# Investing in Commitment: Persistence in a Joint Action is Enhanced by the Perception of a Partner's Effort

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**Abstract**: Can the perception that one's partner is investing effort generate a sense of commitment to a joint action? To test this, we developed a 2-player version of the classic snake game which became increasingly boring over the course of each round. This enabled us to operationalize commitment in terms of how long participants persisted before pressing a 'finish' button to conclude each round. Our results from three experiments reveal that participants persisted longer when they perceived what they believed to be cues of their partner's effortful contribution (*Experiment 1*). Crucially, this effect was not observed when they knew their partner to be an algorithm (*Experiment 2*), nor when it was their own effort that had been invested (*Experiment 3*). These results support the hypothesis that the perception of a partner's effort elicits a sense of commitment, leading to increased persistence in the face of a temptation to disengage.

*Keywords*: commitment, joint action, cooperation, effort, grit, sunk costs

From assembling furniture to painting houses and playing games, joint action is a pervasive and important feature of human sociality. Joint action can be defined as 'any form of social interaction whereby two or more individuals coordinate their actions in space and time to bring about a change in the environment' (Sebanz et al., 2006: 70; Butterfill, 2012). While many other species also participate in forms of joint action, such as birds flocking (Pulliam, 1973), fish schooling (Katz et al., 2011) and chimpanzees hunting (Boesch, 2002), it has been argued that humans are uniquely able and motivated to coordinate their actions, and do so more flexibly and in a wider variety of contexts than other species (e.g. Melis & Semmann, 2010; Konvalinka et al., 2010; Tomasello, 2009; Silk, 2009). This enables us to achieve outcomes we could not otherwise achieve, and to do so more efficiently than we otherwise could (Melis, 2013; Tomasello, 2009).

However, our predilection for joint action also presents us with the challenge of determining when and to what extent we should persist in contributing to joint actions when we may individually be tempted to stop. While it may be superfluous to persist longer than one wants to in joint actions that are unimportant to one's partner or indeed that one's partner may herself abandon, it could be damaging to one's reputation and to one's relationships to disappoint the expectations of a partner to whom the continuation of a joint action is highly valuable (Heintz et al., 2015). But how does one distinguish the former sort of case from the latter sort? Following Michael, Sebanz and Knoblich (2015; 2016), we hypothesized that the motivation to remain engaged in joint actions and to resist tempting alternative options and distractions is governed by an implicit sense of commitment which is modulated by the amount of effort that one's partner has invested in the joint action. Imagine, for example, that you have agreed to attend a cocktail party at your colleague's apartment but, on the occasion, find yourself tired or otherwise tempted to leave after only a short time. If your colleague has obviously invested a great deal of effort in preparing the hors d'oeuvres and decorations, you might find that a sense of commitment leads you to stick around for a few hours after all.

If this is correct, then we should expect people's persistence in a joint action to be modulated by the amount of effort which they perceive their partner(s) to have invested. In order to test this hypothesis, we developed a 2-player version of the classic 'snake game' in which the participant controls the left-right axis while their partner (an algorithm) controls the up-down axis. In Experiment 1, participants were led to believe that their partner was a person whom they had met in the waiting area, and that, before each round of the snake game, the partner had to perform a cognitive task in order to 'unlock' the round. The cognitive task consisted in deciphering a captcha, which could be either difficult (High Effort condition) or

easy (Low Effort condition). Then, the participant and the partner retrieved as many apples as possible by jointly controlling the snake. Since the apples appeared at an ever-slowing rate, each round became progressively boring, generating an incentive to disengage. Participants were instructed to press a 'finish' button whenever they determined that it was time to move on to the next round. This enabled us to operationalize commitment in terms of how long participants persisted in each round. We predicted that participants would feel more committed to the joint action in the High Effort condition than in the Low Effort condition, and that they would therefore persist longer before pressing the 'finish' button in the High Effort condition than in the Low Effort condition.

