HOW WALKING FORWARD INFLUENCES PEOPLE’S EMOTIONAL RESPONSE
TO AND MEMORY FOR STIMULI VIEWED ON A MOBILE PHONE

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ABSTRACT

Thanks to the increased percentage of mobile phone ownership and wireless Internet access, our engagement with media has become more and more mobile. We commonly see people using their cell-phones when they are walking on the street, riding on a bus, or even driving in a car. However, we don’t know whether or not, and how movements influence people’s psychological responses towards stimuli viewed on phones. This study aims to explore how walking forward influence people’s emotional responses to and memory for different types of stimuli. Participants viewed and evaluated a series of stimuli (including shoe brand names, clothes brand names, vivid images, motionless images) on their mobile phones while walking or standing on a treadmill, and did an online recognition memory test of the stimuli a day later. The analysis showed that there were no significant main effects of walking on people’s evaluation and memory. However, main effects of type of information on evaluation and recognition memory were found, such that people rated images more favorably but remembered brand names better.
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CHAPTER 1

INTRODUCTION

Interaction between humans and media has become increasingly mobile. While people used to sit at the table reading newspapers, lie comfortably on a sofa watching television or playing computer games in the bedroom, they now can do the same thing anywhere and anytime thanks to mobile devices and wireless Internet access. A 2014 Pew Research study reported that 90% of American adults owned a cellular phone and 64% of American adults owned a smartphone (PewResearchCenter, 2014). With such a high percentage of mobile phone ownership and Internet access, our engagement with media has become more and more mobile. We now commonly see people using their cell-phones or tablets when they are walking on the street, riding on a bus, or even driving in a car.

As an example of this increased mobility, a 100ft-stretch of pavement has been specially designed for pedestrians who cannot resist using their phones while walking in Chongqing City (China) in 2014 (DailyMail, 2014). Addiction to cell-phones has become a problem in China, it’s important to do something to make it safer for people using cell phones while walking on the street. Having a special lane on the further side from traffic may help decrease accident rate. This is just one illustration of the practical importance of understanding how movement might affect perceptions of stimuli viewed on a mobile phone.

Previous research has shown that physical movements can influence people’s psychological reactions to different stimuli. More specifically, movement that minimizes the distance between a person and an external stimulus has been shown to activate an approach
mindset, leading to more favorable evaluations of novel stimuli (Cacioppo et al, 2003). Research has also shown that movement toward a stimulus may activate a broader global processing style while movement away from a stimulus may activate a more narrow, local processing style (Tucker& Williamson, 1984; Nussinson et al., 2012). Thus people moving forward under a global processing style should be more willing to accept external stimuli than those in a more narrow, local processing state.

However, little existing research has explored how movement might affect people’s evaluation of and memory for media content. In this thesis, I theorize that moving forward while using smartphones might activate an approach mindset, leading to more favorable evaluations of stimuli received on cell-phones, compared with viewing the stimuli while standing still. I also theorize that walking forward might impair memory towards stimuli because both walking and viewing stimuli require cognitive resources, thus generating dual-task costs.

This study also investigates how movements affect the evaluation of and memory for conceptual stimuli (texts) and perceptual stimuli (images). Because the information we receive on cell phones vary so much (words, pictures etc.), it’s important to know whether people would react differently towards different types of information when they are walking. To be more specific, brand information has various formats, for example, names, logos, advertisements and so on. If movement moderates evaluations of different kinds of stimuli (e.g. conceptual/perceptual), demonstration of this could ultimately lead to more efficient use of mobile technology for brand communication.
This thesis begins with a summary of research on how movement might influence emotional evaluations of and memory for stimuli. Then it distinguishes conceptual information and perceptual information, followed by a summary of how they influence people’s evaluations and memory. Later it summarizes how responses to relevant and irrelevant stimuli might be influenced by movement. An experiment testing these relationships is described, followed by an analysis and discussion of results. The thesis concludes with a discussion of, limitations and future research.
2.1 The Influence of Physical Movements on Evaluation

This thesis aims to research how walking forward and viewing various types of stimuli on cell phones would influence people’s evaluation of and memory for these stimuli, comparing with standing still. The underlying theorizing is based on an embodied cognition approach. Theories of embodied cognition suggest that the physical environment plays a formative role in the development of cognitive processes, which means that cognition construction interplays with body and environment (Cowart, 2005). To be more specific, our evaluation towards a particular stimulus may be influenced by other physical cues that are experienced around the same time.

During the early decades of cognitive psychology, the mind was viewed as an abstract information processor, and perceptual and motor systems were treated simply as peripheral input and output devices. The connection between the mind and outside word received little attention (Wilson, 2002). However, another branch of cognitive science began emphasizing sensory and motor functions, and the interaction with the environment. Jean Piaget (1952) proposed a developmental psychology, which stated that the cognitive abilities were based on the groundwork of sensorimotor abilities, especially for infants in the sensorimotor stage of development. Embodied cognition is learned, not innate. For example, locomotor experiences increase spatial cognitive abilities, which enable infants to understand the concept of object permanence (objects continue to exist even when they are not visible). Also, Gibson (2014) viewed perception in terms of “affordances”, which means potential interactions with the
outside world. At the same time, linguists started researching how abstract concepts might be grounded on metaphors for bodily, physical concepts (Lakoff & Johnson, 1980).

