Snacking as distraction:
What kinds of tasks make us eat?

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February 4, 2015

Abstract

Everyone gets distracted at some point of the day, whether it's from external interruptions, such as a cellphone going off, or from internal- or self-interruptions, such as deciding to get a cup of tea. Because most research focuses on external interruptions, we still know relatively little about the causes behind self-interruptions, even though they make up 50% of interruptions in real life. With the current study, we investigated whether the difficulty of a task or the availability of cognitive resources influences the decision to self-interrupt. Two experiments were conducted, a visual task and a problem-solving task, with three difficulty levels for each task. Cognitive resources became either more or less available as the difficulty of each task changed. A bowl of M&M's on a digital scale served as the distractor. Results showed that there were different patterns of distraction in the two tasks. In the problem-solving task participants ate the most in the medium level, while there was no effect of difficulty in the visual task. These results are hard to interpret: the differences in effect of difficulty show that there does not seem to be a strong effect of cognitive resource availability.

Introduction

In everyday life people often get interrupted. These interruptions often starts with a distraction. For example, people get distracted by a phone that's ringing, people talking, a tv in the background and so on. People also interrupt themselves, for example by checking their email or getting a cup of tea. Research has shown that interruptions have a negative impact on tasks, such as longer completion time of an interrupted task (Eyrolle & Cellier, 2000; Monk, Boehm-Davis & Trafton 2004), higher amount of errors (Trafton, Altmann & Ratwani, 2011; Brumby, Cox, Back & Gould, 2013) and a lower quality of complex writing tasks (Foroughi, Werner, Nelson & Boehm-Davis, 2014). Therefore it is interesting and useful to learn more about interruptions so we can use this knowledge to improve work environments and work continuity.

The examples given above can be divided into two groups, external interruptions, that is switching tasks due to environmental cues, and internal interruptions or self-interruptions, that is deciding yourself to switch tasks before completion (e.g. Mark, Gonzales & Harris, 2005). Most research about interruptions focuses on external interruptions (e.g. Edwards & Gronlund, 1998; Hodgetts & Jones, 2006; Monk, Trafton & Boehm-Davis, 2008; Foroughi, et al., 2014). However Czerwinski, Horvitz & Wilhite (2004) found in a diary study, where the participants kept track of their activities on their job, that 40% of the task switches were a result of self-interruptions. Mark, et al. (2005) observed people who work at a information technology company in their cubicle or office, including following them to meetings and reading their email, documents etcetera. From these interruptions, 52% were self-initiated.

Because of these high percentages of self-interruption, it is important to better understand the concept. It seems that there are two hypothesized causes of self-interruptions, the Flow Theory and the Resource Theory. Adler & Benbunan-Fich (2013) conducted a research

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including Flow Theory. They found that when people failed to achieve a flow-state (a balance between difficulty of the task and the skills of a person), they initiated self-interruptions. Katidioti, Borst, van Vugt & Taatgen (submitted) investigated the Resource Theory as a cause of self-interruptions. They conducted a study using distractions, a non-functional form of self-interruption, alongside the main task. They studied the effects of the difficulty of a task and the type of task (visual vs problem-solving) on distractability. In this study they used a visual distractor, a video. When the problem-solving task got harder, participants had to think longer. Therefore the visual resources become more available, because they spend less attention to the visual aspect of the game. This means they got distracted more by the video when the task got harder. On the visual task however participants got less distracted when the task got harder. Their results indicate that cognitive resource availability could explain self-interruptions .

In this follow-up study we also focused on distractibility, but instead of choosing a distraction that uses the same cognitive resource as one of the tasks, we used a distractor that shares no cognitive resources with any of the tasks, namely eating. In order to see if the Flow Theory or the Resource Theory can explain self-interruptions, we investigated how difficulty and type-of-task influences eating-as-distraction. In two experiments we used respectively a problem-solving task and a visual task, just as the previous research (Katidioti, Borst, van Vugt & Taatgen, submitted). There were three difficulty levels in each task. A bowl of M&M's was present to provide the distraction. According to the Flow Theory participants would be distracted most in the easy and hard level and will show a flow-state in the medium level. Having the Resource Theory in mind, we would expect to find that the participants are equally distracted across the difficulty levels, because the distractor does not share a cognitive resource with the two tasks.