Experiment 2 was identical to Experiment 1 except that participants were correctly informed that their partner was an algorithm. If any effect observed in Experiment 1 does indeed reflect the operation of an implicit sense of commitment that is engaged by the perception of others' efforts being invested in a joint action, then we should not expect participants to differentiate between the High Effort condition and the Low Effort condition when they do not believe that there is any agent investing effort at all.

Experiment 3 was designed to test an alternative explanation, namely that participants may persist longer in the High Effort condition due to sunk cost reasoning, i.e. they may persist longer in order to ensure that the effort invested by their partner 'pays off' (Staw, 1976; Arkes & Blumer, 1985). To this end, we instructed participants to perform the cognitive tasks themselves in order to unlock each round. We reasoned that if increased persistence in the High Effort condition is due to sunk cost reasoning, then we should observe the same pattern in Experiment 3.

## Experiment 1

*Participants*

Using G*Power 3.1 (Faul et al., 2009) we determined that a sample size of twenty-six would provide 80% statistical power for detecting a medium-sized effect equivalent to what we observed in a pilot study ($d$= .58), assuming a two-tailed t-test and an alpha level of .05. Our stopping rule was therefore as follows: we continued recruitment until twenty-six participants had completed the number of trials which we determined a priori to mark the minimum threshold (as explained below). In addition to these twenty-six participants who constitute our sample (19 females; age range: 18-29, $M$ = 23.04, $SD$ = 2.67), eight further participants did not meet the minimum threshold and were excluded prior to analysis. All participants were

recruited from student organizations in the Budapest area, were naïve to the purpose of the study, and reported normal or corrected to normal vision. All participants signed informed consent prior to the experiment, and received gift vouchers for their participation. The experiment was conducted in accordance with the Declaration of Helsinki and was approved by the (EPKEB) United Ethical Review Board for Research in Psychology.

*Apparatus and Stimuli*

The experiment was displayed on a 13-inch computer screen (resolution: 2560 x 1600 pixels, refresh rate: 60 Hz). The program for the experiment was written in Python (Peirce, 2007), with a framerate of 17 frames per second.

The algorithm for the partner, which controlled the up-down axis, was programmed to behave in a human-like manner: it follows the shortest path to the apple, but sometimes (randomly) makes mistakes, reacting too late or turning in the wrong direction.

*Procedure*

Participants were first introduced to a person in the waiting area (a confederate), whom they were told would be their partner for the experiment, and who would be playing in the adjacent room. They were informed that their task, together with their partner, would be to collect as many apples as possible over the course of 20 rounds by jointly maneuvering the snake, with the participant controlling the left-right axis, and the partner controlling the up-down axis.

In addition, they were informed that they and their partner had each been randomly assigned an additional task. Their partner would have the additional task of solving a captcha before each round in order to unlock the round. The captchas would sometimes be easy (Low Effort condition) and sometimes difficult (High Effort condition), as depicted in **Figure 1**. The participant would have the task of determining when it was time to conclude each round of the snake game, and move on to the next round, by pressing the spacebar. The easy captchas (Low Effort condition) consisted of 3 characters and were deciphered in 4 seconds, while the difficult captchas (High Effort condition) consisted of 12 characters and were deciphered in 16 seconds. The videos which participants viewed of captchas being deciphered can be found in the Supplementary Material (See **S1**). The captcha before the practice round was of intermediate length (8 characters), taking 12 seconds to decipher.


**Fig. 1.** Sample Captchas. In the instruction phase, participants were presented with examples of easy and difficult captchas.

In a within-subject design, the experiment consisted of 20 trials in total, 10 in the High Effort condition and 10 in the Low Effort condition (See **Figure 2**).