One possible explanation for embodied cognition is that abstract concepts arise from metaphor of physical and cultural experiences. For example, the orientation metaphor “more is up” may come from the experience that we see the level of a pile rise when we add objects to the pile (Lakoff & Johnson, 1980). Similarly, Williams, Huang and Bargh (2008) stated that early life experiences of interacting with physical environment (starting from infant period) serve as building blocks for understanding and reaction to the social world, which they called “scaffolded mind”.

There are many psychology studies researching how people automatically associate physical cues with psychological concepts. For example, Williams and Bargh (2008) found that participants who held a cup of hot (rather than iced) coffee evaluated a target person as having a “warm” (generous, caring) personality. Meier, Robinson and Clore (2004) conducted several studies asking participants to categorize words of different brightness as negative or positive, and they found the categorization was impeded when there was a mismatch between word brightness (light) and word valence (negative), proving that people automatically associate bright objects with good things and dark objects with bad things. Meier and Robinson (2004) also found that people processed positive words more quickly if they are presented in the upper half of a computer screen, compared with seeing it in the lower half. Generally, people tend to depict good things as light (versus dark), up (versus down), and moving forward (versus backward).

Embodied cognition is a subset of priming because there are physical priming and
non-physical priming; embodied cognition belongs to physical priming. When primed with foundational physical concepts like distance and temperature, people’s cognition and feelings are influenced. Regarding distance, most mammals are motivated to be closed to herd and remained far from predators and dangers (Bowlby, 1969; Hamilton, 1971; Mooring & Hart, 1992). Herd effect stated that the closer an animal was to others; the domain of danger was reduced. For example, when a lion appears amongst a herd of cattle, the individual cattle would minimize its domain of danger by approaching its nearest neighbor. That’s why we approach (decrease the distance) the things that make us safe or we like and avoid (increase the distance) the things that are dangerous or dislike. Similarly, this pattern is developed through life experiences since we are infants. An infant may instinctively approach his/her mother because he/she feels safe in her arms. Also, an infant may touch something hot because he/she has no experience with it and doesn’t know it’s dangerous, but after he/she gets hurt by it, he/she will avoid it next time.

Some studies (Cacioppo et al, 1993) showed that certain body movements (arm flexion and extension) could activate an approach or avoidance mindset, which could then be transferred to the evaluation of a stimulus. For example, people in arm flexion situation evaluated neutral Chinese ideographs more favorably than people in arm extension situation.

Based on this, it is possible that the physical cue of moving forward is associated with the abstract concept “approach good things”. When people are moving forward, their approach mindset may be activated, thus transfer to a favorable attitude towards the stimuli they see.

Another explanation that accounts for the favorable evaluation of the stimuli when
people are walking forward is that people may be under a global processing style (which means focusing on larger units and use inclusive categories). It is said that when people under an approach mindset, they tend to have a broader perception (global processing style) while avoid mindset facilitates a narrow, exclusive categorization that focus on individual constituents (local processing style) (Tucker & Williamson, 1984; Nussinson et al., 2012). The underlying mechanism of these different processing styles might be that people feel more secure and open-minded under global processing style. They might also concentrate less while in an approach mindset, enabling them to process larger range of external stimuli; while in avoidance orientation, people feel some kind of danger, which would make them to concentrate on specific stimulus that cause the danger and ignore external irrelevant stimuli. Thus walking forward facilitates a global processing style, which makes people generate a more favorable emotion response to external stimuli, compared with standing still.

To summarize, research suggests that walking would generate an approach mindset that, in turn, would elicit more favorable emotional responses towards stimuli when compared with standing still. This leads to the first hypothesis:

Hypothesis 1: Stimuli viewed on a mobile device while walking will be rated as more pleasant than stimuli viewed while standing still.
2.2 The Influence of Physical Movements on Memory

Besides evaluation (attitude) of the stimuli, memory for the stimuli was another aspect that people in media and advertising area care about, because attitude and memory are two indicators of message effectiveness.

Speaking of memory, first, it’s important to distinguish between long-term short-term effects of physical movements on memory. Regular aerobic exercise (long term) like walking and running improve memory (spatial memory) for both elderly people (Erickson et al, 2011) and young adults (Stroth et al, 2009). Erickson and his colleagues had one group of elderly people walking and the control group stretching with dumbbells several times a week for one year. They found that doing aerobic exercise like walking helped prevent hippocampus shrinkage for elderly people, thus increased their memory. One the other hand, Stroth had one group of young adults running during the last 30 minutes on school days for 6 weeks and the other group relaxing for the same amount of time. They found that running group students showed a significant improvement in visuospatial memory, compared with control group, but the underlying mechanism is unclear yet.

However, performing aerobic exercise task like walking at the same time with other tasks can impair memory due to linkage between sensorimotor control of behavior and cognition (Lindenberger et al, 2000). Postural aspects of behavior like walking impose cognitive control demands on people. It’s possible that people who are engaged in a difficult cognitive task like playing games (Dota2 or Minion Rush), can not walk at the same time, thus proving even purely walking (without the interaction with environment) require cognitive resources. Although walking on treadmills (staying in the same spatial location) is
different from walking on the street (navigating through space), both of them generate interactions with the environment, since even people walking on treadmills have to pay attention not falling down from treadmills. At the same time, episodic memory also requires cognitive control. Since both walking and performing other task require the same cognitive resources, they are going to interfere with each other and generate dual-task costs.