Background Theory

Flow Theory

Adler & Benbunan-Fich (2013) made a first step in the direction of understanding the concept of self-interruptions by making a typology of self-interruption. They divided the triggers of self-interruption into positive triggers, including exploration, stimulation and reorganization, and negative triggers, including frustration, obstruction and exhaustion. They also say that a person initiates self-interruption when failing to achieve a flow-state. A flow-state is a mental state of a person who has total focus and involvement in a particular task (Flow Theory, Csikszentmihalyi, 1990). For a flow-state to take place, there has to be a balance between the difficulty of a task and the skills of a person. When a task is too easy, a person seeks exploration (because of curiosity, looking for a challenge), stimulation (to avoid getting bored) and reorganization (to achieve multiple goals with satisfaction). When a task is too difficult, a person experiences obstruction and gets frustrated and exhausted and thus is likely to take a break (Adler & Benbunan-Fich, 2013). When being in a flow-state, someone is totally focused on one single task and is not likely to multitask.

Resource Theory

In an experiment of Nijboer, Taatgen, Brands, Borst & van Rijn (2013), where participants had to multitask and could decide themselves when to switch tasks (substraction- and a tracking task), it turned out that combining tasks using different cognitive resources is prefered over tasks using the same cognitive resources . This could be explained by the multiple resource theory of Wickens (2002). This theory states that when tasks share more cognitive resources the interference increases. In an experiment of Katidioti, Borst & Taatgen (2014) participants played a memory game and seemed to self-interrupt mosty after they had found two matching cards. This matching led to lower mental workload, because the number of items to be remembered decreased, making the working memory resources more available. In another experiment, conducted by Salvucci & Bogunovich (2010), participants had to answer emails and when an alarm was given, answer questions in a chatbox. They found that people tend to interrupt themselves (in this case answering the chat), when their primary-task mental workload was low (switching between emails). Next to the mental workload, Bogunovich & Salvucci (2011) also found that a combination of time constraint and the distance to a next low workload moment influences the onset of self-interruptions.

Food and interruptions
Not a lot is known about the effects of food as a distractor. Most research about food as distraction uses watching TV as the primary task. It seems that eating while watching TV leads to more snacks that are eaten and more energy consumption. Familiarity with the TV show is correlated with greater food intake (Braude & Stevenson, 2014). Also the more distracting TV content is, the more food people eat. They appear to pay less attention to eating, which makes them eat more (Tal, Zuckerman & Wansink, 2014).

Experiment 1

Method

In this experiment we used a problem solving task as the primary task: the children's game known as 'Memory' or 'Concentration'. This memory game is the same as the one used in the experiment of Katidioti, Borst, van Vught & Taatgen (submitted), which originates from the experiment of Anderson, Fincham, Schneider, & Yang (2012). As distraction participants were free to eat M&M's whenever they liked, while performing the memory game. In the classic version of Memory a deck of cards, with pairs of identical images, is randomly organized face down on a table. The player can flip two cards to see if they are identical to each other. If so, they stay open on the table, if not, they have to flip the cards back and try to remember what was on those two cards. This continues until every card is flipped and every match is made.

The memory card game consisted of 16 cards (8 matching pairs) in a 4x4 matrix. Instead of images there were equations on the cards. There were three different difficulty levels of equations: easy, medium and hard. The easy level consisted of equations of the form $a+b=X$, where a and b were integers from 0 to 9. The medium level consisted of equations of the form $X+a=b$, where a was an integer from 1 to 9. The hard level consisted of equations of the form $a*X+b=c$, where a and b were integers from 1 to 9 and c integers from 8 to 90. X was always an integer from 2 to 9. The solutions of the equations on the two flipped cards had to be the same to be considered a match. For example, the card with the equation $X+7=13$ matches the card with the equation $X+2=8$, because in both cases $X=6$.

Another difference in this version of the game is the sequence of flipping cards. In this version of the memory game the previously opened card closed when the next card was opened. This was done to reduce the complexity of the task. It did not change the game, since it is a one person game in this experiment. When the solution of a card was the same as the solution of the previously flipped card, the two cards matched.