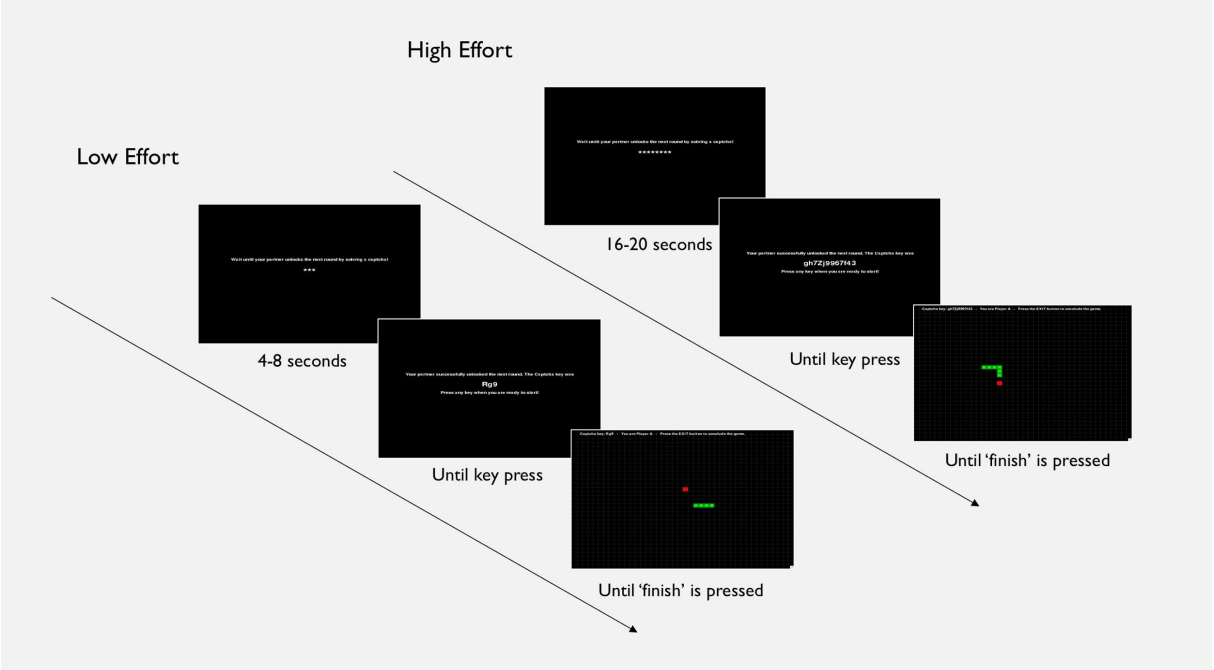


**Fig. 2.** Trial Structure. Each trial consisted of a captcha phase, followed by a round of the snake game. In the captcha phase, a video was presented in which stars progressively appeared to indicate that the partner was solving a captcha, and finally the completed captcha key was displayed (See **S1** in the Supplementary Material). This unlocked a round of the

snake game, which the participant initiated with a key press. Each round continued until the participant pressed the spacebar to 'finish' the round.

To make the joint action increasingly boring, apples were programmed to appear at an ever-slowing rate within each round. In the first 10 seconds, each new apple appeared immediately. After 10 seconds, new apples appeared with a delay of 40 frames; this delay was doubled every ten seconds.

The experiment was preceded by one practice trial. The captcha for the practice trial was of intermediate length between the captcha for the High and Low Effort conditions (8 characters), and took 12 seconds to decipher.

*Results*

For the analysis, we excluded the data from participants who did not complete at least 16 trials (8 in each condition) within the scheduled time slots. We also excluded the data from trials on which participants collected 0 apples (0.77% of the data). There was a high degree of variability in persistence times across trials, with participants persisting as long as 25 minutes on some trials. Since we had no a priori basis for setting any particular upper bound, we did not exclude any of these longer trials. Instead, we elected to use individual participants' median persistence times as the basis for our analyses. In order to test the data for normality and homogeneity of variance we conducted a Shapiro-Wilk test, which revealed a significant deviation from normality, $p$=0.004. We therefore performed a log10 transformation on the data to meet the assumption of normality. We then conducted a paired-samples t-test, which revealed significant difference between conditions, with participants persisting longer in the high effort condition ($M$=85.51, $SD$= 28.65; logtransformed $M$=1.910, $SD$=0.137) than in the low effort condition ($M$=78.29, $SD$= 25.34; logtransformed $M$=1.873, $SD$=0.137), $t(25)$=2.42, $p$=0.023, *Cohen's d*= 0.475 (See **Figure 3** and **Figure 4**).