Previous studies showed that walking while performing another task caused a decline in the performance of the second task and a reduced walking speed even among healthy young adults, but walking pattern or stability were not influenced, (Yoge-Seligmann et al, 2008; Bloem et al; Schrodt et al, 2003; Gerin et al, 2005). This is because under a situation that participants were not given any specific instruction of prioritization of dual tasks, healthy young adults unconsciously used a “posture first” strategy to avoid hazards or falls, thus resulting in a declined quality of the second task but no cost of gait pattern and stability.

Lindenberger researched how different age people perform dual tasks, mostly walking while doing a cognitive task (e.g. comprehend a word list, remember words). In a study he carried out with Marsiske and Batles in 2000, they had participants encoded word lists while sitting, standing, or walking on less complex track (oval track) and more complex track (aperiodic track), and then tested the recall of the word lists (Lindenberger, Marsiske & Batles, 2000). They found that overall recall performance in the context of walking encoding conditions was lower than that in seated and standing encoding conditions. Also, recall was lower in walking on an aperiodic track than walking on an oval track. They thought that walking on an aperiodic track would require more cognitive processing than walking on the less complex oval track, thus causing larger dual-task costs. Here dual-task costs mean the
reduced number of words participant recalled after performing dual-task (walking and encoding word lists at the same time), comparing with doing a single task (seated or standing and encoding word lists). Also, young adults (20-30 years old) had no dual-task loss for recall in the less complex track (less than 5%) and 19% in more complex track. Middle-aged (40-50 years old) and old adults showed 22% lost in less complex track and 36% in more complex track.

To put it further, some of the studies researched the effects of walking and performing different types of cognitive tasks at the same time on task performances. For example, Bock (2008) asked participants to walk and avoid obstacles on a hallway while performing a memo task (look at a drawing for 20 seconds and then answer 10 questions about it) or performing a check task (check off grey box and white box sequentially on a paper sheet that printed in three columns of 25 rows of randomly paired grey-white versus white-grey boxes). They found that performing dual tasks (walking and doing a memo task/check task) reduced memo recall and checking performance, comparing with single task condition (standing still and doing a memo task/check task). Also, checking performance decreased distinctly while memo recall decreased slightly in dual-task condition. This means under the condition that both walking and non-walking task required continuous visual control (checking boxes), the performance dropped a lot more than if the second task required attention and memory resources (memorizing pictures) (Beurskens & Bock, 2012).

In addition, Springer and colleagues (2006) explored how would the difficulty of the second cognitive task interact with walking and cause difference in both walking performance and memory performance. They had participants (young adults and old adults)
walking while performing a simple task (listening to and remember a simple text and then answer 10 multiple-choice questions regarding the content of the text afterwards), or a complex task (the same as simple task besides additionally counting how many times two prespecified words appeared in the text). They found that performance on the memory test was similar when participants sitting or walking and performing the simple task, but was significantly reduced when participants walking and performing the complex task. This means that the memory performance of the cognitive task depends on the difficult of the task, the more difficult the task was; the more dual task costs would be generated.

Besides testing memory performance after dual-task condition, some researchers tested memory retrieval during the dual tasks condition. Krampe et al (2011) carried a study in which participants performed a word fluency task (naming as many words as possible for a given category like “vehicles” or “instruments”) and walking on a narrow oval track at the same time. They found that simultaneous walking reduced memory search performance (which means the number of examples people retrieved from a certain categories was reduced), compared with single-task condition, across three age groups (children, young adults, elderly people).

Previous studies had proved that walking and performing another cognitive task would influence memory performances for both words and images. For this thesis, college students (young people) viewed and evaluated a series of stimuli on their cell phones either walking or standing on treadmills at the same time, which is similar to the experiment carried by Lindenberger et al (2000) and Bock (2008), except that they were not told to remember the stimuli during the task. In this case, they were performing a simple walking task since they
were able to walk on the treadmill at any speed they felt comfortable with and there weren’t any obstacles. On the other hand, viewing stimuli and tapping on cell-phones to evaluate them was a more complex cognitive task that required both attention resources and continuous visual control. Considering these two factors, there may be a dual-task costs for memory performance, which means memories for stimuli that they viewed in walking condition (dual task condition) may be worse than the ones they viewed in standing condition (single task condition). Based on this, the following hypothesis is proposed:

Hypothesis 2: Recognition accuracy for stimuli viewed while standing still will be higher than recognition accuracy for stimuli viewed while walking.
2.3 Influence of Conceptual and Perceptual Information on Evaluation and Memory

As information has different forms (text, images), for instance, brand information can be presented as names, logos, stories and so on, it’s important to see whether viewing different forms of stimuli while walking would generate different emotion responses and levels of memory.

First of all, we need to distinguish between conceptual information and perceptual information. Conceptual information usually facilitates a semantic analysis while perceptual information leads to a feature analysis (Shapiro, 2010). Thus conceptual processing is more semantic processing and based on meaning while perceptual processing is based on physical features like modality and shape (Lee & Labroo, 2004). Based on this, brand names (texts) are more conceptual information that generates semantic analysis, and logos or images are more perceptual information that generates feature analysis.

