Subliminal Priming towards healthy Food choice: The Moderating Effect of Working Memory Capacity

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With special thanks to Ilja Sligte
EFFECTS OF WORKING MEMORY CAPACITY ON SUBLIMINAL PRIMING

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Abstract

Food advertisement has a big impact on the eating behaviour of consumers and policymakers increasingly focus on advertisement for healthier food selection by consumers. Although priming towards healthier food choice has been explored, little research has been done on priming towards Healthier Food Choice at a subliminal level. To determine how Working Memory Capacity (WMC) influences consumers to be subliminally primed towards healthier food, this research combines the fields of cognitive research and consumer behaviour. This research proposed that Subliminal Priming positively influences consumers’ Healthy Food Choice. More specifically, it hypotheses that WMC has a positive moderating effect on the relationship between Subliminal Priming and Healthy Food Choice, if this is in line with the current goals of the consumer. These hypotheses are tested with the use of an experiment in which participants conduct a visual spatial test and consequently view an advertising video in which they were subliminally primed with healthy food related words. Subliminal priming effect was measured through the choice between a healthy and unhealthy drink. Data was attained through an online survey and the final sample contained 61 participants. The results partially support the hypotheses, to the level that goal relevance did not predict Healthy Food Choice. This suggests that WMC could enhance the effect Subliminal Priming has Healthy Food Choice, but the results also show that WMC directly affects Healthy Food Choices regardless of priming and goal relevance of the consumer.

Keywords: Consumer behaviour, subliminal priming, working memory capacity, healthy food choice, advertisement
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Introduction

During a walk on a high street in a major city one can almost impossibly ignore advertisement for food. Different physiological needs like hunger, thirst and even mood can influence one’s behaviour towards the decision of buying fast food or healthy food as a reaction to these adverts in their environment. One’s cognitive ability could reason not to fall for temptations, but a person could be persuaded to a purchase out of the range for what is desirable on a long-term. The consumer’s own personal goals and the ability to maintain and focus on them could protect the consumer from these temptations. This ability, as described in the current research, is Working Memory Capacity (WMC) and is the ability to process information in a short period of time. WMC have turned out to be a predictor of a variety of cognitive abilities, including language comprehension, learning and fluid reasoning (Kane & Engle, 2003).

In today society people are exposed to many unhealthy food advertisements and the increasing presence of imagery of food are contributing to the rising rates of obesity (Cohen-Cole & Fletcher, 2008). According to Mills, Tanner & Adams (2013), unhealthy food advertisement have a big impact on unhealthy eating behaviour. Hence its increasing risk of morbid diseases, obesity is being challenged more and more by policy makers by using similar advertisement for healthier food selection by consumers (Marteau, Hollands, & Fletcher, 2012).

When a consumer is aware of their unhealthy condition their goal can be to eat healthier. Food decisions like: ‘Should I make dinner for myself or buy fast food?’ could be made and choosing a healthier option takes a significant amount of psychological effort, especially if eating healthy is not in the common consideration set (Walsh, 2014). According to Baumeister, Bratslavsky, Muraven and Tice (1998), self-control or self-regulation fails
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when people can invest limited effort and will give into temptation of for example unhealthy food. These findings could imply that limited self-control could lead to unhealthy food choices, which under certain predispositions can be linked to negative effects, such as being overweight or other health problems. When people have the ability to focus on their goals, retrain negative impulses and execute this at different situations, they are able to process much effort on a cognitive level in a short period of time. This implies that people with high WMC could have advanced self-control or self-regulation (Hofmann, Friesen, Geschwendner and Wiers, 2008). As stated by Hofmann et al. (2008), individuals who have high WMC are more likely to engage in better self-regulation and thus have a more explicit goal. Thereby people with high WMC could less likely to be at risk for being overweight or other health issues.

For the society to make healthier food choices, researchers should focus on both the environmental circumstances and the personal abilities of the consumer. Recent research shows that people’s thoughts, feelings, and actions are guided not only by the conscious, reflective, rule based system but also by the non-conscious, impulsive associative system (Sheeran, Gollwitzer and Bargh, 2013). According to Sheeran et al. (2013), these studies encourage focus on environmental features as well as characteristics of the person and could potentially enhance health habits or behaviour of consumers. Health habits mainly operate on a non-conscious level and use impulsive associative systems. Therefore, studies have focused on how consumers could be subliminally primed, subconsciously stimulated to trigger behavioural actions, in advertising (Karremans, Stroebe & Claus, 2006; Bermeitinger et al., 2008; Bustin, Jones, Hansenne & Quoidbach, 2015). These studies have shown that subliminal priming can meaningfully influence consumer behaviour under the condition that the advert product or brand being primed is relevant to the consumer’s current goals and needs. Although these studies focused on different physiological traits and environmental
conditions, still little is known about the explaining mechanisms. According to Bustin et al., (2015), more research is needed to understand why some people are more influenceable to subliminal advertising than others. Additionally, according to Sheeran et al. (2013), examining subconscious processes may help to explain why explicit factors could predict or change health behaviour.

