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ORIGINAL ARTICLE

Getting a tool gives wings: overestimation of tool-related benefits in a motor imagery task and a decision task

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Abstract Two experiments examine whether people overestimate the benefits provided by tool use in motor tasks. Participants had to move different quantities of objects by hand (two at a time) or with a tool (four at a time). The tool was not within reach so participants had to get it before moving the objects. In Experiment 1, the task was performed in a real and an imagined situation. In Experiment 2, participants had to decide for each quantity, whether they preferred moving the objects by hand or with the tool. Our findings indicated that people perceive tool actions as less costly in terms of movement time than they actually are (Experiment 1) and decide to use a tool even when it objectively provides less time-based benefits than using the hands (Experiment 2). Taken together, the data suggest that people overestimate the benefits provided by tool use.

Introduction

Tools can be defined as objects amplifying the user's sensorimotor capabilities, allowing the user to reduce the various costs (e.g., effort, time) required to accomplish a task (Baber, 2003; Goldenberg & Iriki, 2007; Penn, Holyoak, & Povinelli, 2008; van Lawick-Goodall, 1970). Humans are unique not because they use tools, but rather because they use tools frequently (Gibson, 1991; Johnson-Frey 2007; Osiurak, Jarry, & Le Gall, 2010, 2011). So, one unexplored explanation of this specificity might be the propensity to overestimate the benefits provided by the tools. The aim of this paper is to examine this hypothesis in a motor imagery task and in a decision task.

A series of recent studies have shown that visual perception is affected by intended actions, including tool use (Proffitt, 2006; Witt, 2011a). For instance, Witt, Proffitt, and Epstein (2005) asked participants to estimate the distance to targets located beyond their arm's reach. After this estimation, participants had to reach the targets with the hand (No-Tool condition) or with a baton so that the targets were within reach (Tool condition). Participants perceived the targets as closer in the Tool condition than in the No-Tool condition suggesting that perception is influenced by the anticipated benefits provided by tool use (see also Osiurak, Morgado, & Palluel-Germain, 2012; Witt, 2011b; Witt & Proffitt, 2008).

However, in these studies, participants were systematically placed in situations in which the use of a tool provided clear and real benefits, as compared to the use of the hand. The tool was either in the participant's hand or within reach so that the cost to get it was minimal if not nonexistent. However, in everyday life, the decision of using a tool is guided not only by the benefits that it provides, but also by the costs associated with the need to get it (e.g., time/effort). And getting a tool and using it is sometimes more costly than doing the action without it. Imagine you come back from shopping with a friend and you have to move your purchases from the car. Have you never discussed with this friend about the necessity of getting a bag in your home? While sometimes getting it is objectively more costly than moving the purchases by hand, it is frequent that you or your friend affirms that the use of this tool is the more practical option.

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The present study aims to examine whether people tend to overestimate the benefits provided by the tools in a motor imagery task (Experiment 1) and in a decision task (Experiment 2). To test this idea, participants had to move toilet tissue rolls from a distributor to a container. Participants could move the rolls either by hand (two at a time) or with a tool, namely, a plastic tub (four at a time). This tub was not placed near the rolls so participants had to get it before moving the rolls. We manipulated the quantity of rolls and the distances between the distributor, the container and the plastic tub. In some cases, the distance was shorter in the Hand condition whereas in others it was shorter in the Tool condition. In Experiment 1, we collected the time to carry out the task in a Real and in an Imagined situation to examine the anticipated time in the Hand and Tool conditions (Motor imagery task). In Experiment 2, participants had to decide whether they prefer moving the rolls by hand or with the tub (Decision task). We used these two types of paradigms to examine whether people tend to perceive the benefits provided by a tool greater than they are (Motor imagery task) and whether this leads them to decide to use a tool before even if it provides less benefits than performing the action by hand (Decision Task).

Experiment 1

It has been shown that the time required to perform an imagined action varies in function of the anticipated effort (Decety, Jeannerod, & Prablanc, 1989; Flusberg & Boroditsky, 2011; Kunz, Creem-Regehr, & Thompson, 2009; Macramalla & Bridgeman, 2009). Concerning tool use, Macuga, Papailiou, and Frey (2012) recently observed that motor imagery was influenced by the tool-related constraints. In Experiment 1, different distances had to be covered in the Hand and the Tool condition. Therefore, we used the difference between the real and the imagined movement speed (hereafter referred as imagery-related speed gain) to estimate the perception of the costs and benefits of tool use. If human tool use lies in the propensity to overestimate the time-based benefits provided by the tools, then the imagery-related speed gain should be greater in the Tool condition than in the Hand condition.