One stream to study perceptual (visual) versus conceptual (verbal) information in psychology and consumer research focused on the effects they have on attitudes (Kim & Lennon, 2008). Literature in psychology proved that learning visual stimuli occurs more readily than the verbal counterparts of the same stimuli (Bower & Gordon, 1970; Childers et al, 1983; Paivio & Allan, 1969; Shepard, 1967), indicating that processing visual stimuli was easier and faster than processing verbal stimuli. Because of this, visual stimuli may be perceived as less difficult and less uncomfortable than verbal stimuli on the same topic (Hirschman, 1986). Also, based on culture conditioning that visual stimuli were regarded more as aesthetic objects and verbal stimuli were regarded more as knowledge (Holbrook & Zirlin, 1985; Polanyi & Prosch, 1977), it was suggested that visual stimuli would be rated
higher in aesthetic value than verbal stimuli. To be more specific, visual stimuli like photographs and paintings are placed in museums and galleries that collect aesthetic objects, which generate the association between visual stimuli and aesthetic objects. On the contrary, verbal stimuli like books and magazines are placed in libraries that collect knowledge and information, which generate the association between verbal stimuli and knowledge. This doesn’t mean that visual stimuli are absolute aesthetic objects or verbal stimuli are absolute knowledge. Imaging a continuum that has aesthetic value and knowledge value on each end, visual stimuli are closer to the end of aesthetic value while verbal stimuli are the opposite. Based on this, visual stimuli would be rated higher than verbal stimuli in an aesthetic scale. Hirschman (1968) carried a study researching the influence of advertisements in all-visual format and all-verbal format on people’s aesthetic responses (including five adjective pairs: attractive/not attractive, desirable/not desirable, arousing/not arousing, beautiful/not beautiful, and make me like this product/does not make me like this product) for 14 different product categories. She found that all-visual format advertisements were rated significantly higher than all-verbal format advertisements in seven categories (camera, Rosenthal tea set, women’s shoes, stereo, luggage, rings and Norman house). No significant relationship was found in five categories (sleeping bag, hairdryer, men’s boot, antique clock and antique tea chest) and a reverse result was found in other two categories (English Queen Anne house and princess-style telephone). The results indicated that for some categories, visual (perceptual) stimuli might generate a more favorable emotion response than verbal (conceptual) stimuli. This leads to the next hypothesis:
Hypothesis 3: People will have a more favorable emotion response towards perceptual stimuli than conceptual stimuli.

The other stream to study perceptual (visual) versus conceptual (verbal) information focused on the effects they have on memory. Studies had found that recognition for pictures were significantly higher than recognition for sentences in similar test environment (Shepard, 1967). There was a visual superiority effect on memory due to dual coding theory, which was first proposed by Paivio (1971). Dual coding theory proposed that cognitive activity had two mental subsystems, one was verbal system that processed linguistic units, and the other was imagery system that processed nonlinguistic units. The two systems differed at verbal system processed information sequentially while imagery system processed information simultaneously. Because images were simultaneously processed and were more likely to be encoded both as images and as verbal traces (people would label images when they processed it), the additive coding made them remembered better than words (Paivio & Csapo, 1973).

Paivio and Csapo (1969) did a research showing participants lists of images, concrete nouns and abstract nouns at a very fast rate of 5.3 items per second or a slower rate of 2 items per second. Here concrete nouns mean words that can be referred to objects, materials or persons, for example, PIANO, SNAKE. Abstract nouns mean words that cannot be experienced by senses, for example, AFTERLIFE, JUSTICE (Paivio, Yuille & Madigan, 1968). They found that people remembered picture better than concrete words, and concrete words were remembered better than abstract words, only in slower rate but not in fast rate because people were unable to label the pictures (no dual coding) during the presentation at the faster rate (Paivio & Csapo, 1969). Based on this, perceptual stimuli (images) should have higher
recognition rate than conceptual stimuli (brand names) because participant viewed each stimuli for at least 3 seconds in this study, which was enough to generate dual coding for images.

Hypothesis 4: Recognition accuracy for perceptual stimuli will be better than that of conceptual stimuli.

Another important factor to consider is whether the information someone is viewing is relevant to his/her sensorimotor condition. Because one’s cognitive activity is based on the interaction with environment, proposed by embodied cognition theory. From a pilot study that was carried out last year, it was found that walking didn’t influence evaluations of neutral stimuli (Chinese characters), compared with standing still. Also, the influence of walking on emotional responses to brand logos was more pronounced for sport brands like Nike and Adidas. It was speculated that these brands were relevant with walking or running, viewing these brand logos while walking activated the association, thus generated more favorable emotion responses to these logos. Thus it’s important to test whether walking can influence people’s evaluation of and memory for the stimuli only when the stimuli are relevant to walking. In other words, walking may not influence people’s evaluation of and memory for the stimuli that’s not relevant with walking. Based on this, conceptual relevant stimuli (shoe brand names), conceptual irrelevant stimuli (clothes brand names), perceptual relevant stimuli (vivid images) and perceptual irrelevant stimuli (motionless images) were selected and used as experiment materials.

