and an inverted orientation on the other half (see Figure 1A). Consequently, the position of the strips in the lower or upper part of the image varied and was a relevant cue for the required judgement. The varying position of the strips vertically from trial to trial, along with their location being relevant to the task, would cause them to be weighted more in the decision process (Memelink & Hommel, 2013; Yamaguchi & Proctor, 2012). Crucially, the position of the row of strips to the left or right of display centre corresponded with the left or right location of the handle (see Figure 1A). Because the entire display was centred, this left–right position difference for the strips was larger when the light was in an active state (the top two rows) rather than in a passive one (the bottom two rows). Thus, the correspondence effect for the active-state torches in Pellicano et al.'s study could have been due to the asymmetric row of strips being coded as left or right and not to the handle affording grasping.

Experiment 1 of the present study was designed to verify Pellicano et al.'s (2010) results and to obtain initial evidence as to whether participants attend to the row of strips. Experiment 2 provided a test of the grasping-affordance and feature-asymmetry accounts by removing the handles from the torches, which also increased the asymmetry of the row of strips. The feature-asymmetry account predicts a larger correspondence effect when the handle is removed, whereas the grasping-affordance account predicts an effect that is reduced in size, or at least no larger, than that in Experiment 1. Finally, in Experiment 3, strip asymmetry was manipulated to be in opposition to the barrel of the torch, by which it could be grasped.

EXPERIMENT 1

Pellicano et al. (2010) reported a small, but significant 10-ms correspondence effect relative to the graspable end of the torch in the active state but not in the passive state. Experiment 1 used the same stimuli to verify that we could observe this result pattern under similar conditions. Participants were asked at the end to specify to which part(s) of the stimuli they attended in making their judgements.

Method

Participants

Thirty-two undergraduate students (22 males) participated for credits toward a course requirement. All reported having normal or corrected-to-normal vision and were naïve to the purpose of the study.

Stimuli, apparatus, and procedure

The experiment took place in a dimly lit room equipped with a personal computer. Stimulus presentation, response recording, and data collection were controlled by E-Prime 2.0 software. The participant sat facing a 17″ monitor, with his or her head positioned in an adjustable head-and-chin rest, at a viewing distance of 58 cm. The stimuli were greyscale pictures of a torch, in an active or passive state. The active-state stimuli were 17.5 × 6 cm, whereas the passive-state stimuli were 14 × 6 cm, presented in an upright or inverted (180° vertically rotated) view (see Figure 1A). The stimuli were presented in eight different configurations: 2 (functional state: active vs. passive) × 2 (vertical orientation: upright vs. inverted) × 2 (horizontal orientation: handle on the left vs. right). Responses were recorded by pressing a left or right key ("A" and "L" keys on the middle row of a computer keyboard, centred about the vertical midline of the screen) with the corresponding index finger.

Participants were instructed to respond to the upright/inverted orientation of the stimuli, while ignoring the horizontal orientation and functional state. Each participant performed two blocks, with one block using the active-state torches and the other using the passive-state torches. The order of the active- and passive-state blocks was counterbalanced across participants. Each object occurred equally often in each horizontal orientation, with order randomized for each participant. Half the participants responded to the upright torch with the left key and the inverted torch with the right key, and half with the opposite mapping.

Printed pictures of four sample stimuli were shown initially to the participants to familiarize them with the stimuli. Then, two blocks of 16 practice trials, each followed by 200 test trials, were performed. Each trial began with a 500-ms blank screen, followed by a 1000-ms fixation cross (4 × 4 mm) at the centre of the screen. Next, the stimulus was displayed on the screen until a response was made. A 400-Hz tone was immediately presented for 500 ms after each error trial, but no feedback was provided on correct trials. Participants were instructed to respond as fast and accurately as possible. After the two blocks, participants were asked to indicate on which part of the torch they based their judgements by circling the part on printed figures of the torch.

Results and discussion

Mean RT for correct responses and percentage correct (PC) were computed for each participant. Trials with RT <150 ms or >2000 ms were excluded from the subsequent analysis (1.9% of trials). A 2 (correspondence: handle-to-response position corresponding vs. noncorresponding) × 2 (functional state: active vs. passive) within-subjects analysis of variance (ANOVA) was conducted for the RT and PC data, respectively. See Table 1 for mean values as a function of the two independent variables.