Method

Participants

Twenty healthy participants took part in the study (14 women, $M_{age} = 21.67$, $SD_{age} = 2.65$). All participants were right-handed (mean Edinburgh score: 94.17, $SD = 11.01$) and had normal or corrected-to-normal visual acuity. Informed consent was obtained from the participants. The study was conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki.

Materials and stimuli

A schematic representation of the apparatus is presented in Fig. 1. There were three rectangular tables on which were placed three keyboards linked to a same computer (Superlab Version 4.0, Cedrus Corp.). On the Table A was placed a toilet-tissue-roll distributor, which distributed the rolls four at a time. It could contain up to 24 rolls (i.e., a column of six rows of four rolls). On the Table B was placed a container (height: 25 cm; width: 100 cm; depth: 100 cm). On the Table C, there was a plastic tub that was wide enough to contain 4 rolls (height: 15 cm; width: 50 cm; depth: 30 cm) and that was light enough (250 g) to be easily handled and carried. There were six quantities of rolls: 4, 8, 12, 16, 20, and 24. To control the distances, dotted lines were drawn on the floor in front of each table. On the basis of these lines, the distances AB and AC were 2 and 3.5 m, respectively.

Procedure

Participants had to move rolls from the distributor to the container as if they came back from the supermarket and put away their purchases. Before each trial, participants could see the quantity of rolls contained in the distributor. In the Hand condition, rolls had to be moved two at a time, one in each hand. Participants started at the Position A, moved the rolls to the Position B, and had to come back to the Position A at the end of each trial. In the Tool condition, the rolls could be moved four at a time by slipping the rolls in the tub and then pouring the rolls into the container. In this condition, participants started at the Position A, got the tub at the Position C, came back at the Position A, then moved the rolls to the Position B, came back to the Position A, brought back the tub at the Position C and, finally, came back to the Position A. Participants had to cross the lines marked on the floor for each position. The experimenter stood up behind the Table A.

In the Real situation, participants actually performed these actions and pressed the spacebar of the keyboard each time they arrived at one of the tables. This procedure allowed us to collect the real movement time for each distance. In the Imagined situation, participants stayed at the Position A and pressed the spacebar of the keyboard each time they imagined arriving at a new position,