Viewing relevant stimuli like shoe brand names and vivid images while walking falls in a conceptual fluency condition. On the other hand, viewing irrelevant stimuli like clothes
brand names and motionless images while walking doesn’t fall in conceptual fluency condition. Conceptual fluency was defined as the ease that the target comes to consumers’ minds and pertains to the processing of meanings (Tversky & Kahneman, 1973; Hamann, 1990). Previous studies had investigated the effects of conceptual fluency on affective judgment and memory. Whittlesea manipulated conceptual fluency by making the last word of the sentence either neutral (e.g., "He saved up his money and bought a boat") or semantically predictive (e.g., "The stormy sea tossed the boat") and then had participants rate the last word on a pleasantness scale. They found that participants rated target words in semantically predictive sentence more favorably than the ones in neutral context (Whittlesea, 1993, Experiment 5). This is because that people often make judgments based on “the ease with which instances or associations come to mind” (Tversky & Kahneman, 1973, p208). When the encounter of the target word is more expected, people experience conceptual fluency of the target word, resulting in a more positive attitude towards it.

Conceptual fluency was caused by semantic analysis of stimuli (Shapiro, 1999). However, the stimuli were not limited to words. Contextual scene information can activate a gist of the scene, which in turn creates expectations about what objects will be present. The object identification facilitated by these expectations will influence the following judgments about the object (e.g. Boyce et al. 1989; Henderson 1992).

Lee and Labroo (2004) replicated and extended Whittlesea’s study by using pictures and brands. They developed mock-up advertisements in the form of storyboard that consisted of several frames. Also, they chose ketchup as target product. They manipulated conceptual fluency by putting a picture of ketchup in the last frame of a predictable scenario (a boy
riding a scooter down the street, entering a restaurant and ordered a hamburger) or neutral scenario (a woman in a supermarket walking to product-display shelves) and had participants rate the ketchup. The results were similar to those found by Whittlesea: People rated the ketchup in the fast-food scenario more favorably than in the supermarket scenario. To ensure that ketchup was conceptually more fluency in fast-food scenario than in supermarket scenario, Lee and Labroo also did a pretest by presenting participants with the two scenarios and asked them to indicate the extent to which they anticipate to see ketchup. They found that participants expected ketchup more in the fast-food scenario than in supermarket one.

In this study, viewing shoe brand names and vivid images while walking falls in the conceptual fluency context because walking creates a context that make people more easily process relevant information (shoe brand names and vivid images) since they are predictable. Thus people’s evaluation towards these stimuli would be better than the irrelevant ones.

**Hypothesis 5:** There will be an interaction between movement and relevancy such that people will have a more favorable emotional response towards movement-relevant stimuli (shoe brand names and vivid images) than movement-irrelevant stimuli (clothes brand names and motionless image) while walking.

Possible effects of conceptual fluency on memory can be informed associative network models of memory. Associative network models stated that based on the levels of association, a bunch of nodes are linked to one another in our memory system (Anderson & Bower, 1973; Anderson, 1984). When a new thing is learned, a new node might be created and the pathways to relevant existing nodes are also created according to the strength of associations. In mental process like retrieval or recognition, one node is activated, the activation spread
randomly through the whole network, activating those nodes that are highly associated with the original one (Schmitt et al, 1993). Based on this, people’s memory towards relevant stimuli will be higher than those irrelevant stimuli since nodes will be more easily activated if they are highly associated:

**Hypothesis 6: People will have more accurate recognition memory for relevant stimuli (shoe brand names and vivid images) than irrelevant stimuli (clothes brand names and motionless images) viewed while walking.**

Besides six hypotheses, I have a research question that whether people would react differently towards different types of information when they are walking.

These hypotheses and research question were tested in an experiment in which participants viewed and evaluated a series of stimuli (including shoe brand names, clothes brand names, vivid images, motionless images) on their own mobile phones while walking or standing on a treadmill, and did an online recognition memory test of the stimuli one day later.
CHAPTER 3

METHODOLOGY

3.1 Participants

Sixty (60) undergraduate students at a large Midwestern university participated in the study for course credit.

3.2 Power Analysis

This sample size was based on a G*power analysis for the within-subjects factor of a repeated measures ANOVA (F test). For the input parameters, effect size f was set as 0.2 (corresponding to a partial eta-squared value of 0.04), power was set as 0.8, and number of measurements was 2. This analysis yielded a recommended sample size of 52. I collected data from 60 participants, oversampling slightly in case some participants failed to complete the recognition test that was conducted the day after the main experiment.