The purpose of this study is to examine what effect WMC has on Subliminal Priming towards choosing healthier food. In particular, it examines the moderating effect of Working Memory Capacity on the relationship between Subliminal Priming and healthier food choice. Therefore, the research question to be answered will be: Does working memory capacity moderate the effect that subliminal priming has on healthier food choice, when this is in line with the consumer current goals?

**Theoretical framework**

**Subliminal Priming**

Priming can be defined as the psychological effect in which exposure to a stimulus is found to increase the accessibility of semantically related concepts, reflected in faster reaction times or in recognition of more degraded images (Forwood, Ahern, Hollands, Ng and Marteau, 2014). For example, when personal trait like being confident is activated in one context, it could result in modification of an unrelated behaviour like a better exam performance, without raising consciousness awareness of the link between the two. In this perspective, cues from the environment can act like primes that could activate behaviour of people without their awareness (Bargh, 2000).
Studies on subliminal priming investigate the extent to which non-consciously perceived stimuli could be processed and the effect they have on other processes (Hassin, 2013). In 1957, James Vicary claimed that he increased the sales of popcorn and cola in a cinema after subliminally flashing ‘eat popcorn’ and drink ‘Coca Cola’. Unfortunately, his study has never been published and turned out to be a publicity hoax and some researchers argue that Subliminal Priming is a myth (Pratkanis, 1992). However, recent studies have shown that subliminal priming can influence consumer behaviour, subject to the condition that the primed product or brand is relevant to the goals and needs of the consumer.

Karremans et al. (2006) demonstrated that the brand name ‘Lipton Ice’ subliminally presented could increase the intention of consumers to choose the specific brand, under the condition that the participants were thirsty. Bermeitinger et al. (2008), demonstrated in a comparable experiment that only tired participants consumed more of the subliminally presented brand Dextro energy pills than the not presented brand. Research even found that priming could increase the choice for a primed brand at the expense of a habitual brand (Verwijmeren, Karremans, Stroebe, and Wigboldus, 2010). Beyond situational factors, like thirst or tiredness, which increase consumer’s sensitivity to subliminal advertising, more recent studies show that dispositional factors, like sensation seeking towards Red Bull, can have the same effect (Bustin, Jones, Hansenne & Quoidbach, 2015). Other research even shows that subliminal conditioning can motivate need-related behaviours as if people were deprived and thereby induce the need (Veltkamp, Custers and Aarts, 2010).

Although more and more researchers focus on the mechanisms behind the sensitivity to subliminal advertising, little research has been done on personal traits or abilities (Bustin et al., 2015). Therefore, this research is will focus on a personal cognitive ability to explore the underlying mechanisms that result in positive effects of subliminal priming to make healthier food choices.
Working Memory Capacity (WMC)

As argued in the introduction, people who have limited effort to exercise self-control could be more at risk to become overweight. People, who have little ability to process loads of information, could lose focus on their goals fall in negative impulses. People with high working memory (WMC) would have an advantage in processing these loads of information; they stay focused on their goals and could be less likely at risk. The research of Baumeister et al. (1998) showed that acts of choice, e.g. the choosing for healthier food, and self-control would take an amount of cognitive resource available and decreases the amount of resource left for completing a puzzle task. Their research showed that the more one’s cognitive ability is occupied the harder it will be to process information in the benefit for one’s own goals. This phenomenon could appear on a subconscious level as well.

Most researchers regard working memory as a mental faculty that has evolved in order to maintain information in a conscious, active state, to support thought processes by mental transformations, to provide an interface between long-term and memory and action (Hofmann, Gschwender, Friese, Wiers, 2008). WMC is the amount of information an individual can perceive in their attentional field and actively recall and shield it from interference and distraction (Hofmann et al. 2008; De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012). In their research, Hofmann et al. (2008) argued that automatic, impulsive processes of behaviour become more dominant in individuals who lack WMC necessary to inhibit or override behavioural responses. In addition, WMC has a double function to firstly inhibit automatic behaviour tendencies that may otherwise translate directly into behaviour and secondly to retrieve, maintain and shield explicitly endorsed attitudes and self-regulatory goals so that they can be continuously used for the self-monitoring of behaviour (Hofmann et al. 2008).
In line with the premise that subliminal advertising could influence consumers, as long as the priming in line with the goals and needs of the consumer, high WMC could intensify the goals and so possibly increase the subliminal priming effect. Yet, the literature has not shown evidence.

**Conceptual Framework**

**Subliminal Priming towards Healthy Food Choice**

Studies have proven that subliminal priming could lead to influencing consumers towards similar product choices, in the condition that the priming is in line with the consumers goals and needs (Karremans, et al. 2006; Bermeitinger et al., 2008; Bustin, et al. 2015). This study will put this premise to test for healthy food choice. Therefore, the first Hypothesis is proposed:

*H1: Subliminal priming has a positive effect on healthy food choice, if the primed stimulus is in line with the consumer’s current goals.*

**WMC as a moderator**

More research is needed to understand the mechanisms behind subliminal priming to predict consumer behaviour towards a healthier food choice. In the literature little is explored about the interaction of WMC on a conscious and on a subconscious level (Hassin, 2013). In previous research WMC and self-regulation have been studied on a conscious level (Hofmann et al. 2008; De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012), but according to Hassin (2013) high Working Memory Capacity on a subconscious level could lead to the ability to perform a high level cognitive process and thereby set up a behavioural action. As stated by
Hofmann et al. (2008), individuals who have high WMC are more likely to engage in better self-regulation and thus have a more explicit goal. If a brand or product is relevant to this goal, a consumer is more likely to be subliminally primed (Karremans et al., 2006).