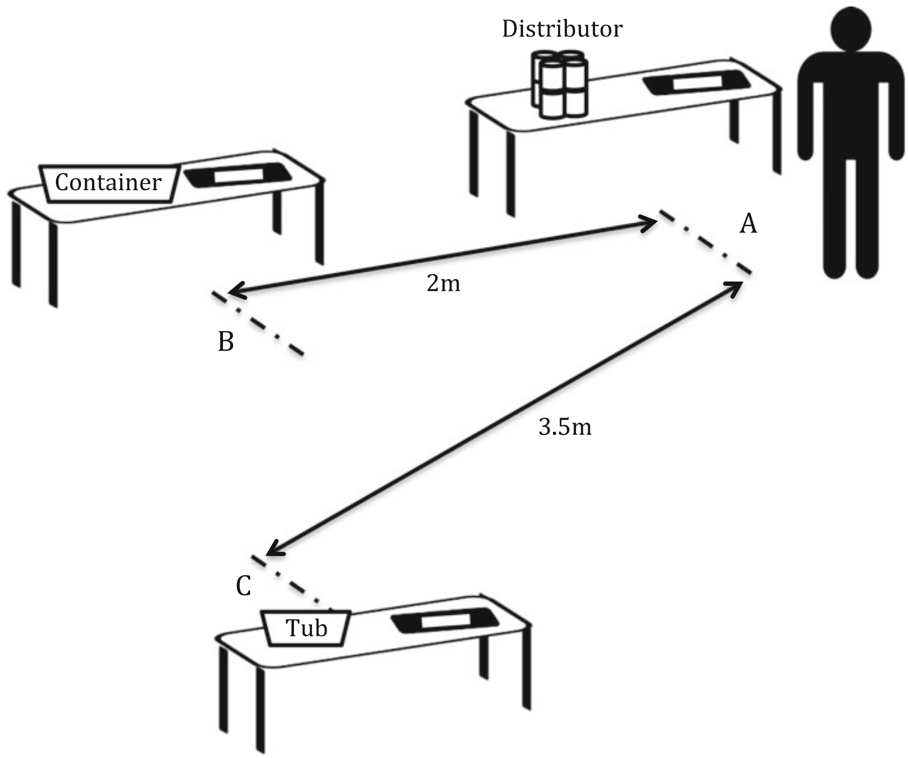

Fig. 1 Schematic representation of the apparatus used in the present study

allowing to collect the imagined movement time. In other words, participants had to imagine all the actions performed in the Real situation, including the pressing of the spacebar. In this Imagined situation, the experimenter followed the progression of the participant on a monitor linked to the computer and removed progressively the rolls from the distributor to help participants to know how many rolls remained to be moved. The situations (Real vs. Imagined) and the conditions (Hand vs. Tool) were counterbalanced between participants, leading to the four following orders: (1), Hand/Real, Tool/Real, Hand/Imagined, and Tool/imagined; (2), Tool/Real, Hand/Real, Tool/Imagined, and Hand/Imagined; (3), Hand/Imagined, Tool/Imagined, Hand/Real, Tool/Real; (4), Tool/Imagined, Hand/Imagined, Tool/Real, and Hand/Real. The quantity of rolls was presented in a quasi-random order, which was different for each participant. Participants performed four training trials before each situation. They completed one trial for each of the six quantities of rolls, each condition and each situation for a total of 24 trials. Each quantity was tested just once to keep the duration of the experiment to a reasonable time (about 45 min including the preparation of the materials by the experimenter between each trial). Distances AB and AC were chosen so that the Hand condition was supposed to take less time than the Tool condition for the three smallest quantities and vice versa for the three greatest quantities (Table 1).

Results

Data were entered in a four-way ANOVA with Condition (Hand vs. Tool), Quantity of Rolls (4 vs. 8 vs. 12 vs. 16 vs. 20 vs. 24), Situation (Real vs. Imagined) as within-subject factors, Order (Real-then-Imagined vs. Imagined-then-Real) as between-group factor, and the movement time as dependent variable. Results are presented in Fig. 2. The analysis revealed a significant main effect of Quantity of Rolls, $F(5, 90) = 458.69$, $p < .001$, $\eta^2 = .96$, as time increased with the quantity. The main effects of Situation, $F(1, 18) = 16.99$, $p < .001$, $\eta^2 = .49$, and Condition, $F(1, 18) = 26.18$, $p < .001$, $\eta^2 = .59$, were also significant. Participants spent less time in the Imagined situation (M = 31.6 s) than in the Real situation (M = 42.1 s) as well as in the Tool condition (M = 35.4 s) compared to the Hand condition (M = 38.3 s). No main effect was found for Order as well as no interaction between this factor and the other variables ($F < 1$). Interestingly, the Condition × Situation × Quantity of Rolls interaction was significant, $F(5, 90) = 2.44$, $p = .036$, $\eta^2 = .12$.

The interaction was decomposed by comparing, for each situation and quantity, the time in the Hand versus Tool condition. For the Real situation, the Hand condition took less time than the Tool condition for the quantities 4 and 8, both $t(19) > 7.24$, both $p < .001$, and more time for the quantities 16, 20 and 24, all $t(19) > 6.23$, all $p < .001$. No difference was found for the quantity 12, $t(19) = .30$,

Table 1 Distance in function of the quantity of rolls and the condition (Hand vs. Tool)

Quantity of rolls	Hand condition (two at a time)			Tool condition (four at a time)		
	Number of distances AB (2 m)	Number of distances AC (3.5 m)	Total distance	Number of distances AB (2 m)	Number of distances AC (3.5 m)	Total distance
4	4	0	**8**	2	4	18
8	8	0	**16**	4	4	22
12	12	0	**24**	6	4	26
16	16	0	32	8	4	**30**
20	20	0	40	10	4	**34**
24	24	0	48	12	4	**38**

Values in bold indicate that the given condition is the most beneficial of both on the basis of the distance