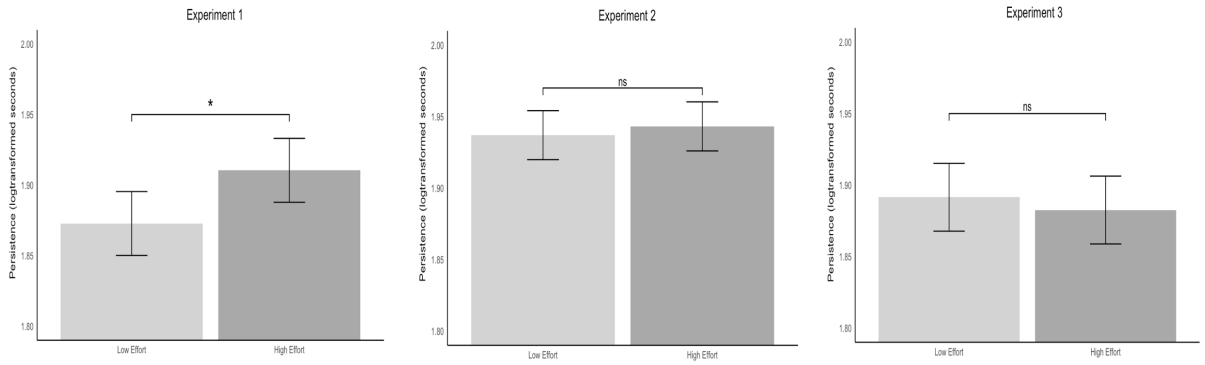


**Fig. 3.** Persistence for High and Low Effort conditions. Error bars represent the within-subject confidence intervals (following the method proposed by Cousineau, 2005; cf. Loftus & Masson, 1994). Symbols indicate significance level (*** p<0.001; ** p<0.01; * p<0.05; ns= non-significant).

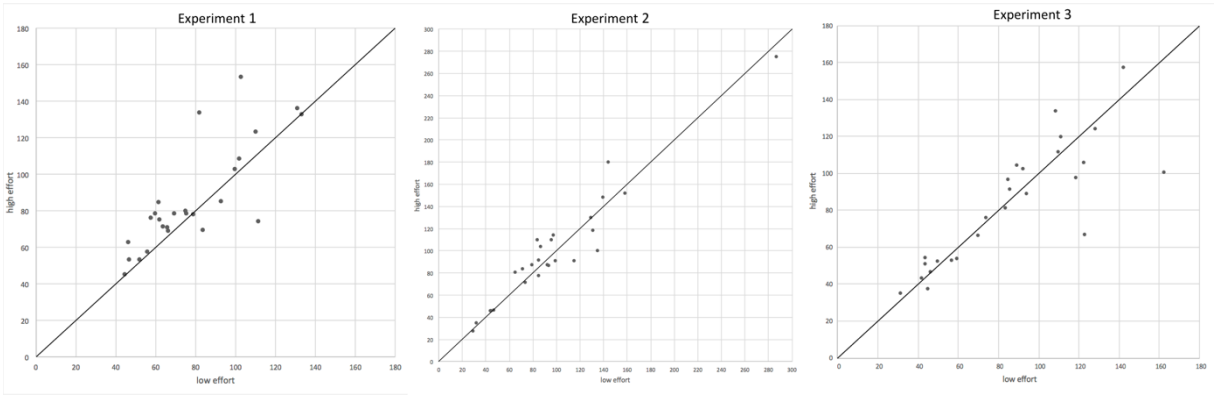


**Figure 4**: Individual Data. Each dark circle represents one participant's median persistence for each of the two conditions: the median persistence for the High Effort Condition lies on the Y axis, while the corresponding median persistence for the same participant in the Low Effort Condition lies on the X axis. The identity line indicates where each participant's dot would lie if her or his median persistence did not differ between conditions.