For RT, there was a significant effect of correspondence, $F(1, 31) = 9.70$, $p = .004$, $\eta_p^2 = .24$, with shorter RT when the handle position corresponded with the response ($M = 546$ ms) than when it did not ($M = 556$ ms). The main effect of functional state was not significant, $F < 1$, but the Correspondence × Functional State interaction approached the .05 level, $F(1, 31) = 3.70$, $p = .064$, $\eta_p^2 = .11$. Simple effect ANOVAs for each functional state showed a significant 18-ms correspondence effect for the active-state stimuli (Ms = 541 vs. 559 ms), $F(1, 31) = 23.91$, $p < .001$, $\eta_p^2 = .44$, but a 2-ms nonsignificant effect for the passive-state stimuli (Ms = 550 vs. 552 ms), $F < 1$, a similar pattern to the significant 10-ms and nonsignificant 1-ms effects found by Pellicano et al. (2010).

For PC, the two-factor ANOVA showed only a main effect of correspondence, $F(1, 31) = 7.00$, $p = .013$, $\eta_p^2 = .18$. Neither the main effect of functional state nor the Correspondence × Functional State interaction was significant, Fs < 1.

In response to the postexperiment question about the part of the figure on which they based their judgements, 22 of the participants (69%) selected the strips, four (12%) the handle, four (12%) the switch, and two (6%) both the strips and handle. Thus, 75% of the participants indicated that they attended to the strips in making their judgements.

To summarize, the results showed an object-based Simon effect, as in Pellicano et al.'s (2010) study. As they found, the effect was evident for the active torches (18 ms) but not the passive

Table 1. *Mean reaction time and percentage correct as a function of correspondence and functional state, and the correspondence effect in Experiments 1, 2, and 3*

		Reaction time (ms)			*Percentage correct*		
Experiment	*Functional state/No. of strips*	*Corr*	*NonCorr*	*CorrEff*	*Corr*	*NonCorr*	*CorrEff*
Experiment 1	Active state	541	559	18**	98	97	1*
	Passive state	550	552	2	97	97	0
Experiment 2	Active state	584	625	41**	98	96	2**
	Passive state	569	587	18*	98	96	2**
Experiment 3	Six strips	548	551	3	98	98	0
	Three strips	574	550	–24**	96	98	–2*

Note: Corr = corresponding; NonCorr = noncorresponding; CorrEff = correspondence effect.
*$p < .05$. **$p < .001$.

torches (2 ms). Tellingly, though, three quarters of the participants said that they attended to the strips, located at the bottom of the upright torch and the top of the inverted torch, to make the orientation judgements.

EXPERIMENT 2

In Experiment 1, the position of the strips to the left or right of the display centre, which corresponded to the left or right location of the handle, was more extreme when the torch was in the active state. Thus, the correspondence effect for the active-state stimuli in Experiment 1 and in Pellicano et al.'s (2010) study could have been due to coding the location of the row of strips as left or right and not to the handle providing a grasping affordance. To test this hypothesis, in Experiment 2 the left–right asymmetry of the strips was made more salient by removing the handle (see Figure 1B). Because the modified torches can no longer be grasped by the handle, which Pellicano et al. called "the graspable portion", it might be assumed that there is no longer a grasping affordance, and, hence, the object-based correspondence effect should not be evident. However, since a torch is more typically grasped by the barrel, grasping may still be afforded, in which case an effect of similar size to that of Experiment 1 would be expected. The feature-asymmetry account, in contrast, makes the unique prediction that the object-based correspondence effect should be larger than that in Experiment 1, because removal of the handle renders the strip locations more asymmetric on the horizontal dimension of the display (particularly for the active-state torches; see Figure 1B).

Method

Thirty-two new undergraduate students (24 males) from the same pool participated in this experiment. The apparatus and procedure were the same as those for Experiment 1, except that the torches had the handle removed (see Figure 1B). The active-state torches were 14.5 × 6 cm, whereas the passive-state torches were 11 × 6 cm.

Results and discussion

Using the same criteria as those for Experiment 1, 2.2% of trials were deleted. The mean RT and PC values are shown in Table 1. For RT, there were main effects of correspondence, $F(1, 31) = 34.22$, $p < .001$, $\eta_p^2 = .53$, with shorter RT for spatial correspondence ($M = 577$ ms) than for noncorrespondence ($M = 606$ ms), and functional state,

$F(1, 31) = 10.42$, $p = .003$, $\eta_p^2 = .25$ (Ms = 604 vs. 578 ms for active and passive states, respectively). This latter effect of functional state was not significant in Experiment 1, but it was in Pellicano et al.'s (2010) Experiment 2, after which Experiment 1 was modelled. The tendency to be faster overall with the passive-state stimuli could in part be due to the critical information for the upright/inverted judgements being more centrally located on the display for those stimuli than for the active ones (see Figure 1B).