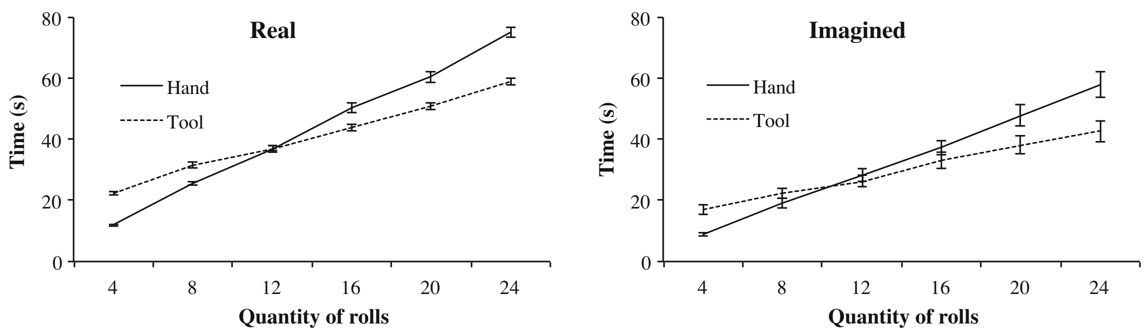

Fig. 2 Time (in s) in function of the situation (Real vs. Imagined), condition (Hand vs. Tool), and quantity of rolls (Experiment 1). *Error bars* indicate standard errors to the means

$p = .77$.[1] Note that this result is inconsistent with the predictions we made on the basis of distances only (Table 1), thus, justifying the use of a speed-based measure (see below). For the Imagined situation, the Hand condition took less time than the Tool condition for the quantities 4 and 8, both $t(19) > 2.56$, both $p < .02$, and more time for the quantities 12, 16, 20 and 24, all $t(19) > 2.13$, all $p < .05$. The important result here is that in the Imagined situation and for quantity 12 the movement time was shorter in the Tool condition than in the Hand condition, while in the Real situation this difference was not observed.

For each participant and quantity of rolls, we computed the movement speed in dividing the distance by the movement time. Then, we subtracted the real from the imagined movement speed. The result was an imagery-related speed gain that was submitted to a two-way ANOVA with Condition (Hand vs. Tool) and Quantity of rolls (4 vs. 8 vs. 12 vs. 16 vs. 20 vs. 24) as within-subject factors. Results are shown in Fig. 3a. The analysis revealed only a significant main effect of Condition, $F(1, 19) = 6.93$, $p < .02$, $\eta^2 = .27$, suggesting that the imagery-related speed gain was greater for the Tool condition. To examine whether this effect concerned either the distances AB or the distances AC, or both, we conducted a second two-way ANOVA with Condition (Hand vs. Tool/Distances AB vs. Tool/Distances AC) and Quantity of rolls (4 vs. 8 vs. 12 vs. 16 vs. 20 vs. 24) as within-subject factors. Results are displayed in Fig. 3b. We found a significant main effect of Condition, $F(1, 19) = 11.57$, $p < .001$, $\eta^2 = .38$. More particularly, the imagery-related speed gain was greater for the Tool/Distances AC condition than for the Hand condition and the Tool/Distances AB condition, both $t(19) > 3.12$, both $p < .01$. No difference was obtained between the two latter, $t(19) = .65$, $p = .53$.

[1] The difference between the Hand condition and the Tool condition in the Real situation is particularly important for Experiment 2, so we report here the differences (in s) between the Hand condition minus the Tool condition in the Real situation. Note that a positive difference reflects a gain in favor of the Hand condition, and a negative difference a gain in favor of the Tool condition: Quantity 4 (M = 10, SD = 1.39, range: 8:17), Quantity 8 (M = 6, SD = 3.52, range: 4:13), Quantity 12 (M = 0, SD = 3.38, range: −8:5), Quantity 16 (M = −6, SD = 4.44, range: −18:−1), Quantity 20 (M = −10, SD = 5.05, range: −19:−5), and Quantity 24 (M = −16; SD = 6.35, range: −29:−11). Importantly, these descriptive results indicate that the gain in favor of the Hand condition was present for all the participants for the quantities 4 and 8.