It would appear that WMC could enhance the sensitivity of consumers towards subliminal advertisement for healthy foods, but only when it is in line with the current goals of consumer. In order for a society to become healthier it could be favourable to subliminally prime consumers towards healthier food ideas despite not having their own goal clear to become healthful. Based on the definition of WMC, being the amount of information an individual can perceive and actively recall, one could argue that subliminal priming could form subconsciously the idea of choosing the healthier product. The research of Veltman et al. (2010) shows evidence that goals are linked together and could subliminally conditioned to a more abstract higher-level goal, for example healthier lifestyle. According to Kane and Engle (2003), WMC is related to latency of recalling tasks and goals in contexts and enhances the ability of actively maintaining them. In addition, according to Förster, Liberman and Friedman (2007), it could be possible that subconsciously individuals have a hierarchical order of their goals and when activated by subliminally priming and higher-level goals could override temptations. When these goals are subconsciously activated by associative words, what could be easier for people with high WMC, consumers could be primed towards the related goal. In this research the goal would be a healthy life style and the associated priming would be towards Healthy Food choice. Therefore, this research proposes the second hypothesis:

\[H2: \text{Consumers’ WMC enhances the positive effect subliminal priming can have on healthy food choices, if this choice is in line with the current goals of the consumer.}\]
Method

Participants

A broad variety of adult participants were attained through the distribution of a link to an online survey. This link was distributed through online social media, Facebook and Blackboard for students of the University of Amsterdam, and a selected group of email addresses. This method was chosen in order to achieve an as large as possible group of participants, since the effect of subliminal priming has been shown to be relatively small (Bustin et al, 2015). In addition, little research has been done on what factors influence the sensitivity of people and therefore a broad variety of participant would probably induce the best result.
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Design

The online survey contained two parts. The first is the part where WMC was tested and the second part is where the priming was tested. Participants were randomly assigned into two groups. In the primed group the participants were viewed a video in which subliminal messaging was included. In the second not-primed group the participants were viewed a video without subliminal messaging, in order to be the control group. Both groups were tested on WMC. After the video participants chose between a healthy (Spa Rood) and an unhealthy (soft drink) drink. Health intention was a categorical variable based on participants self rated Healthy life-style. The total amount of time to conduct the test took approximately 15 minutes.

Procedure

Data is collected though the use of an online survey (Qualtrics, Version 2250169). Participants were told they were participating in a Bachelor’s business administration thesis survey where they had to conduct a test, view a video and answer some questions. The participants were not aware of the research question or the subject in any way. Participants accessed the survey through the provided link and conducted the survey on their PC or laptop. In the survey the participants received a personal ID, an external link and instructions to copy and paste this ID in the first test. The access to the test was obtained through the second link and the instructions clearly inform the participant to continue the original survey when the test is completed.

The first test is conducted to examine what level of WMC participants have. Participants’ WMC levels were tested using a visual-spatial test (McNab, Zeidman, Rutledge, Smittenaar, Brown, Adams, Dolan, 2015). The test involved three different tasks: simultaneous spatial memory, serial spatial memory, and change localization. These
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comprised of storage attributes and distractor interferences. This resulted in 8 different trial-types, in which participants had to recall a number of objects presented in a 5x5 grid. In the first-trail type a number of red (target) footballs were displayed on the grid for 250 milliseconds (ms), and participants had to memorize the locations of all the red balls and designate them on the grid. In the second trial-type, the same task was displayed, but in addition yellow footballs appeared on the grid for distraction. In the third trial-type, the red footballs were displayed first for 250 ms and in succession, with a delay of 500 ms, yellow footballs appeared for 250 ms on different locations in the grid for distraction. In the fourth trial-type, the red footballs appear in serial order and each individual football is displayed for 250 ms as well. In the fifth trial type, the footballs appear serial as well, but yellow footballs are included for distraction. In the sixth trial-type, red tennis rackets are displayed for 250 ms and with a delay of 500 ms, the tennis rackets appear in the same position in the grid, again for 250 ms, but one of the rackets has turned direction. The task is to point the position of that particular tennis racket when the grid is empty again. In the seventh trial-type, yellow tennis rackets are included for distraction. And finally, the eighth trial-type first displays the red tennis rackets for 250 ms, then 500 ms later, yellow rackets appear for 250 ms to distract.

The football trial-types increased in the number of items to memorize and thereby increased difficulty. The tennis racket trial-types increased in the number items as well and caused increased difficulty for detecting the turned racket. After two mistakes are made in each trail-type the next will be presented. After all the tasks are done, participants see ‘thank you’ displayed and they could continue with original survey. For visual examples, see figure 2.
Figure 2. Screenshots of the visual spatial test. The first is the test introduction; the second comprises a number of red (target) footballs to be remembered; the third example including yellow (distractor) footballs, the last example shows the tennis racket of which one will have a turned direction.