More important, the Correspondence × Functional State interaction was significant, $F(1, 31) = 5.96$, $p = .021$, $\eta_p^2 = .16$. Simple effect ANOVAs for the two functional states showed that the correspondence effect was present with both active-state stimuli (Ms = 584 vs. 625 ms), $F(1, 31) = 29.19$, $p < .001$, $\eta_p^2 = .49$, and passive-state stimuli (Ms = 569 vs. 587 ms), $F(1, 31) = 7.99$, $p = .008$, $\eta_p^2 = .21$, although larger for the former (41 ms) than for the latter (18 ms). For PC, there was only a main effect of correspondence, $F(1, 31) = 43.04$, $p < .001$, $\eta_p^2 = .58$; other Fs < 1.

For the postexperiment question, 24 participants (75%) circled the strips as the part on which they relied to make their decisions. The remaining eight participants (25%) indicated that they relied on the switch location. Thus, again, the majority of participants indicated that they attended to the strips in order to make the orientation judgements.

COMBINED ANALYSES OF EXPERIMENTS 1 AND 2

ANOVAs with Experiment 1 versus Experiment 2 as a factor in addition to correspondence and functional state were conducted to compare effects of presence or absence of the handle. There was no main effect of experiment on RT or PC, Fs(1, 62) = 2.60 and 0.01, ps = .112 and .932, $\eta_p^2 = .04$ and <.01, and both measures showed a main effect of correspondence, Fs(1, 62) = 43.66 and 42.83, ps < .001, $\eta_p^2 = .42$ and .41. More informative, the Experiment × Correspondence interaction was significant for both RT and PC, Fs(1, 62) = 10.68 and 9.91, ps = .002 and .003, $\eta_p^2 = .18$ and .14, as was the Correspondence × Functional State interaction for RT, $F(1, 62) = 9.65$, $p = .003$, $\eta_p^2 = .14$, but neither the Experiment × Functional State interaction nor the three-way interaction was significant for either measure, Fs (1, 62) = 2.89 and 0.19, ps = .094 and .661, $\eta_p^2 = .05$ and .03. Thus, the object-based Simon effect was larger in Experiment 2 (without handle) than in Experiment 1 (with handle) to a similar extent for active- and passive-state torches.

If attending to the strips for the upright/inverted judgements causes the left–right asymmetry of the strips to be weighted more heavily in the decision process, the object-based correspondence effect should be larger for participants who specified that they attended to the strips than for those who indicated another feature. In each experiment, 75% of participants indicated attending to the strips, and 25% did not, giving totals of 48 and 16 participants in each category. An unequal-N ANOVA was performed on the RT data with the between-subjects variable of attending to strips or not and the within-subject variables of correspondence and functional state. RT was shorter for corresponding than for noncorresponding trials (Ms = 581 and 602 ms, respectively), $F(1, 62) = 32.62$, $p < .001$, $\eta_p^2 = .35$, and for the participants who indicated attending to the strips than for those who did not (Ms = 550 and 632 ms, respectively), $F(1, 62) = 8.58$, $p = .005$, $\eta_p^2 = .12$. The only other significant effect was the three-way interaction of all variables, $F(1, 62) = 13.15$, $p = .001$, $\eta_p^2 = .18$ (all other Fs < 1.30, ps > .250).

Follow-up ANOVAs of RT for each of the two groups clarified the result pattern (see Figure 2). Participants who said they attended to the strips showed a significant effect of correspondence, $F(1, 47) = 21.68$, $p < .001$, $\eta_p^2 = .32$, and a Correspondence × Functional State interaction, $F(1, 47) = 30.16$, $p < .001$, $\eta_p^2 = .39$. The correspondence effect was significant with the active-state stimuli (Ms = 543 vs. 576 ms), $F(1, 47) = 42.38$, $p < .001$, $\eta_p^2 = .47$, but not the passive-state stimuli (Ms = 540 vs. 543 ms), $F <$ 1, as reported initially by Pellicano et al. (2010). In contrast, participants who did not attend to the strips also showed a main effect of correspondence, $F(1, 15) = 21.96$, $p < .001$, $\eta_p^2 = .59$, but no interaction with functional state, $F(1, 15) = 1.16$, $p = .298$, $\eta_p^2 = .07$. Their mean data in fact showed the opposite pattern of results: The correspondence effect did not quite attain the .05 level for the active-state stimuli (Ms = 623 vs. 639 ms), $F(1, 15) = 4.26$, $p = .057$, $\eta_p^2 = .22$, but did for the passive-state stimuli (Ms = 617 vs. 649 ms), $F(1, 15) = 9.55$, $p = .007$, $\eta_p^2 = .39$.