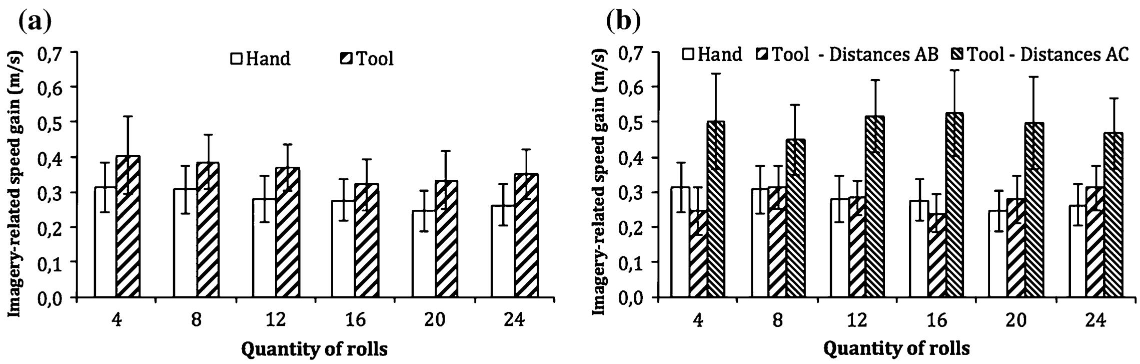

Fig. 3 Imagery-related speed gain in function of the condition and the quantity of rolls (Experiment 1). For the *left panel* (**a**), conditions are Hand versus Tool. For the *right panel* (**b**), conditions are Hand versus Tool/Distances AB versus Tool/Distances AC. *Error bars* indicate standard errors to the means

Discussion

The major finding of Experiment 1 is that even when tool actions were more costly than non-tool actions, participants perceived tool actions as more beneficial. More particularly, our results showed a greater imagery-related speed gain in the Tool condition than in the Hand condition. To a lesser extent, this is also supported by what we observed for quantity 12, for which participants imagined spending less time in the Tool condition than in the Hand condition, whereas in the Real situation the two conditions did not differ significantly. Another interesting finding is that the overestimation mainly referred to the action of getting the tool. In the present study, using the tub provided a benefit (moving objects in greater quantity) but also involved a cost (getting the tub). If both actions were imagined as less costly than they really were, then we should have observed an increase of the imagery-related speed gain for both distances AB and AC. As we only found an increase for the distances AC, this result indicates that participants did not overestimate the benefits provided by the tool but rather underestimated its related costs.

Two methodological issues may be responsible for the increase of imagery-related speed gain for distances AC only, limiting the strength of our interpretation. First, in the Tool condition, returning the tub via B–C–A could seem to be the obvious route rather than walking from B, back to A, then to C, and finally back to A. For the Imagined situation, participants may have imagined taken shortcuts, thereby compressing the task-irrelevant AC distance. If so, then differences in terms of imagery-related speed gain should be found between the path A–C–A when getting the tub at the beginning of the trial and between the path A–C–A when returning the tub at the end of the trial. Additional analyses were conducted to examine this issue and did not reveal such differences, ruling out this first possibility.[2] Note that these results also show that the increase of imagery-related speed gain did not only occur to get a tool but also to return it. Second, as shown in Fig. 3, participants imagined being two times faster for distances AC (3.5 m) than distances AB (2 m). This result may be explained by a non-linear relationship between real and imagined walking times (e.g., an exponential relationship). This possibility can nevertheless be ruled out because it has been shown that the relationship between real and imagined movement times is linear (e.g., Decety et al., 1989). In sum, neither of these two possibilities can account for the increase of imagery-related speed gain observed for distances AC.

Experiment 2

In Experiment 1, participants imagined the action to be performed with or without the tool. However, this experiment did not assess whether they explicitly preferred to use the tool. Our findings suggest that in a choice-paradigm like those proposed by Rosenbaum and Gaydos (2008; see also Rosenbaum, Brach, & Semenov, 2011) people might prefer using the tub even if this choice is not necessarily more beneficial than using the hands. Experiment 2 was specifically designed to explore this possibility. As shown in Fig. 2 (see also Footnote 1), the use of the tub took less time for the quantity of rolls 16, 20 and 24. Conversely, moving the rolls by hand took less time for the quantity 4 and 8. The two conditions were approximately similar in terms of time for the quantity 12. On the basis of the results of Experiment 1, we expected that participants of Experiment 2 would prefer the Tool condition for the quantity 12

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[2] Imagery-related speed gain was submitted to an ANOVA with Path (A–C–A to get the tub vs. A–C–A to return the tub) and Quantity of rolls (4 vs. 8 vs. 12 vs. 16 vs. 20 vs. 24) as within-subject factors. The analysis revealed no significant main effects and no interaction between the factors (Fs < 1).

and even perhaps for smaller quantities, indicating a bias for the use of the tub.