Participants had to click on a card, solve the equation mentally, remember the value of X and then click on another card. When this card matched the previous clicked card the word "MATCHED" was displayed on the back of both cards and those cards couldn't be clicked again. (see Figure 1 for a screen shot) There were three possible types of moves to be made in this game: a *new card* (opening a card for the first time), a *revisit* (opening a card they had opened before) or a *match* (opening a card that matched the previously opened card).

Participants

14 students (7 female) of the University of Groningen participated in the experiment. Two participants were removed because of problems

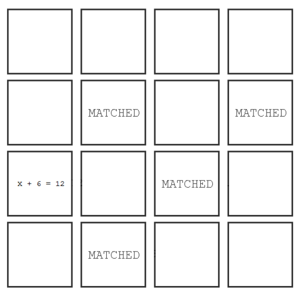

Figure 1: A screen shot of the medium difficulty level of the memory game.

with the digital scale (scale results turned out to be uninformative with regard to the current question and are therefore not reported in this paper). The remaining 12 participants (6 female) had an age range of 18 - 26 with a mean age of 22 . They all gave informed consent and received a monetary reward of 5 euros.

Apparatus and setup

The experiment was conducted in a small windowless room during the experiment. Participants were seated at a desk with an LCD monitor with a screen resolution of 1920 x 1080 pixels. A dymo postal scale M5 was used to measure the weight of the bowl of M&M's. The scale was located on the left side of the table and was wrapped in a M&M's wrappingpaper. The start weight of the M&M's was on average 125 grams.

Procedure

As practice the participants completed one memory game with integers on the cards. The experiment lasted for 45 minutes and consisted of three 15-minute-blocks, one block for each difficulty level. In each block participants finished as many trials (memory games) as they could. They were instructed to be as accurate as possible and that the time for each block was fixed. After 15 minutes they had to finish the memory game they were doing at that moment and could take a break. The participants were free to eat M&M's whenever they liked during the experiment. Also there was a glass of water in case they got thirsty. The weight was measured at the beginning and end of the experiment, each block and each trial and after each mouse click.

Design

The experiment has a within-subject design. The independent variable was the difficulty of the task (easy, medium, hard). The dependent variable was the weight of the M&M's and the performance of the memory game. To counterbalance the order of blocks in the experiment we used six different sequences of the difficulty levels, with two participants conducting each sequence.

Table 1: Task performance per difficulty level in Experiment 1 (standard errors in the parentesis).

	Easy	Medium	Hard
Average time per memory game (sec)	47.01 (8.66)	93.49 (40.95)	207.13 (72.93)
Number of memory games completed in exact 15 minutes	19.61 (3.65)	11.19 (4.23)	4.80 (1.49)
Average number of revisits	4.07 (2.42)	6.06 (3.59)	10.77 (11.70)

Analysis

For the analysis we looked at several variables, namely the weight, block, difficulty, participant gender, start time of the experiment and when the participant last ate. First as exploratory analysis we calculated the mean of the weight per participant and of all the participants together and plotted this against the difficulty levels. After that we made linear models, which we compared with an ANOVA to see if there were any effects and if these effects were significant.

Results

Table 1 shows that our difficulty manipulation worked as expected. We expected participants to be faster, (and thus having a higher number of memory games completed) and have the least revisits in the easy level. In the hard level we expected them to be slower, so less number of memory games completed, and to have the most revisits. Participants were the fastest in the easy level and the slowest in the hard level. A repeated measures ANOVA ($F(2,22)=62.07$, $p<.001$) and follow-up t-tests (all $ps<.005$) show that the differences between these levels are significant. They also completed the highest number of games in the easy level and the least in the hard level. According to a repeated measures ANOVA ($F(2,22)=163.5$, $p<.001$) and follow-up t-tests (all $ps<.001$) these differences were also significant. A third measure of performance is how often participants reopened a card (revisit). The participants had the most revisits in the hard level and the least in the easy level. Also these differences were significant according to a repeated measures

ANOVA (F(2,22)=4.456, p<.01) and follow-up t-tests (all ps marginally significant).

Participants ate the most in the medium level and about the same in the easy and hard level, (Figure 2). Seven of the twelve participants showed this same trend (Figure 3).