A similar ANOVA of PC showed a main effect of correspondence and a three-way interaction, Fs(1, 62) = 32.90 and 6.46, ps < .015, $\eta_p^2 = .35$ and .09. Follow-up analyses showed that the pattern of results for PC was similar to that for RT: The correspondence effect for participants who attended to the strips tended to be larger for the active than for the passive state (2.2% vs. 1.2%), $F(1, 47) = 2.90$, $p = .095$, $\eta_p^2 = .06$, whereas the opposite relation tended to hold for participants who did not attend to the strips (1.3% vs. 3.2%), $F(1, 15) = 4.23$, $p = .058$, $\eta_p^2 = .22$. Thus, as predicted by the feature-asymmetry account, across Experiments 1 and 2 the larger object-based Simon effect for active than passive torches was evident only for participants who reported having attended to the strips.

EXPERIMENT 3

In Experiment 2, 25% of the participants specified that they based their orientation judgements on the location of the switch, and indeed those participants (and those who indicated relying on the switch or handle in Experiment 1) showed a large correspondence effect for the passive-state stimuli, whereas those who reported relying on the strips did not. Therefore, in Experiment 3 the switch was removed, leaving only the strips as a basis for the orientation judgements (see Figure 1C). By forcing participants to rely on the strips, the result pattern for all participants should now show no significant correspondence effect for the passive-state torches containing the six strips (bottom two rows of Figure 1C).

Rather than including a condition with active-state stimuli in this experiment, we added a passive-state condition in which the torches had only three strips, those nearest the head of the torch (see Figure 1C, top two rows). Assuming that no correspondence effect would be obtained for the passive-state stimuli with six strips, then the three-strip torches would be expected to yield a correspondence effect favouring the head of the torch, a finding that would be difficult to explain in terms of a grasping affordance since it would be to the side opposite the barrel.

Method

Thirty-two new undergraduate students (20 males) from the same pool participated in this experiment. The apparatus and procedure were the same as those for Experiment 2, except for the stimuli (see Figure 1C). The six-strip torch, used for half of the trial blocks, was the same as that for the passive condition in Experiment 2, except that the switch and the thin line running from it to the first strip on the switch side were removed. The three-strip torch, which was used for the remaining trial blocks, included only the three strips nearest the head of the torch (see Figure 1C). In the follow-up questionnaire, after indicating the part of the torches on which they based their orientation judgements, the participants were asked how they would grasp each of the two types of torches used in this experiment.

Results and discussion

All participants indicated at the end of the experiment that they based their orientation judgements on the strips. The unanimity in this experiment was expected because, with the switch removed, the strips are the only remaining salient cue for upright versus inverted orientation. The participants also agreed that they would grasp the torches by the long body.

Using the same criteria as those in Experiments 1 and 2, 1.7% of trials were deleted. The resulting mean data are shown in Table 1. For RT, there was a significant main effect of correspondence,

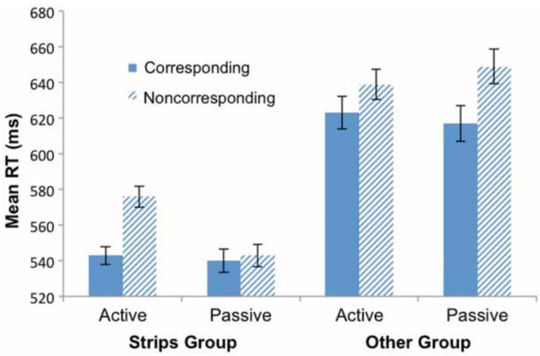

Figure 2. *Experiments 1 and 2 combined: Mean reaction time (RT) in milliseconds for the group that based their judgements on the strips (left half) and the group that did not (right half), as a function of correspondence and functional state (active vs. passive). Error bars represent ±1 standard error of the mean, computed using the method for within-subjects designs (Cousineau, 2005). To view a colour version of this figure, please see the online issue of the Journal.*

$F(1, 31) = 8.65$, $p = .006$, $\eta_p^2 = .22$, but no main effect of number of strips, $F < 1$. The interaction between correspondence and number of strips was significant, though, $F(1, 31) = 12.06$, $p = .002$, $\eta_p^2 = .28$. Simple effects ANOVAs indicated no significant correspondence effect (3 ms) for the six-strips stimuli, $F < 1.0$, but a –24-ms correspondence effect (i.e., a correspondence benefit for the head of the torch) for the three-strips stimuli, $F(1, 31) = 20.31$, $p < .001$, $\eta_p^2 = .40$.