Method

Participants

Twenty undergraduate students participated in the study (13 women, $M_{age} = 20.55$, $SD_{age} = 2.85$). None of them took part in Experiment 1. All participants were right-handed (mean Edinburgh score: 87.16, SD = 23.46) and had normal or corrected-to-normal visual acuity. Participants gave their informed consent. The study was conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki.

Materials and stimuli

The apparatus was similar to that of Experiment 1 except that we introduced a decision task. This task was computer based, using Superlab (Version 4.0, Cedrus Corp.). For this task, participants were seated at a table in front of a monitor and a keyboard (monitor size: 32 × 50 cm; distance participant-monitor: 75 cm; distance participant-keyboard: 30 cm). This table was located near the Table A and faced to the three tables used for the roll-moving task (see above, Experiment 1). Participants were presented with photographs of rolls (quantity: 4 vs. 8 vs. 12 vs. 16 vs. 20 vs. 24) placed in the distributor. As in Experiment 1, the rolls were presented in columns, and each row contained four rolls (e.g., for the quantity 8, there were two rows of four rolls). Participants could choose whether they preferred moving the rolls by hand or with the tub by pressing the right key ("m") with the right index finger or the left key ("q") with the left index finger.

Procedure

First, participants were informed that they would have to move rolls from the distributor to the container as if they came back from the supermarket and put away their purchases. After explaining the procedure for each condition (see above, Experiment 1), the experimenter asked participants to actually perform four training trials, two in the Hand condition (quantities 8 and 16) and two in the Tool condition (quantities 8 and 16). The quantities 8 and 16 were chosen because they corresponded with the two quantities around the critical quantity 12 for which no clear benefit was observed in Experiment 1 between the two conditions in the Real situation. Then, participants were asked to sit down at a table in front of the monitor and the keyboard, and instructed that they would be presented with photographs of rolls of different quantities. Each photograph remained on the screen for 3,000 ms so they had to respond before the photograph disappeared from the screen. More particularly, participants were asked to respond as rapidly as they could. They had to press the right key or the left key if they preferred to move the rolls with the tub or by hand. The order of keys was balanced across participants. No information was provided concerning the quantities of rolls presented. The quantities of rolls (4 vs. 8 vs. 12 vs. 16 vs. 20 vs. 24) were displayed in a fully random manner. There were 20 photographs for each quantity, totaling 120 photographs. The decision and the response time were collected for each photograph. Importantly, participants were informed that after the decision task the computer would randomly draw 12 out of the photographs viewed so that they would have to move the corresponding quantities of rolls according to the choice made. This was done to ensure that participants took the task seriously and always tried to choose the best option for them. They were told that they were free to choose either condition on any photograph and that they should feel free to choose one condition more often than the other if they preferred it. No training trial was given in the decision task.

Finally, the experimenter informed participants that they would not have to move the rolls as explained before the task, and debriefed them. The experiment lasted only 15 min including the informed consent procedure and demographic data collection, the training trials and the decision task. All the participants believed that they would have to move the rolls subsequently, notably because they were initially recruited to perform a 30-min experiment. The duration of the task and the fact that they would have to do a certain amount of effort were specially emphasized during the recruitment phase.[3]

[3] Another possibility to collect the choices could have been, for each trial, to present the participants with a quantity of rolls, to ask them to choose the condition in which they would move the rolls and to actually move the rolls. However, as explained in Experiment 1, moving the rolls in the Real situation required a substantial amount of time. So this procedure would have taken too much time, preventing the collection of several trials for each quantity. Moreover, we did not decide to ask the participants to actually move the rolls after the decision task for each quantity and in each condition (Tool and Hand). This procedure could have been interesting to compare the choices made by the participants with the time taken to actually move the rolls. Nevertheless, we thought that the participants might have modified their way to move the rolls to be consistent with the choices made during the decision task. We posited that the time taken by the participants of Experiment 2 to actually move the rolls for each quantity and in each condition (Tool and Hand) should be similar to that of the participants of Experiment 1. This assumption is based on the results of Experiment 1 indicating that the time-based benefit between the two conditions was globally constant among the participants of Experiment 1 (see Footnote 1).