For the second part of this study participants continue in the survey with demographic questions. Ages, gender, education level, are asked on a categorical scale. Next, participants are asked ‘How often they exercise per week?’ on a 7-point Likert scale ranging from (1) ‘less than 1 x’ (5) ‘more than 5 x’. Then the next question is ‘On a scale of 0-10 how healthy do you consider your eating habits?’ and participants can point out an appropriate number.
For the next part, participants were viewed a video, in which for the priming group are included subliminal semantic messages. The video was constructed with the use of video editing software (Adobe Premiere, Version 2015; Wondershare Filmora, Version 6.9.0). The video used in this research (Best of Surf, ItsAFckingCHANNEL, 2016) is a surfing compilation video, in which a combination of sunny beaches, surfing men and women and curling waves are viewed. This video was chosen because waves of water could be associated with drinking, just as sporting near a sunny beach. Figure 3 shows a screenshot of the video.

With the use of video editing software (Adobe Premiere, Version 2015), this compilation video was reduced to the length of 1:00, in order to be appropriate to view in the survey and maintain the participant’s interest and attention.

Figure 3. Screenshot of de surf compilation video

To include subliminal messages in the video, semantic primes were chosen since research shows words to be effective than audio or other visual primes (Bargh, 2000). The chosen words to subliminal prime with were ‘Apple’, ‘Orange’ and ‘Spinach’. These words were chosen because they can be associated with healthy food choices. According to previous
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research, these primes were included in the video on different point of time for 20 ms. This is the appropriate length of time of which people are unable to consciously perceive the messages (Fishbach et al., 2003). For the words to be clearly (unconsciously) seen in the 20 ms, this study used white letters in a black background in the peripheral focus area. An Example is shown in figure 4. These primes were included in the video in between the change of scenes in order mask their appearance optimally. To include the primes for 20 ms, other video editing software (Wondershare Filmora, Version 6.9.0) was needed to obtain this short time range.

Figure 4. Examples of semantic primes in the video.

Before the video is viewed, participants are informed that the video will be used in a commercial for drinks to emphasize it relation with drinking. In addition, participants are instructed to pay close attention to the brand names on the short of the surfers and their boards. After the video a question will be asked and if they answer it correctly, participants could win a prize. This instruction is designed to increase the participants’ concentration, in order to increase the priming effect.
After the video is viewed, participants immediately are asked to choose between two drinks; Spa Rood, as the healthy choice, and two examples of soft drink, Coca-Cola and Sprite, as the unhealthy choice, as shown in figure 5.

![Choice between healthy and unhealthy drinks](image)

*Figure 5. Choice between healthy and unhealthy drinks.*

The following question was the choice between two preferred prizes, being; two ‘Nationale bioscoop’ (movie) tickets and a registration ticket to the ‘Dam tot Damloop by night’ (running event in Amsterdam). Next, the prize-winning question, ‘Can you name three brands viewed on the shorts and boards in the video?’, was asked as an open question. In reality, the answer is not possible, since no brands were viewed. As a final check whether participant did notice the subliminal messages, the question ‘did you notice anything unusual in the video?’ was asked as an open question. Lastly, participants had the option to fill in their email address to possibly win the price of their choice. In the appendix larger images of the experiment setup are presented.
**Measurements**

*Dependent variable: Healthy food choice*

In this study the ‘Healthy Choice’ had to be made between two kinds of beverages. According to the research of Karremans et al., (2006), where priming and brand choice was tested, drinks were selected to be the choice in the dependent variable. Their study shows that priming and thirst can affect the choice of a particular brand of drink. This study chose for that reason drinks that Karremans et al. (2006) showed to be equally valued to order on a terrace, Spa Rood, a commonly known brand of sparkling water in the Netherlands, Coca-Cola, and Lipton Ice. Since this study investigates healthy choice, the decision was Spa Rood for the healthy choice since it contains little to none calories (Spa, 2016). Coca-Cola contains 42 Kcal and 10.6 gram of sugar per 100ml and a similar soft drink Sprite contains the same amount (Coca-Cola, 2016). Therefore, these two drinks are used to be the unhealthy choice. Both sorts of drinks contain the same amount of carbonic acid as well. Immediately after the video Healthy choice was measured, as shown in figure 5, as binary variable, with Healthy = 1 and unhealthy = 0.

*Independent variable: Subliminal Priming*

Subliminal priming is measured through the use of the video with the subliminal priming messages for the primed group and the video without for the control group. Subliminal priming is measured as a binary variable, with primed = 1 and not primed = 0.

*Independent variable: Working Memory Capacity*

Using the visual spatial test (McNab et al., 2015), WMC was calculated using the K formula: \( K = (\% \text{ correct} - \text{chance}) \times n \text{ stimuli} / 0.875 \), which estimates the maximum number of items individuals are able to store in their working memory (Cowan, 2001). A high
score represents a high WMC, i.e. the participant is able to retain a great number of items in his/her working memory and is a continuous variable.