*Discussion*

The results corroborate the prediction that participants would persist longer on rounds of the snake game in the High Effort condition than on rounds in the Low Effort condition, despite the increasing boredom resulting from the decreasing rate at which apples appeared. However, these do not conclusively demonstrate that it was the perception of their partner's effort that led participants to persist longer. An alternative explanation is that participants might have persisted longer in the High Effort condition because they themselves had to wait

longer while their partner solved the captcha. If so, the effect may be a function of participants' own investment of time rather than their partner's investment of effort.

Experiment 2 was designed to test this alternative explanation. To this end, we correctly informed participants that the role of their partner in the snake game would be played by an algorithm, and otherwise repeated the same procedure as in Experiment 1. We reasoned that if the alternative explanation is correct, we should predict longer persistence in the High Effort condition even if participants do not believe that their partner is a real agent, and we should therefore observe the same pattern as in Experiment 1. In contrast, if the effect observed in Experiment 1 indeed reflects the operation of an implicit sense of commitment that is engaged by the perception of a partner's effortful contribution, we should not expect participants to differentiate between the High and Low Effort conditions when they do not believe that there is a real agent investing effort.

## Experiment 2

*Participants*

Our stopping rule was the same as in Experiment 1. In addition to the twenty-six participants who made up our sample (18 females; age range: 20-37, $M$ = 23.81, $SD$ = 3.73), six further participants were excluded prior to analysis because they did not finish the minimum number of trials. Participants were recruited from student organizations in the Budapest area, and received gift vouchers for their participation. All were naïve to the purpose of the study, reported normal or corrected to normal vision, and signed informed consent prior to the experiment. The experiment was conducted in accordance with the Declaration of Helsinki and was approved by the (EPKEB) United Ethical Review Board for Research in Psychology.

*Procedure*

We implemented the same procedure as in Experiment 1, with the exception that we correctly informed participants at the outset that their partner was an algorithm.

*Results*

For the analysis, we employed the same procedure as in Experiment 1. First, we excluded the data from participants who did not complete at least 16 rounds (8 in each condition) in the scheduled time slots. Next, we also excluded trials on which participants collected 0 apple

(0.77 % of the data). We then conducted a paired-samples t-test, which revealed no significant difference in persistence between the high effort condition (*M*=99.09, *SD*=50.85; logtransformed *M*=1.943, *SD*=0.220) and the low effort condition (*M*=98.09, *SD*=52.14; logtransformed *M*=1.937, *SD*=0.221), *t*(25)= 0.52, *p*=0.606, *Cohen's d*= 0.102 (See **Figure 3**).

*Discussion*

The absence of any difference between the High and Low Effort conditions in Experiment 2 is difficult to reconcile with the alternative explanation which Experiment 2 was designed to test, namely that participants persisted longer in the High Effort condition of Experiment 1 because they themselves had had to wait longer for their partner to solve the captcha.

Experiment 3 was designed to probe the possibility that participants' increased persistence in the High Effort condition of Experiment 1 may have been a product of sunk cost reasoning, whereby participants persist longer in order to ensure that the previously invested effort 'pays off' (Staw, 1976; Arkes & Blumer, 1985). To test this, participants in Experiment 3 were instructed to solve the captchas themselves to unlock each round of the snake game. If the sunk cost explanation is correct, then we should expect to observe the same pattern as in Experiment 1. In contrast, if participants' increased persistence in the High Effort condition of Experiment 1 was due to a sense of commitment to their partner, then we should not expect longer persistence in the High Effort condition than in the Low Effort condition of Experiment 3.