Results

The percentage of tool choices was submitted to a one-way ANOVA, with Quantity of rolls (4 vs. 8 vs. 12 vs. 16 vs. 20 vs. 24) as within-subject factor. The analysis revealed a significant effect, $F(5, 95) = 60.13$, $p < .001$, $\eta^2 = .76$. The percentage of tool choices was greater for the quantities 12, 16, 20 and 24 than for the quantities 4 and 8, all $t(19) > 4.24$, all $p < .001$ (Fig. 4a). This percentage was also higher for the quantity 8 than for the quantity 4, $t(19) = 5.03$, $p < .001$. No difference was found between the quantities 12, 16, 20 and 24, all $t(19) < 1.42$, all $p > .16$. For each quantity, we examined the preference for one condition over the other with a Wilcoxon signed-rank test. The analysis indicated that participants significantly preferred the Tool condition over the Hand condition for the quantities 12, 16, 20 and 24 (all $p < .001$) and the Hand condition over the Tool condition for the quantity 4 ($p < .005$). However, no preference was obtained for the quantity 8 ($p = .25$). For this last quantity, we tested whether the absence of preference resulted from a global trend or from the fact that some participants preferred the tub and others the hand. Ten participants showed a significant preference for the tub and 7 for the hand (Binomial test, $p < .05$). The three remaining participants did not exhibit any significant preference (Binomial test, $p > .05$).

We conducted a one-way ANOVA, with Quantity of rolls (4 vs. 8 vs. 12 vs. 16 vs. 20 vs. 24) as within-subject factor, and decision times as dependent variable. Decision times below or above two standard deviations from the mean for each quantity were removed. There was a significant main effect of Quantity of rolls, $F(5, 95) = 21.26$, $p < .001$, $\eta^2 = .53$ (Fig. 4b). More specifically, participants took more time to decide for the quantity 8 than for the other quantities, all $t(19) > 2.85$, all $p < .02$. Decision times were also longer for the quantities 4 and 12 than for the quantities 16, 20 and 24, all $t(19) > 4.12$, all $p < .001$. However, no difference was observed between the quantities 4 and 12, $t(19) = 0.34$, $p = .73$, nor between the quantities 16, 20 and 24, all $t(19) < 0.61$, all $p > .55$.

Discussion

The major finding of Experiment 2 was that participants preferred the tub over the hands even for quantities for which the hands were more beneficial in terms of time, as demonstrated in Experiment 1. The analysis of decision times corroborated this finding by indicating that decision times were longer for the quantities for which participants hesitated between using the tub or the hands. Interestingly, the decision time for the quantity 4 (preference for the hand) was longer than for the quantities 16, 20, and 24 (preference for the tub). This might suggest that participants were already attracted by the tub. Should this hypothesis be true, the same result should be obtained for the quantity 2 for which the use of the hand is even more likely. Future research is needed to explore this particular question.

An important aspect of Experiment 2 was that the participants had a relatively low experience of the roll-moving task because they only performed four training trials. Nevertheless, in everyday life we rarely perform non-tool actions and tool actions to carry out the same task to examine which one of these options is the more beneficial. In a way, these results indicated that with a somewhat limited experience, people seem to prefer using a tool even if the time-based benefit is objectively less than doing the action by hand.