For the PC measure, there was a significant effect of number of strips, $F(1, 31) = 5.09$, $p = .031$, $\eta_p^2 = .14$, with higher PC for the six-strips torch (98%) than for the three-strips torch (97%). The main effect of correspondence was not significant, $F(1, 31) = 1.66$, but the interaction between correspondence and number of strips was significant, $F(1, 31) = 6.33$, $p = .017$, $\eta_p^2 = .17$. In agreement with the RT data, the six-strips stimuli showed no significant correspondence effect, $F < 1.0$, whereas the three-strips stimuli showed a negative effect, $F(1, 31) = 5.04$, $p = .032$, $\eta_p^2 = .14$ (see Table 1). Thus, with the switch removed, the six-strips torch produced no correspondence effect in RT or PC, but the three-strips torch yielded a reversal of the correspondence effect to favour the torch head (the end toward which the strips were located). It is worth reiterating that the absence of correspondence effect for the six-strip passive-state stimuli in this experiment, for which the strips provided the only salient feature for judging orientation, is in agreement with the 3-ms nonsignificant effect for those participants in Experiments 1 and 2 who indicated that they relied on the strips for their judgements when handle and switch features were also present.

The effect of inclusion/exclusion of the switch can be evaluated by ANOVAs comparing the passive-state stimuli of Experiment 2, which had six strips plus the switch, to the passive-state stimuli with six strips of Experiment 3, which did not have the switch. These ANOVAs showed a main effect of correspondence on RT and PC, $Fs(1, 62) = 6.34$ and 17.06, $ps = .014$ and $< .001$, $\eta_p^2 = .09$ and .22, but no main effect of switch presence or absence, $Fs(1, 62) = 0.74$ and 2.91, $ps = .392$ and .093. More informative, the Switch × Correspondence interaction approached the .05 level for RT and exceeded it for PC, $Fs(1, 62) = 3.24$ and 9.28, $ps = .077$ and .003, $\eta_p^2 = .05$ and .13. This interaction pattern indicates that the correspondence effect was larger in Experiment 2 (with the switch present) than in Experiment 3 (with the switch removed), for which neither measure showed a significant effect. This result implies that the left–right location of the switch contributes to the correspondence effect. Indeed, when only the 75% of participants from Experiment 2 who indicated attending to the strips were compared to the six-strip condition of Experiment 3 (in which all participants said they attended to the strips), the F ratio for the interaction term became <1.0 for RT, although it remained significant for the PC data, $F(1, 54) = 4.8$, $p = .033$, $\eta_p^2 = .08$.

To summarize, the results of Experiment 3 are consistent with the view that a subset of participants in Experiment 2 based their orientation judgements on switch position, and they were responsible for the passive-state torches showing a correspondence effect. With the opportunity for using only the remaining six strips as an orientation cue, that effect was eliminated. When only the half of the strips towards the head of the torch (the light end) were included, this asymmetry yielded a correspondence effect for the head with the key-press responses. The absence of correspondence effect with six strips and the reversal to favour the torch head with the three steps provide strong counter to the grasping affordance account.

GENERAL DISCUSSION

Experiment 1 replicated Pellicano et al.'s (2010) Experiment 2 closely and obtained similar results. For participants making upright/inverted judgements of torches, an object-based Simon effect was evident for active-state stimuli but not for passive-state stimuli. Given that Pellicano et al.'s results proved to be replicable, our main concern was whether they are explained best by the grasping-affordance account favoured by Pellicano et al. or an alternative feature asymmetry account suggested by Cho and Proctor (2013). Cho and Proctor's argument was that participants may attend to the vertical position of strips on the torch to make the upright/inverted judgements and consequently also code the row of strips as left or right. Because this asymmetry is most apparent for the active-state torches, they are the ones that show a significant correspondence effect. Experiment 1 yielded initial evidence for this feature-asymmetry account, as 75% of participants indicated using the strips for their judgements.