Independent variable: Sportsmanship

In order to test whether the participant goals are in line with healthy food choice, this research has chosen to ask participants about their healthy lifestyle. When participant score relatively high on healthy lifestyle one could assume healthy food choice is in line with their current goals. This research has chosen for two variables. The first one, Sportsmanship, is measured in the survey with a 7-point Likert scale question: ‘How often they exercise per week?’ ranging from (1) ‘less than 1 x’ (5) ‘more than 5 x’. Sportsmanship is therefore measured as categorical ordinal variable.

Independent variable: Healthy Eating Habit

The second variable in line with Healthy lifestyle is Healthy Eating Habit. This variable is measured with the question is ‘On a scale of 0-10 how healthy do you consider your eating habits?’. Participants can point out an appropriate number. Similar as Sportsmanship, Healthy Eating habit is measured as categorical ordinal variable.

Analysis and Predictions

To determine the effect WMC has on subliminal goal priming in line with the consumer’s goals (H1), the dependent variable healthy food choice was modelled as a function of the four predictors, Subliminal Priming, WMC, Sportsmanship and healthy eating habit (Model 1). Model 1 was tested in a logistic regression analysis, which checked the main effects of Subliminal Priming, WMC, Sportsmanship and healthy eating habit on Healthy
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food choice. To test whether there is a moderating effect of WMC on the relationship between Subliminal priming and Healthy food choice (H2), an interaction variable was created and added to the function of healthy food choice (Model 2). The second logistic regression checked if there was an interaction effect between WMC and the main effect of subliminal Priming on Healthy food choice.

The logistic regression for Model 1 tests the probability of Healthy Choice incurring given known values of the predictors Subliminal Priming, WMC, Sportsmanship and Healthy Eating Habit. The logistic regression equation from which the probability of Healthy food choice is predicted is given by:

\[
P(Y) = \frac{1}{1 + e^{-(b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4)}}
\] (1)

In this equation (1), \(P(Y)\) is the probability of Healthy Food Choice incurring, \(e\) is the base of natural logarithms, \(b_0\) represents the constant or intercept of the model, \(b_n\) the weight of the predicting variables \(X_n\). \(X_1\) is the predictive variable Subliminal Priming, \(X_2\) represents WMC, \(X_3\) represents Sportsmanship, and lastly, \(X_4\) represents Healthy Eating Habit.

The second logistic regression for Model 2 tests the probability of Healthy Choice incurring as well. In addition, the interaction variable Subliminal Priming * WMC is inserted in the equation, to test if the added variable has an impact on the prediction. The second logistic regression equation is given by:

\[
P(Y) = \frac{1}{1 + e^{-(b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5)}}
\] (2)
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In this equation (2), $P(Y)$ is the probability of Healthy Food Choice incurring, $e$ is the base of natural logarithms, $b_0$ represents the constant or intercept of the model, $b_n$ the weight of the predicting variables $X_n$. $X_1$ is the predictive variable Subliminal Priming, $X_2$ represents WMC, $X_3$ represents Sportsmanship, $X_4$ represents Healthy Eating Habit and lastly, $X_5$ represents the interaction variable Subliminal Priming * WMC.

The results of the data collection are processed with the use of statistical analysis software (IBM SPSS Statistics, version 22, 2015).

This research predicted positive correlations between Subliminal Priming and Healthy food choice. This research also predicted positive correlation between goal relevance, expressed in Sportsmanship and healthy eating habit, and Healthy Food Choice. Furthermore, this research predicted that people with high WMC would experience a stronger effect of Subliminal Priming towards Healthy Food Choice. Additionally, when people have low WMC the effect of Subliminal Priming towards Healthy food Choice would be weaker.

Results

Sample

Data from the participants completing the survey correctly was collected and unexpectedly, from the 111 respondents of the online survey only 57.6% fully completed the visual-spatial test and viewed the video. Of these remaining respondents, 57.8% were in the primed group and the rest in the control group. The results of the experiment are shown in Table 1 and a graphical representation is shown in Figure 6. Overall, 57.4% of the participants choose for the Healthy choice Spicy Rood. For the primed group this was 71.4% and for the control not primed group 38.5%. Out of the primed group, only three participants noticed the
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subliminal messages (8.1%). Therefore these respondents were removed and the sample was final (N = 61). There were more male participants than female (52.5% male). The participants were aged between 18-24 and 65-74 (M = 3.39, SD = 1.37) and the largest age group was 25-34 (55.7%). Additionally, the level of education of the participants was between IBO, MAVO, VMBO (lower level high school) and Higher Level education (higher than HBO and WO)(M = 3.85, SD = 0.543). The largest education group was HBO, WO (university)(83.6%). The results of the experiment are shown in Table 1 below.