It is also noteworthy that during the debriefing three participants reported to have a somewhat similar experience in the professional domain. One of them was a part-time sales assistant in a shoe shop and said that she had frequently to choose between moving shoe boxes by hand or with a trolley. The experience has progressively led her to do so by hand because of the numerous manipulations needed to use the trolley. On the basis of this experience

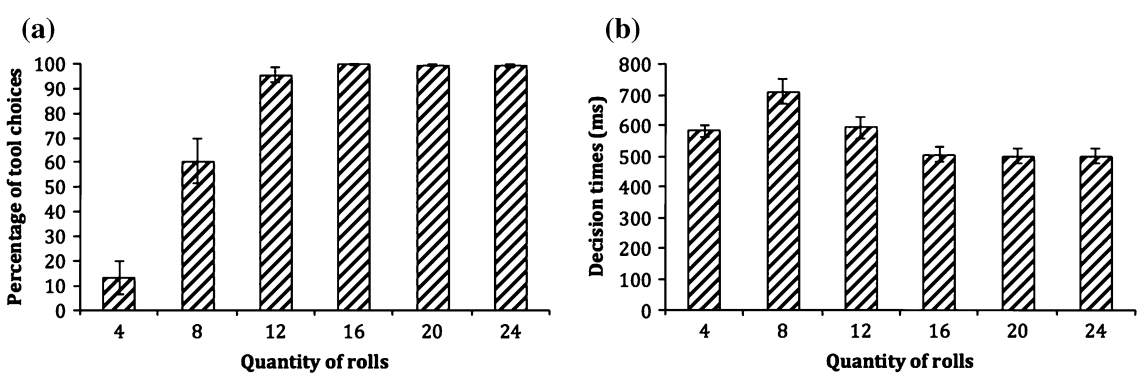

Fig. 4 Percentage of tool choices (**a**) and decision times (**b**) in function of the quantity of rolls (Experiment 2). *Error bars* indicate standard errors to the means

she said that she thought that the tub was certainly more beneficial from the quantity 4 but she adjusted her responses to choose the tub only from the quantity 8. This kind of comments is informative, showing that the bias toward the use of a tool is very pronounced and difficult to correct even when somewhat similar situations have been experienced. Future research might be useful to specify the role of experience in decision tasks as that used in Experiment 2.

General discussion

Taken together, the findings indicated that (1) people might perceive tool actions as less costly in terms of time than they actually are (Experiment 1) and (2) this might lead people to decide to use a tool even when it objectively provides less time-based benefits than using the hands (Experiment 2). Several interpretations can be made from these findings.

First, results of Experiment 1 showed that people imagine spending less time in the Tool condition than in the Hand condition as compared to the Real situation. One possible interpretation is that using a tool leads people to imagine gaining time, explaining why participants of Experiment 2 chose the tool, prematurely. However, this time-related bias might be nothing more than the resultant of a process involving other factors. In other words, the question is whether the participants imagined spending less time in the Tool condition because they were subjected to a time-related bias per se or to other types of biases, leading secondarily to imagine spending less time.

A second related interpretation is that the overestimation of the time-based benefits provided by the tools results from an effort-related bias. This hypothesis is consistent with the action-specific account of perception, which assumes that the function of perception is not to construct an objective representation of the physical world, but rather to allow people to anticipate the efforts they have to exert on the environment to satisfy a current goal (Proffitt, 2006; Witt, 2011a). As explained above, tool use can affect perceived distance (e.g., Witt et al., 2005), thereby suggesting that perception might be influenced by the benefits in terms of effort provided by tool use. Consequently, our results might be explained by an effort-related bias, namely, the benefits provided by the tub (moving the rolls four at a time instead of two at a time) led participants to imagine carrying out tool actions with less effort to a similar extent as people perceive distances as closer, when using a tool (e.g., Witt et al., 2005).

A third interpretation can be offered in the light of an interesting result reported in Experiment 1: The overestimation mainly referred to the action of getting the tool. This suggests that human tool use might lie not in the propensity to overestimate the benefits of the use per se, but rather to underestimate the costs associated with the need to get tools. Participants seem to focus on the benefits provided by the tools and tend to ignore the associated costs.

Anecdotally, two categories of attitudes can be observed when a table has to be cleaned. Some people claim themselves as "practical" and rush to the kitchen to get a tray, considering that this option requires less effort. Others prefer to clean the table by hand, thus being viewed by practical individuals as non-practical people. In line with our findings, and more particularly with the inter-individual differences observed for the quantity 8 (Tool choices of Experiment 2), the practical people actually might strongly overestimate the benefits provided by the tools (e.g., the tray) as compared to non-practical people. This practical attitude, which appears generally highly valued, might result from a bias in the perception of time or effort associated with tools. In conclusion, even if the present study is far from resolving the issue of the specificity of human tool use, it highlights directions for future research on a topic that has received very little attention.

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