A test of predictions from the two accounts was accomplished in Experiment 2 by removing the graspable handle from the torches. Rather than obtaining a correspondence effect no larger than that in Experiment 1, as the grasping-affordance account would seemingly predict, the effect became larger. This result is forecast by the feature-asymmetry account because removal of the handle creates a greater left–right asymmetry for the strips on the barrel, particularly when the torch is depicted in active state. Somewhat puzzling was that the enhanced correspondence effect in Experiment 2 was equally evident for passive- and active-state torches. However, the participants in Experiments 1 and 2 who indicated relying on the strips for the orientation judgements showed little or no correspondence effect for the passive-state torches. Although not reported earlier, the same held true when the RT data of only the subset of those participants from Experiment 2 were analysed (11 ms difference), $F(1, 23) = 2.86$, $p = .105$, $\eta_p^2 = .11$. Experiments 1 and 2 together revealed, though, that 25% of the participants apparently relied on the handle or switch for their judgements. For them, the correspondence effect was at least as large for the passive-state stimuli as for the active-state stimuli, which is to be expected since handle and switch occupied distinct left or right positions for both functional states of the torches.

Experiment 3 provided further evidence consistent with the feature-asymmetry account. Removal of the switch, making the barrel strips the only cue for the orientation judgements, resulted in elimination of the correspondence effect for passive-state torches when averaged across all participants. When the three strips farthest from the torch head were removed, a correspondence effect reappeared, but in this case favouring the end with the torch head rather than the barrel, by which one would typically grasp a torch without an explicit handle. This result seems particularly difficult to reconcile with a grasping affordance account, unless one wants to argue that the change to three strips introduces an affordance for grasping the head of the torch, counter to what the participants in Experiment 3 indicated they would grasp.

The combined results of the experiments provide the following picture. In Experiments 1 and 2, for which the stimuli contained the handle and switch (Experiment 1) and switch (Experiment 2), the majority of participants attended to the barrel strips on the torch. Those participants showed a correspondence effect for the end opposite the head mainly for active-state torches and little if any effect for the passive-state torches, because the strip asymmetry was evident mainly for the former. A minority of participants attended to the handle or switch in Experiment 1 and the switch in Experiment 2, showing a correspondence effect for both active- and passive-state torches since those features are left or right for both states. All participants had to attend to strip orientation when the switch was removed in Experiment 3, and for the passive-state torches that were used no correspondence effect was observed. When the torch contained only three strips, providing a salient feature toward the head, the correspondence effect shifted to that end of the torches.

Where does this leave the status of the notion that grasping affordances are activated when people make key-press responses to pictures of graspable objects? The initial idea of automatic activation implies that a correspondence effect should be evident for any task in which left and right grasping responses are differentially afforded. This result does occur if a graspable handle physically switches left and right locations from trial to trial, but evidence indicates that such correspondence effects are due entirely to spatial coding rather than to grasping affordance (Cho & Proctor, 2010, 2011). Studies such as those of Tipper et al. (2006) and Pellicano et al. (2010) showed that, with centred stimuli for which the handle does not appear in distinct left and right locations, colour judgements do not exhibit any sign of a grasping affordance affecting performance, arguing against automatic activation of grasping affordances. Those authors obtained correspondence effects with shape and orientation judgements, respectively, which they interpreted as meaning that grasping affordances are activated only when a task requires attention to action-related properties. Although the features to which participants attend are an important factor, the present study and that of Cho and Proctor (2013) provide evidence that it is spatial properties of visual features that are crucial to the correspondence effects and not grasping. Finally, it has been suggested that priming participants with a video clip of people operating the device may be necessary to activate grasping affordances (Bub & Masson, 2010; Tipper et al., 2006), but such priming does not reliably yield correspondence effects (Cho & Proctor, 2013; Gray, Jardin, Lien, & Proctor, 2013). In short, 15 years after Tucker and Ellis's (1998) study, there is no credible evidence that grasping affordances influence performance when people make left and right key-presses to classify pictures of objects displayed on a screen.

The last statement should make it clear that our conclusions are restricted to situations in which one would expect factors unrelated to grasping to predominate. The stimuli are not real objects, and the responses have no bearing to grasping but to relative location. It is hardly surprising, then, that coding of the locations of stimuli and elements of them would be much more influential than properties related to grasping. A general message of this research is that caution should be exercised when trying to justify ecological concepts in nonecological settings.

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