Table 1

*Cross tabulation of results*

<table>
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<th>Not primed</th>
<th>Primed</th>
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<td></td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>WMC low</td>
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<td>WMC high</td>
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<td>7</td>
</tr>
<tr>
<td>Total</td>
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<td>18</td>
</tr>
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</table>

*Note:* Choice of healthy or non healthy product, N= 61.
The means, standard deviations and correlation coefficients of the five variables used in this research are presented in Table 2. A reliability analysis (Cronbach’s Alpha) showed that the visual spatial test used to measure WMC was reliable ($\alpha = .80$). The lowest score for WMC was 4.71 and the highest was 9.14. However, due to the relatively low size of the sample and the small variation in WMC among the participants ($M = 7.10$, $SD = 1.17$), this study chose to split the participants in a Low WMC group ($WMC < 7.10$) and a High WMC group ($WMC > 7.10$) ($M = .48$, $SD = .85$). The minimum score for Sportsmanship was ‘Less than once a week’ and the maximum score was ‘more than 5 times a week’. Most participants exercised 2 times a week ($M = 2.74$, $SD = 1.22$). The minimum score for Healthy Eating Habit was rated with a 3 and the highest score was rated an 8 ($M = 6.70$, $SD = 1.26$). As expected, Subliminal Priming was positively related to Healthy Food Choice ($r (61) = .29$, $p = .02$). WMC (split-off) was positively related to Healthy Food Choice as well ($r (61) = .28$, $p = .05$)
Unexpectedly, Sportsmanship was negatively related to Healthy food Choice, although this relationship was not significant ($r(61) = -0.07, p = 0.60$). Expectedly, Healthy Eating Habit was positively related to Healthy Food Choice as well, however, this relationship is weak and not significant ($r(61) = 0.15, p = 0.60$). There was a positive relationship between Sportsmanship and Healthy eating habit as well ($r(61) = 0.27, p = 0.03$).

Table 2

*Descriptives and correlations between the variables (Cronbach's Alphas on diagonal)*

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Healthy food choice</td>
<td>.59</td>
<td>.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Subliminal Priming</td>
<td>.57</td>
<td>.50</td>
<td>.29*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Working Memory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity (split-off)</td>
<td>.63</td>
<td>.48</td>
<td>.28*</td>
<td>-.10</td>
<td>(.80)</td>
<td></td>
</tr>
<tr>
<td>4 Sportmanship</td>
<td>2.74</td>
<td>1.22</td>
<td>-.07</td>
<td>.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Healthy Eating Habit</td>
<td>6.70</td>
<td>1.26</td>
<td>.15</td>
<td>.01</td>
<td>.15</td>
<td>.274*</td>
</tr>
</tbody>
</table>

Note. $N = 61$. * $p<0.05$

Regression Analysis

The regression results for Model 1 and 2 are shown in Table 3. First, this research predicted a positive relationship between Subliminal Priming and Healthy Food Choice. This
research also predicted positive correlation between goal relevance, expressed in Sportsmanship and healthy eating habit, and Healthy Food Choice. Hence, it proposed the H1: Subliminal Priming has a positive effect on healthy Food Choice, if the primed stimulus is in line with the consumer’s current goals. Expectedly, Subliminal Priming and Healthy Food Choice were positively related ($r = .29$). Also, the logistic regression analysis showed that Subliminal Priming had a positive effect on Healthy Food Choice ($B = 1.585$, Wald = 6.465, $p = .011$, $se B = .623$). However, Sportsmanship was not positively related to Healthy Food Choice ($r = -.07$). Also the regression analysis showed no significant effect ($B = -.171$, Wald = .428, $p = .513$, $se B = .261$). In addition, Healthy Eating Habit had a weak and insignificant correlation with Healthy Food Choice ($r = .150$) and the regression analysis showed no significant effect as well ($B = .276$, Wald = 1.140, $p = .286$, $se B = .258$). Therefore, H1 is not fully supported.

Although not hypothesised, WMC and Healthy Food Choice do have a positive correlation ($r = 0.28$) and the logistic regression analysis of Model 1 shows furthermore that WMC has a positive effect on Healthy Food Choice as well ($B = 1.379$, Wald = 4.648, $p = .031$, $se B = .640$).

Table 3

| Model Summaries for all Interaction Models with Dependent Variable Healthy Choice |
|--------------------------------------|-----|-----|-----|-----|
| DV                                  | Independents | $\chi^2$ | $B$  | $se B$ | $e^B$ | $\rho$ |
| Healthy Choice                      |                |          |      |        |       |       |
| Model 1                             | Subliminal Priming | 1.585*  | .623 | 4.878  | .011 |


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<table>
<thead>
<tr>
<th>Model 2</th>
<th>Subliminal Priming</th>
<th>WMC split-off</th>
<th>.139*</th>
<th>.640</th>
<th>.971</th>
<th>.031</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sportsmanship</td>
<td>-.171</td>
<td>.261</td>
<td>.843</td>
<td>.513</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Healthy Eating Habit</td>
<td>.276</td>
<td>.258</td>
<td>1.318</td>
<td>.286</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Constant</td>
<td>-2.735</td>
<td>1.711</td>
<td>.059</td>
<td>.097</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.955*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model 2</th>
<th>Subliminal Priming</th>
<th>WMC split-off</th>
<th>-.293</th>
<th>.794</th>
<th>.746</th>
<th>.712</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sportsmanship</td>
<td>-.112</td>
<td>.257</td>
<td>.894</td>
<td>.664</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Healthy Eating Habit</td>
<td>.361</td>
<td>.286</td>
<td>1.435</td>
<td>.211</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subliminal Priming</td>
<td>2.022*</td>
<td>.729</td>
<td>7.556</td>
<td>.006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*WMC split-off</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Constant</td>
<td>-2.242</td>
<td>1.933</td>
<td>.106</td>
<td>.246</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25.647*</td>
<td></td>
</tr>
</tbody>
</table>