3.3 Design and Independent Variables

This experiment is a 2 (Physical Activity: Walking/Standing) × 2 (Types of Information: Conceptual/Perceptual) × 2 (Relevancy: Relevant with Moving/Irrelevant with Moving) ×2 (Repetition) within-subjects design. Physical activity refers to any bodily movement produced by skeletal muscles that requires energy expenditure and has two levels: Walking, which was operationalized by having participants walk forward on a treadmill, and Standing, which was operationalized by having participants stand still on a treadmill. Types of information refer to different formats of the stimuli and have two levels: purely conceptual ones, which were texts (shoe brand names and clothes brand names) and purely perceptual
ones, which were images (vivid images which imply movement such as a colorful whirlpool and motionless images which imply static status such as colorful squares). Here, purely visual stimuli were used instead of brand logos because existing brand logos have conceptual meaning in it. For example, when we see a “swoosh” logo, we can easily think of Nike. In addition, some brand logos like Mercedes Benz is associated with moving not because of the image (a circle with a triangle inside) itself, but the conceptual meaning it has (car brand). In order to avoid this kind of confusion and separate conceptual and perceptual information as much as possible, purely visual stimuli were used. Relevancy refers to the relationship between stimuli and the physical activity (walking) can be connected or not and has two levels: relevant ones were associated with moving (shoe brand names and vivid images); irrelevant ones were not associated with moving (clothes brand names and motionless images). All stimuli that were used can be found in Appendix A.

3.4 Dependent Variables

Emotional response: valence. Valence refers to intrinsic attractiveness (positive valence) or aversiveness (negative valence) of an event, object, or situation (Frijda, 1986, p207). Valence was measured with a five-point graphic scale: a face that could be assigned expressions ranging from frowning (1 = unpleasant) to smiling (5 = pleasant). An example of the measurement bar can be found in appendix B.

Memory: recognition. Recognition memory refers to the ability to recognize previously encountered events, objects, or people. One day after participants finished viewing and rating those pictures, they did a memory test online. They were shown 16 targets (appeared in experiment) and 16 matched foils (didn’t appeared in experiment) in a random sequence.
Each target or foil appeared for 1 second and participants were given unlimited time to
answer whether or not they had seen the picture the day before.

3.5 Experimental Procedure

The experiment had two parts. Part 1 was done in the Neurocognitive Kinesiology
(NCK) Laboratory in Freer Hall. Part 2 was a Qualtrics online recognition test done one day
after the completion of Part 1.

For Part 1, each participant entered the laboratory, read and signed a consent form and
finished a Pre-Participation Health Screening Questionnaire (PAR-Q), which has been widely
used in applied physiology and psychology studies that involve walking or running. The
purpose of this questionnaire is to screen participants for cardiac and other health problems
(chest pain, dizziness). Because there are some risks (slips, falls, and heart attack) associated
with walking on treadmills, it’s necessary to ensure that participants are able to walk on
treadmills, thus reducing possible risks to a minimum level. Few participants who answered
yes to any of the questions were asked whether they were able to walk on a treadmill (or had
they ever walked on a treadmill before), all of them said they were able to do that.

After that, participants read the instructions for the study carefully and used their own
mobile phone to access a Qualtrics link containing the stimulus presentation sequence. After
entering their participant number, they did two practice trials while walking on the treadmill
at a comfortable speed. Next, each participant was randomly assigned to begin with either the
walking or standing condition.

The data collection for Part 1 consisted of two blocks: one standing and one walking.
The order in which participants completed each block was randomly assigned. Each block
consisted of 30 trials, 8 of them were used for this study, and the rest of them were not for this study. For each trial, a picture appeared for at least 3 seconds, then participants could click a button to go to next page and rate the picture’s valence using the graphic (“smiley face”) rating scale described earlier. After completion of the first block, participants were given a short break before completing the second block. When both walking and standing blocks were finished, participants were given instructions for accessing the online memory test the next day. Part 1 took approximately 30 minutes.

For Part 2, participants did a force yes-or-no response recognition test online using the same participant number the next day. Each stimulus appeared for 1 second and then they were asked whether or not they had seen the picture the day before by answering a yes-or-no question. After they finished both parts (Part 1 in the lab, Part 2 online), they were thanked, debriefed, and dismissed online.

3.6 Data cleaning and recoding

60 students participated in Part 1 of the experiment, in which valence data was collected. Six participants failed to complete Part 2, and two additional participants entered a wrong participant number for part 2, which made it impossible to link their recognition data with their Part 1 data. This left 52 cases for memory data.

For recognition test, participants were asked whether or not they saw the picture the previous day in the walking experiment. Correctly recognizing target stimuli (those appear in the experiment) were coded as 1; failures in recognizing target stimuli were coded as 0. On the other hand, correctly rejecting foils (those didn’t appear in the experiment) were coded as 1; failures in rejecting foils were code as 0. In addition, there were 8 data missing points for 7
different participants. Because SPSS would eliminate the entire case from repeated measures analyses if there were missing points, the missing points were treated as misses and recoded as 0. Among the 8 missing points, 3 of them were for targets, 5 of them were for foils. Moreover, because foils didn’t varied through physical condition (walking/standing), they were not included in memory analysis.

### 3.7 Analyses

Both valence and recognition data were analyzed with a 2 (Physical Activity) × 2 (Type of Information) × 2 (Relevancy) × 2 (Repetition) repeated measures ANOVA.

### 3.8 Results

The sequence of walking first or standing first was randomly assigned and balanced across all participants. Including sequence as a between group factor with other independent variables yielded no significant interactions, indicating that the sequence of whether walking first or standing first had no effect on people’s evaluation.

Hypothesis 1 predicted that stimuli viewed on a mobile device while walking will be rated as more pleasant than stimuli viewed while standing still. Results showed that there was no main effect of physical activity on valence, $F(1, 59) = .81, p > .05$, thus hypothesis 1 was not supported.