## Experiment 3

*Participants*

Our stopping rule was the same as in Experiments 1 and 2. In addition to the twenty-six participants who made up our sample (18 females; age range: 19-40, *M = 23.41*, *SD* = 3.93), nine further participants were excluded prior to analysis because they did not finish the minimum number of trials. For recruitment, we used the participant database at the University of Warwick (UK), where the experiment was conducted. All participants were naïve to the purpose of the study, reported normal or corrected to normal vision, and signed informed consent prior to the experiment. The experiment was conducted in accordance with the Declaration of Helsinki and was approved by the Humanities & Social Sciences Research

Ethics Sub-committee (HSSREC) at the University of Warwick. Each participant received £6 for participating.

*Apparatus and Stimuli*

The captchas which participants were instructed to solve before each round of the snake game are included in the Supplementary Material (See **S3**).

*Procedure*

We implemented the same procedure as in Experiment 1, with the exception that participants solved the captchas themselves before each round of the snake game.

*Results*

For the analysis, we employed the same procedure as in Experiments 1 and 2. First, we excluded the data from participants who did not complete at least 16 rounds (8 in each condition) in the scheduled time slots. Next, we also excluded trials on which participants collected 0 apple (0.19 % of the data). We then conducted a paired-samples t-test, which revealed no significant difference in persistence between the high effort condition ($M$=82.68, $SD$=32.62; logtransformed $M$=1.883, $SD$=0.182) and the low effort condition ($M$=85.32, $SD$=35.42; logtransformed $M$=1.891, $SD$=0.195), $t(25)$= 0.55, $p$=0.588, *Cohen's d*= 0.108 (See **Figure 3**).

*Discussion*

The absence of any difference between the High and Low Effort conditions in Experiment 3 is not consistent with the alternative explanation which Experiment 3 was designed to test, namely that participants' longer persistence in the High Effort condition of that experiment was due to sunk cost reasoning. This is because, if sunk cost reasoning had been driving the increased persistence in the High Effort condition of Experiment 1, then it should also do so when it is the participant herself who invests the effort. In contrast, the absence of any difference between conditions in Experiment 3 is consistent with the hypothesis of a sense of commitment that is elicited by the perception of a partner's effort.

## General Discussion

Our results reveal that participants' persisted longer at an increasingly boring joint action when they perceived what they believed to be cues of their partner's effortful contribution (*Experiment 1*). Crucially, this effect was not observed when they knew their partner to be a algorithm (*Experiment 2*), nor when it was their own effort that had been invested (*Experiment 3*). Taken together, these results support the hypothesis that the perception of a partner's effort can elicit an implicit sense of commitment to joint action, leading to increased persistence in the face of a temptation to disengage (Michael, Sebanz and Knoblich 2015; 2016). Such a mechanism may play an important role in managing one's relationships and one's reputation, because a partner' investment of effort indicates that the continuation of a joint action is likely to be valuable to her, and that she may therefore be disappointed if one disengaged (Heintz et al., 2015).

The findings reported here raise interesting new questions for further research. In particular, it would be important to investigate the role of coordination in mediating the effects of a partner's effort upon commitment to a joint action. Previous research has shown that coordination can enhance rapport (Bernieri, 1988; Hove & Risen, 2009) and trust (Launay et al., 2013; Mitkidis et al., 2015), and lead to cooperation in social dilemmas (Wiltermuth & Heath, 2009; Van Baaren et al., 2004) as well as pro-social helping behavior (Kokal et al., 2011; Valdesolo & Steno, 2011). It would therefore be reasonable to speculate that the effect of perceived effort observed in the present study may have been due in part to the context of coordination. To test this, one possibility would be to independently manipulate the perceived effort of a partner and the degree of coordination within the joint action. Further research is also needed in order to investigate what other cues of a partner's mental effort, and also what other forms of investment (e.g. physical effort, time and/or money), may elicit a sense of commitment.

## Author Contributions

Marcell Székely and John Michael developed the study concept and contributed to the study design. Programming and data collection were done by Marcell Székely. Marcell Székely performed the data analysis and interpretation under the supervision of John Michael. Marcell Székely and John Michael jointly prepared the manuscript, and both approved the final version for submission.

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