Note. N = 61. * p<.05, **p<.01

Model 2 shows the main and the interaction effects on Healthy Food Choice. It was predicted that consumers with high WMC would experience a stronger effect of Subliminal Priming towards Healthy Food Choice, if this were in line their current goals. Additionally,
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when people have low WMC the effect of Subliminal Priming towards Healthy food Choice would be weaker. Hence this research proposed $H2$: Consumer’s WMC enhances the positive effect subliminal priming can have on healthy food choices, if this in line with de current goals of the consumer. Because of the moderating effect of WMC, it is also expected that Model 2 would predict Healthy Food Choice better than model 1. Although Model 1 itself, tested in the logistic regression against the constant model, has shown significance ($\chi^2(4) = 12.955, p = .011$, Nagelkerke $R^2 = .258$), Model 2 explained more of the Healthy Food Choice prediction ($\chi^2(5) = 25.647, p < .000$, Nagelkerke $R^2 = .463$). In addition, the interaction variable Subliminal Priming *WMC split-off has shown to be effective ($B = 2.022$, Wald = 7.693, $p = .006$, se $B = .729$). However, the predicting variables Sportsmanship ($B = -.112$, Wald = .189, $p = .664$, se $B = .257$) and Healthy eating habit ($B = .361$, Wald = 1.565, $p = .211$, se $B = .286$) were not explaining the prediction in the model. Therefore, $H2$ was not fully supported by this experiment.

Discussion

General discussion

The main goal of this research was to examine the roles of WMC and Subliminal Priming on influencing consumer behaviour towards healthier Food Choice. It also seeks to examine the moderating effect of WMC on the relationship between Subliminal Priming and Healthy Food Choice.

The first hypothesis ($H1$) proposed that Subliminal Priming has a positive effect on Healthy Food Choice, if the primed stimulus is in line with the consumer’s current goals. Unexpectedly, the results did not fully support this hypothesis. This research did show
a significant effect of Subliminal Priming on Healthy Food Choice, but the participant’s goal of a healthy lifestyle did not have any effect. This is in contrast to previous research in which subliminal has shown to be effective only under goals relevance conditions (Karremans et al., 2006; Bermeitinger et al., 2009; Verwijmeren et al., 2010). An explanation could be that the goal relevance tested in this experiment, Healthy lifestyle, was a relatively longer-term goal than for example thirst (Karremans et al., 2006). Also, thirst among other factors like habits and personal traits could have influenced the on the association participant could have made with the subliminal messages ‘Apple’, ‘Orange’ and ‘Spinach’.

The second hypothesis (H2) proposed that consumer’s WMC enhances the positive effect Subliminal Priming can have on healthy Food Choices, if this is in line with the current goals of the consumer. Unexpectedly this was not fully supported as well. Although the results show significant evidence of WMC moderating the effect Subliminal Priming has on Healthy Food choice, participant with high WMC were more likely to choose the healthy Spa Rood, however, again the goal relevance of the participant did not have any influence on this effect. This could suggest that other factors like the healthy context of the video induced a more explicit healthy lifestyle goal as shown in the research of Veltman et al. (2010).

An interesting result found in the analysis is that WMC was directly related to Healthy Food Choice. This was not expected since the literature shows no evidence for this relationship to occur. This could suggest that participants with higher WMC did experience more subliminal priming, but this could be explained by the direct relationship of WMC and Healthy food choice. People with higher WMC in this sample could simply prefer Spa rood to Soft drinks, regardless of their goals and in and in a lesser degree subliminal priming. As proved by Kane and Engle (2003), WMC is related to agility of reinforcing and actively maintaining the goal. The results of the current research did show evidence for the
enhancement of the subliminal priming effect towards healthier food choice by consumer with high WMC, but unfortunately no evidence for a associated personal goal.

**Strengths and Limitations**

The main limitation of this research was the size of the sample used for the experiment. An explanation for this is the setup of the experiment. The current research connected two parts of the experiment, which took effort of the participant. This created room for error, since only 57.6% fully completed both the visual-spatial test and viewed the video. Participants had to ‘copy and paste’ their provided unique participant-ID into the visual-spatial test, which opened in a new window. The first error could be made if the participant overlooked the instructions at the beginning of the survey and skipped the link to the visual-spatial test. This happened for five respondents. The next error could be made when participant did not copy the participant-ID and started the test anyway. Unfortunately, the participant without input of the participant-ID could conduct the test, but then could not be linked to the rest of the survey. The main error made by the majority of the respondent was finishing the visual-spatial test, but not continuing with the rest of the survey. This could be explained by the duration of the visual spatial test, which takes approximately ten minutes, where at the end of the visual-spatial test participant forget to continue with the rest of the survey. Also, the intensity of the tasks in the test could demand much concentration and when the visual-spatial test was completed, the presented ‘thank you’ message could wrongly imply the whole survey is completed.