Hypothesis 2 predicted that recognition accuracy for stimuli viewed while standing still will be higher than recognition accuracy for stimuli viewed while walking. Results showed that there was no main effect of physical activity on recognition memory, $F(1, 51) = .01, p > .05$, thus hypothesis 2 was not supported.
Hypothesis 3 predicted that people will have a more favorable emotion response towards perceptual stimuli than conceptual stimuli. Results showed that there was a significant main effect of type of information on valence, $F(1, 59) = 8.20, p < .01, \eta^2_p = .12$. Perceptual stimuli ($M = 3.27, SD=.07$) were rated significantly higher than conceptual stimuli ($M = 3.06, SD=.06$), thus hypothesis 3 was supported.

Hypothesis 4 predicted that recognition accuracy for perceptual stimuli will be better than that of conceptual stimuli. Results showed that there was a significant main effect of type of information on recognition memory, $F(1, 51) = 26.74, p < .01, \eta^2_p = .34$. However, the recognition rate of conceptual stimuli ($M = 0.89, SD=.02$) were significantly higher than perceptual stimuli ($M = 0.73, SD=.03$), which was opposite to Hypothesis 4.

Hypothesis 5 predicted that there will be an interaction between movement and relevancy such that people will have a more favorable emotional response towards movement-relevant stimuli (shoe brand names and vivid images) than movement-irrelevant stimuli (clothes brand names and motionless image) while walking. Results showed that physical activity $\times$ relevancy interaction on valence was not significant, $F(1, 59) = .65, p > .05$, thus hypothesis 5 was not supported.

Hypothesis 6 predicted that people will have more accurate recognition memory for relevant stimuli (shoe brand names and vivid images) than irrelevant stimuli (clothes brand names and motionless images) viewed while walking. Results showed that physical activity $\times$ relevancy interaction on recognition was not significant, $F(1, 51) = .13, p > .05$, thus hypothesis 6 was not supported.

Regarding the research question whether people would react differently towards
different types of information when they are walking, results showed that physical activity × type of information interaction on either evaluation, $F(1, 59) = .11, p > .05$, or recognition, $F(1, 51) = .41, p > .05$, were not significant.

The type of information × relevancy interaction on recognition was significant, $F(1, 51) = 7.52, p < .05, \eta^2_p = .13$. For conceptual stimuli, irrelevant ones ($M = 0.91, SD=.03$) were recognized better than relevant ones ($M = 0.86, SD=.03$). However, for perceptual stimuli, relevant ones ($M = 0.78, SD = .04$) were recognized better than irrelevant ones ($M = 0.67, SD=.04$). In other words, clothes brands were remembered better than shoe brands, and vivid images were remembered better than motionless images. A graph of this interaction effect can be found in Figure 1.
CHAPTER 4

DISCUSSION

The goal of this study was to explore how physical activity (walking) influences people’s emotional response to and memory for different types of stimuli. Results showed that walking didn’t influence people’s evaluation of and memory for stimuli compared with standing still. One possible explanation was that approach mindset might not be activated because participants didn’t actually “walking forward”. They walked on treadmills at a constant speed that they felt comfortable with, which looked like doing aerobic exercise at the same spatial position, but their spatial location never changed. In other words, they weren’t actually approaching something. Also, participants in this study were undergraduate students, who were less influenced by dual tasks that both require cognitive resource, compared with elderly people (Lindenberger, Marsiske & Batles, 2000). Their memory performance might not be influenced if they performed a simple behavior task (walking on treadmills) and an evaluation task at the same time.

Results also showed that people have a more favorable emotion response towards perceptual stimuli (images) than conceptual stimuli (brand names). However, conceptual stimuli (brand names) were remembered better than perceptual stimuli (images), which was opposite to hypothesis 4. One possible explanation was that abstract images and concrete words were used in this experiment, which was different from Paivio and Csapo (1969) study. In this situation, it would be easier for concrete words (brand names) to stimulate imagery processing because familiar brand names have many association nodes in memory networks, compared with abstract images to stimulate verbal processing because it’s hard to label an
abstract image. It’s been found that the concreteness of words was significantly related to the level of imagery value (Paivio, Yuille & Madigan, 1968), and verbal superiority on memory can occur for words that have high imagery values (Paivio, 1971).

In addition, results failed to support that people have a more favorable emotion response towards relevant stimuli compared with irrelevant stimuli, which means hypothesis 5 was not supported. One possible explanation may be participants didn’t experience conceptual fluency for the relevant stimuli in walking condition. One way to test it is having participants walk (and stand) on treadmills, and then ask them to indicate the extent to which they anticipate to see the relevant and irrelevant stimuli (similar to Lee and Labroo’s 2004 study). If the anticipation ratings for relevant stimuli were significantly higher than irrelevant stimuli in walking condition, it means that the relevant stimuli fall in the conceptual fluency context that can probably lead to a more favorable attitude.