To see if there were any effects of the variables included in this experiment we first fitted an LME to weight only. We added block (the three time frames of 15 minutes), which gave a significant effect in the model (β=6.72, t=3.37, p<.001). Comparing this model to the model without block showed that the second model is to be preferred: $\chi^2(1)$=9.65, p<.005, indicating that the added model complexity is warranted given the data. Next adding difficulty to the model gave a significant effect of the medium level (β=-4.45, t=-1.28, p<.05). Comparing the two models showed that the LME with difficulty was preferred to a model without difficulty ($\chi^2(1)$=6.43, p<.05). Then we added the start time of the experiment, morning or afternoon (ExpTime). This gave a significant effect for morning (β=-10.52, t=-2.48, p<.05) and results show that it explained sufficient additional variance to be warranted ($\chi^2(1)$=5.74, p<.05). Adding the variable sex gave no significant effect (β= 5.99, t=1.27, p<.1) an a model without sex is preferred to a model with sex ($\chi^2(1)$=1.98, p>.05). When adding sex without the variable ExpTime however, results in a significant effect of sex (β= 9.71, t=2.24, p<.05). The value of Bayesian Information Criterion was a bit lower for ExpTime than for sex and so we will continue with ExpTime. Both the interactions between block and difficulty ($\chi^2(1)$=0.41, p>.1) , and difficulty and exptime ($\chi^2(1)$=4.43, p>.1) explained no sufficient additional variance to be warranted. The LME with the interaction between block and ExpTime was preferred to a model without the interaction term: $\chi^2(1)$=6.01, p<.05. All the interactions with the variable sex did not explain sufficient additional variance to be warranted. The final model can be seen in table 2.

Table 2: Linear mixed model effects of Experiment 1.

	β	t	p
Intercept	42.03	6.10	1.31e-06
Difficulty(Hard)	-1.43	-0.43	0.673372
Difficulty(Medium)	5.18	1.48	0.154608*
Block	-11.66	-4.41	0.000273
ExpTime(Morning)	-27.47	-3.32	0.002423
Block:ExpTime (Morning)	8.48	2.39	0.027007

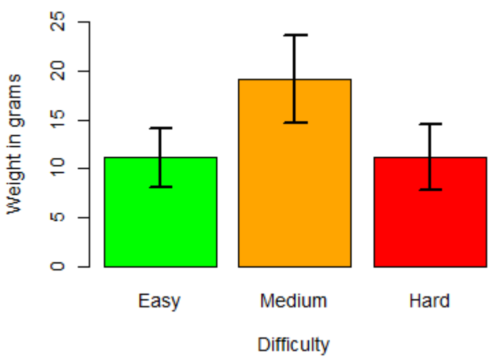

Figure 2: Amount of M&M's eaten per difficulty level in Experiment 1.

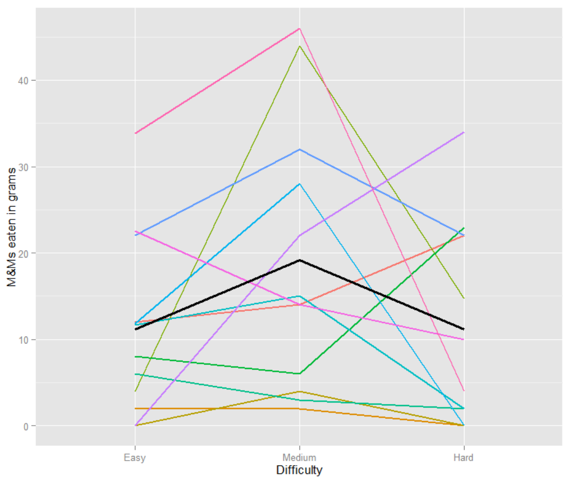

Figure 3: Amount of M&M's eaten per participant in Experiment 1.

*Difficulty(Medium) showed a significant effect without the interaction term.

Discussion

In Experiment 1 participants ate more M&M's when the task was of medium difficulty. Because the difficulty does not have a significant effect with the interaction in the model, but has a small significant effect without the interaction in the model, we can say there is an effect of difficulty, but this effect is not so strong. The participants also ate more in the beginning of the experiment than later in the experiment. Participants that started the experiment in the morning ate less M&M's than the participants that started in the afternoon. These results don not show the presence of effect of resource load, because the weight should then be roughly the same for all three difficulties for the distractor shares no cognitive resources with the task. The results also show the opposite effect of the Flow Theory with the medium level having the highest weight. These results support neither of our hypotheses.