The next limitation of the current research is that conducting an online subliminal priming experiment could compromise precision. In particular, the online connection for the participant to view the video could interfere with presentation of the subliminal messages.
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Also, according to Bustin et al. (2015), an open-ended manipulation check cannot completely rule out the possibility that weak conscious processing might have played a role in the results.

Another limitation of the current research is that the length of the experiment already was approximately 15 minutes in which additional exploratory data acquisition could decrease the concentration and attention of the participants and decrease the probability of completing the whole survey. More questions to measure the goal level of healthy lifestyle, could possibly have improved the results.

A limitation of this research as well is the variation of participants. The majority of the sample was student and between 25-34. A wider variety of participants could show more effect in the results. Also, to attain a wider variety of respondents, this research used an English survey, assuming that most Dutch respondents could comprehend the language as well. This could have interfered with the priming of some participants who did not subconsciously respond to English words.

On the contrary, strength of this research is that it explored the possibilities online research in the cognitive and consumer behaviour field. An online survey enables a large scope of respondents with individual, geographical, cultural and age differences (Bustin et al. 2015). The anonymity of the participants is a strength as well, participants did not have to feel their data input could be referred back to them and they could answer freely (Grinyer, A., 2002). Another strength is that although the visual spatial test was lengthy and intensively, WMC was measured in a thoroughly manner (McNab et al., 2015). Another strength of this research is the instruction of an assignment for the participant prior to the primed video in order to enhance to concentration of the participant during the video and decrease the possibility that the subliminal messages are to be seen.
Contributions and Future Research

The current research adds new insights to the field of subliminal priming research. WMC is a well-researched subject, yet little research has been done on WMC on a subconscious level. This research provides insight into WMC on a subconscious level applied to consumer behavioural research. This research was based on the concept of Karreman et al. (2006) and adds insights to the existing online subliminal research (Bustin at al., 2015). In line with the explorative research of Sheeran, Gollwitzer and Bargh (2013), this research contributes in the research of subconscious processes towards health behaviour. It also sets new targets for prediction and intervention in health related behaviour.

Future research should continue focussing on subconscious processes that predict health behaviour. Online subliminal research methods provide promising new channels to attain great scope of participants. The current experiment contained room for error and future online research should include different tests in one survey link, in order to enhance the respondent’s concentration and increase the chance of completion. To further explore the mechanisms behind WMC and subliminal priming towards health behaviour, future research should replicate the present experiment in a controlled lab environment. In this way, thorough assessment of the variables can be conducted. Future research could also add a neutral prime group to the experiment in order to compare the priming effect more thoroughly.

Also, to fully measure the healthy lifestyle goal of the participant, more questions concerning this goal could be asked in order to have a more explicit measurement and possibly an effect in the current experiment setting. The goal relevance for healthy lifestyle could possibly be examined as a moderating predictor.
Practical Implications

The findings in this research suggest that subliminal priming does have influence on consumer behaviour. Although advertising ethics have proposed that subliminal advertising violates basic ethical concerns (Nebenzalh & Jaffe, 1998), recent research has shown that subliminal advertising would be less effective for choices that people generally make more cautiously, such as purchasing something expensive or very important (Vermijmeren, Karremans, Bernriter, Stroebe and Wigboldus, 2013). The current research has demonstrated that higher WMC could lead to an increase of subliminal priming effect. Although the related healthy lifestyle goal is not proven, policy makers could focus on health associating words in advertising to possibly increase promotion effects of healthy food for consumers with higher WMC.

Conclusion

Consumers on a walk through a high street of a city need their cognitive ability to protect them from being tempted to purchase unhealthy food. The current research has shown underlying mechanisms of this cognitive ability and showed evidence in the perspective of an increasing focus of policy makers by using advertisement for healthier food selection by consumers. More specific, this research examined the effects of WMC on Subliminal priming towards Healthier food Choice. This study has shown Subliminal Priming could be moderated by WMC towards Healthier food choice, however future research needs to determine what additional factors explain this effect.
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References


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Appendix

Screen shots of visual-spatial test

Working Memory Task

This game measures the capacity of your working memory and how easily you are distracted. The game consists of two subgames.

1. RED FOOTBALLS: WHERE DO THEY APPEAR?
Remember the RED footballs. Ignore the YELLOW footballs. Press the location where the RED footballs were presented.

2. TENNIS RACKETS: WHICH RACKET TURNS?
This game resembles a ‘find the difference’ game. You are shown a number of tennis rackets. Remember the RED tennis rackets, ignore the YELLOW rackets. Next, you’ll see the same number of tennis rackets. ONE of the rackets has turned direction. CLICK THE RACKET THAT HAS TURNED in between screens!
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Screen shots of video
EFFECTS OF WORKING MEMORY CAPACITY ON SUBLIMINAL PRIMING

Subliminal Primes

Apple

Spinach
Healthy Food Choice

Q31. Which choice of drink would you prefer?