Experiment 2

Method

This second experiment used a visual task: spot the difference. This spot the difference game is the same as the one used in the experiment of Katidioti, Borst, van Vught & Taatgen (submitted). The goal of this task is to find the difference between two almost identical images. As in Experiment 1, during this task participants were free to eat M&M's whenever they liked. These M&M's were the distractor of the experiment.

Participants

16 students (8 female) of the University of Groningen participated in the experiment. One subject was removed because he was not distracted at all (no eating) and thus would not give insight into task distraction. Three subjects were removed because of problems with the digital scale (scale results turned out to be uninformative with regard to the current question and are therefore not reported in this paper). The remaining 12 participants (6 female) had an age range of 18 - 22 with a mean age of 20 . They all gave informed consent and received a monetary reward of 5 euros.

Apparatus and setup

The experiment was conducted in a small windowless room during the experiment. Participants were seated at a desk with an LCD monitor with a screen resolution of 1920 x 1080 pixels. A dymo postal scale M5 was used to measure the weight of the bowl of M&M's. The scale was located on the left side of the table and was wrapped in a M&M's wrappingpaper. The start weight of the M&M's was on average 174 grams. This is a different start weight from Experiment 1 because of different experimenters. The two images of the spot the difference task were randomly generated.

Circles, ovals, squares and rectangles were drawn in randomly chosen grey and black color shades on random places on the screen. The screen was divided in two parts, the upper part of the screen with one image and the lower part of the screen with the other image. A 7 mm thick black line was drawn between the two parts. (see Figure 1 for a screen shot) The image on the lower part of the screen contained one shape that was bigger than the one on the upper part of the screen. The participants had to indicate the difference in the lower picture. There were three difficulty levels. The easy level consisted of 3-5 shapes, up to 400 pixels big. The different shape in the lower part of the screen was 60 to 90 pixels bigger than the one in the upper part of the screen. The medium level consisted of 15-17 shapes, up to 200 pixels big. The different shape in the lower part of the screen was 40 to 55 pixels bigger than the one in the upper part of the screen. The hard level consisted

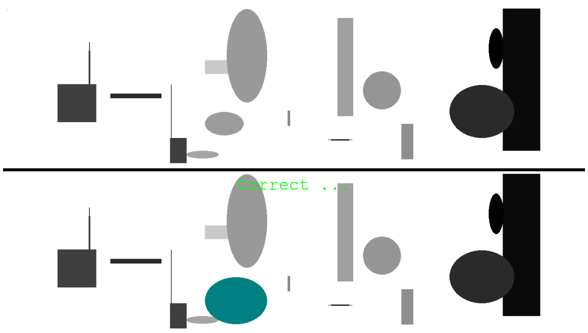

Figure 4: A screen shot of the medium difficulty level of the Spot the Difference game.

of 40-42 shapes, up to 100 pixels big. The different shape in the lower part of the screen was 20 to 25 pixels bigger than the one in the upper part of the screen. Because the oval shapes did not show distinct differences with these values, we made the differences for the ovals bigger. For the easy level 120 to 140 pixels, for the medium level 80 to 95 pixels and for the hard level 40 to 45 pixels.

Procedure

In the beginning the participants completed a one minute practice of the easy condition. The experiment lasted 45 minutes and consisted of three 15-minute-blocks, one block for each difficulty level. In each block participants finished as many trials as they could. They were instructed to be as accurate as possible and that the time for each block was fixed. After finishing a block, participants could take a break. The participants were free to eat M&M's whenever they liked during the experiment. Also there was a glass of water in case they got thirsty. The weight was measured at the beginning and end of the experiment, each block and each trial.

Design

Identical to Experiment 1.

Analysis

For the analysis we looked at several variables, namely the weight, block, difficulty, participant gender, reaction time, start time of the experiment and when the participant last ate. First as exploratory analysis we calculated the mean of the weight per participant and of all the participants together and plotted this against the difficulty levels. After that we made linear models, which we compared with an ANOVA to see if there were any effects and if these effects were significant.

Results

Table 3 shows that our manipulation worked as expected. We expected participants to be faster, and so have a higher number of trials, and have the least wrong answers in the easy level. In the hard level we expected them to be slower, so less number of games, and to have the most wrong answers. In the easy level participants were fastest to find the difference between the two images and the slowest in the hard level. According to a repeated measures ANOVA (F(2,22)=242.1, p<.001) and follow-up t-tests (all ps<.001) these differences were significant. Table 3 also states that the most number of trials were done in the easy level and the least in the hard level. All levels were significantly different from one another according to a repeated measures ANOVA (F(2,22)=690.9, p<.001) and follow-up t-tests (all ps<.001). The third measure for performance is number of wrong answers. Participants had the most wrong answers in the hard level and the least in the easy level. Also these levels differed significantly from one another according to a repeated measures ANOVA (F(2,22)=3.675, p<.05) and follow-up t-tests (all ps

Table 3: Task performance per difficulty level in Experiment 2 (standard errors in the parentesis).

	Easy	Medium	Hard
Average response time (sec)	2.30 (0.42)	6.77 (1.07)	22.07 (4.09)
Number of trials completed in 15 minutes	183.67 (14.91)	97.67 (11.53)	38.25 (5.41)
Percentage of wrong answers	1.47 (0.91)	1.77 (1.65)	4.15 (4.78)

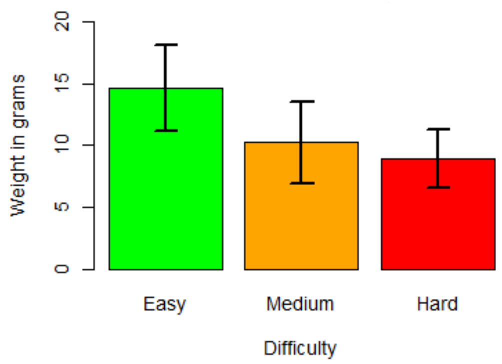

Figure 5: Amount of M&M's eaten per difficulty level in Experiment 2.

marginally significant).

Participants ate the most in the easy level and the least in the hard level (Figure 5). However just two of the twelve participants showed this same trend (Figure 6).

To see if there were any effects of the variables included in this experiment we first fitted an LME to weight only. Then we added difficulty, which gave no significant effect for the hard level (β=-5.72, t=-1.52, p>.1) and the medium level (β=-4.45, t=1.18, p>.1) in the model and a model without difficulty is preferred to a model with difficulty ($\chi^2(1)$=2.6362, p>.1). Adding block did have a significant effect in the model (β=-3.73, t=-2.10, p<.05). Comparing this model with the model without block showed that the first model is to be preferred: $\chi^2(1)$=4.19 p<.05. Next we added ExpTime, which also gave no significant effect (β=-2.28, t=-0.51, p>.1) and this model was not preferred to a model without ExpTime ($\chi^2(1)$=0.305, p>.1). Adding the variable sex didn't show any significant effect either (β=2.34, t=0.52, p>.1), and so this model was also not preferred to a model without sex ($\chi^2(1)$=0.3201, p>.1). We added interactions one by one, but non of the interactions in a model were preferred to a model without the interactions. The final model can be seen in table 4.

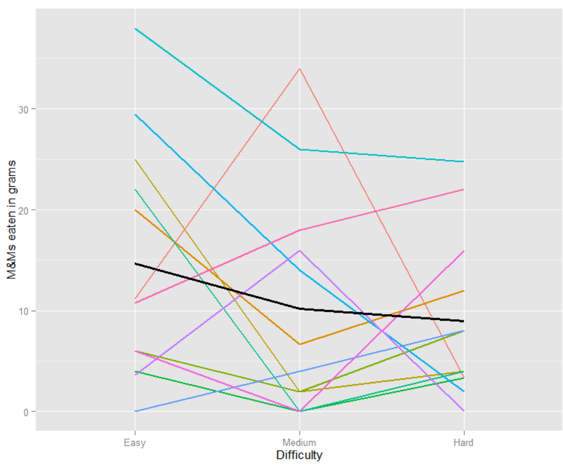

Figure 6: Amount of M&M's eaten per participant in Experiment 2.

Table 4: Linear mixed model effects of Experiment 2.

	β	t	p
Intercept	18.73	4.17	7.79e-05
Block	-3.73	1.78	0.0473

Discussion

In Experiment 2 participants ate more in the beginning of the experiment than later in the experiment. Other effects were not found. These results do not support the Flow Theory, but they could support the Resource Theory.

General Discussion

The current study investigated how difficulty and type-of-task influences eating-as-distraction, in order to see if the Flow Theory or the Resource Theory can explain self-interruptions. In the two experiments we conducted, two different cognitive resources were required. For the task in Experiment 1 a problem-solving resource and working memory was needed and the task in Experiment 2 required a visual resource.

With a not so strong effect of difficulty in Experiment 1 and no effect of difficulty in Experiment 2, we can say that overall there was no effect of difficulty on eating-as-distraction. Because achieving a flow-state requires a balance between the difficulty of a task and the skills of a person (Csikszentmihalyi, 1990), the Flow Theory would predict an effect of difficulty. Even if our medium level would not have the required balance for a flow state, there should still be a difference between the easy- and hard level, especially taken into account that Katidioti, et al. (submitted) did show a strong effect of difficulty with the same tasks but a different distractor. Therefore we can say that the Flow Theory can not be considered as an explanation for self-interruptions in this task or perhaps even for snacking-as-distraction.

A second possible explanation for self-interruptions was the Resource Theory. People should be distracted evenly across the experiment, since the distractor doesn't share cognitive resources with the tasks. Even though this effect in Experiment 1 is very weak (Figure 2), the results in Experiment 2 (Figure 5) show this effect. This means that we can not discard the Resource Theory as an explanation for self-interruptions.

Limitations

There are some aspects of the experiments we conducted that could be handled more properly, in order to get better results and give more meaning to them. The most important limitation is a result of the variable block. The current study has two within-subject design experiments. We saw a great effect of block on snacking-as-distraction in both experiments, which is not desirable. Maybe it is better to make the two experiments between-subject design to rule out this large effect of block. This large effect of block could maybe also be explained by the kind of snack we are using. Perhaps people are satisfied pretty quickly after eating some M&M's. Maybe it is better to use a 'lighter' snack, like popcorn, or a variety of snacks.

We also saw effects of the time of day participants started with the experiment. In a future version of this experiment it is better to rule out this variable by letting participants perform the experiment all at the same time of the day.

In addition, the digital scales used were not very precise and sometimes fluctuated more than we would want to because of leaning on the table. It would be better to use scales of better quality, so we have a precise measure. The scale should also be placed in a way that nothing else than grabbing the snack can influence the changes of the weight. This is important, because weight fluctuations, as a result of other reasons than eating, that are interpreted as fluctuations as a result of eating can alter the conclusions that are being made. It could appear that people ate way more than they actually did.

The conditions of the room people were sitting in were not the same for all participants. During some sessions, there was a lot of noise from the hallway, and in some sessions there was not. Some participants participated with three at a time, which could lead to distractions from noise or talking of the other participants, while some participated alone and didn't encounter these problems. Feedback of some participants also indicated that the overall silence in the room also influenced the amount of M&M's eaten. When it was too silent, some participants weren't comfortable with making eating sounds.

Because of the small group of participants, some participants can have a great individual impact on the results, whereas these results would be different if the group would be larger. Therefore it is better to have a larger group of participants, to rule out big individual differences and increase the power of this study.

Conclusion

It is useful to learn more about self-interruptions, to prevent the negative impacts and to improve work environments. With this study we made a step closer to understanding self-interruptions. We found that the Flow Theory can not be an explanation for self-interruptions in this study, but the Resource Theory could be. Though, further research is needed to show if it really is. If we would apply this knowledge to the work environments, this would mean that when arranging the work environment, the type of tasks that will be performed in that room has to be taken into account. If for example someone has to do a lot of visual tasks, a tv on the wall would not be a big problem, since they share the same cognitive resource. If someone has to do a lot of problem-solving tasks, it would be a problem, because the task and the tv appeal to different cognitive resources and therefore the chance of distracting oneself is higher.

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