An interesting interaction effect on memory was found between type of information and relevancy. For conceptual stimuli, irrelevant ones (clothes brand names) were remembered better than relevant ones (shoe brand names). However, for perceptual stimuli, relevant ones (vivid images) were remembered better than irrelevant ones (motionless images). Possible explanation may be participants were more familiar with these clothes brands (e.g. GAP, LEVI’S) than shoe brands (e.g. K-SWISS, SKECHERS) since I chose not quite popular shoe brands here. For perceptual stimuli, they were novel images either indicating movement or not, thus the relevant ones were remember better than irrelevant ones, partially supported hypothesis 6. If the familiarity of the clothes brands and shoe brands were controlled,
recognition rate may be higher for relevant ones (shoe brand names) than irrelevant ones (clothes brand names).

4.1 Theoretical Importance

Previous studies researching walking while performing another cognitive task came from a physiology and neurology perspective. The researchers focused on the influence of the second cognitive task (speaking, remembering, fasten buttons) on walking speed, walking pattern, and walking stability, which generate dual-task costs. The influences of walking on the second cognitive task were seldom researched. This study used a media perspective that focused on the influence of walking on people’s emotion response to and memory for the information they saw on phones, which filled in a gap in the literature.

Also, previous studies treated the reduced performance of walking and cognitive task as a deficiency of aging or clinical problems. The researchers used mostly between group analyses to compare the performance of old adults or patients with young adults. Young adults were treated as a reference group and the within group differences for young adults were seldom researched. This study focused on the within group differences for young adults. Differences of responding to stimuli while walking or standing still were studied here.

4.2 Practical Importance

Although this experiment failed to support that walking influenced people’s evaluation of and memory for the stimuli they saw at the same time, future research need to explore this idea probably in a revised way. Nowadays our interaction with media information and advertisements become more and more mobile. We can access information by using our cell phones when we are sitting, standing, walking or lying down. In addition, GPS are placed in
our phones that our physical status (whether moving or static) can be tracked. It’s important to see whether the physical condition will influence our cognitive response to stimuli we saw on phones in order to facilitate a more effective commutation.

One of the findings of this study was that people have more favorable emotion responses towards perceptual stimuli (images) but they remember conceptual stimuli (brand names) better. This indicates that depending on the purpose of the company or advertisement (whether to generate a favorable attitude or increase memory), different type of information should be used on a limited size screen (phones).

4.3 Limitations and Future Research

One of the limitations was that I didn’t carry out a pretest for all the stimuli to ensure that they have similar familiarity and attitude, thus the different emotion responses and recognition rates for conceptual stimuli (brand names) and perceptual stimuli (images) may due to participant’s initial familiarity and attitude towards them. For example, since I use familiar conceptual stimuli (brand names) and novel perceptual stimuli (images), the higher recognition rate for the conceptual stimuli (brand names) than perceptual stimuli (images), may due to the fact that people were more familiar with conceptual stimuli (brand names), instead of the difference between conceptual information and perceptual information. For future research, I will do a pretest first to control the familiarity, arousal level, and attitude towards all the stimuli that will be used in the main experiment. In addition, when I tested participants’ recognition memory towards the stimuli they saw a day before, I framed the question like “Did this picture appear in the walking experiment”, which might cause confusions because it’s a within subject design that participants walked for one section and
stand for the other. They might answer “yes” to those pictures they saw in the walking section, instead of the experiment they did yesterday. In the future, I will frame the question like “Did you see this picture in the experiment that you participated yesterday” to avoid possible misunderstanding.

Another limitation of this study was that the association between walking and approach mindset hadn’t been testified. Walking may probably associate with many other concepts. Future research can carry a qualitative experiment first to find out several concepts that people associate walking with, and then use an IAT test to find out the association strength.

Also, future research can research people viewing phones while walking on a hallway or path that has obstacles. In reality, people walk in many places, and different environment generate different cognitive load for people. It’s important to see how the difficulty level of the behavior activities influences people’s cognitive response.

Last but not least, stimuli that are both conceptual and perceptual (advertisement that have both text and images) should be used to test what proportion of conceptual and perceptual information generate the cognitive responses that we want when people are walking.

4.4 Conclusion

Many studies explored how physical cues might influence people’s psychological responses, but seldom of them looked at walking specifically. This study examined how walking might influence people’s evaluation of and memory for different types of stimuli. No main effects of walking on either evaluation or memory were found, however, it’s been found
that people have more favorable emotion responses towards perceptual stimuli (images) but they remember conceptual stimuli (brand names) better.
REFERENCES


Schmitt, B. H., Tavassoli, N. T., & Millard, R. T. (1993). Memory for print ads:


TABLES AND FIGURES

TABLE 1
MEANS (SD) FROM EXPERIMENT

<table>
<thead>
<tr>
<th></th>
<th>Valence (Mean/SD)</th>
<th>Recognition Accuracy (Mean/SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk</td>
<td>3.20 (.07)</td>
<td>0.81 (.03)</td>
</tr>
<tr>
<td>Stand</td>
<td>3.13 (.06)</td>
<td>0.81 (.03)</td>
</tr>
<tr>
<td>Conceptual</td>
<td>3.06 (.06)</td>
<td>0.89 (.02)</td>
</tr>
<tr>
<td>Perceptual</td>
<td>3.27 (.07)</td>
<td>0.73 (.03)</td>
</tr>
<tr>
<td>Walk×Relevant</td>
<td>3.21 (.08)</td>
<td>0.82 (.03)</td>
</tr>
<tr>
<td>Walk×Irrelevant</td>
<td>3.18 (.07)</td>
<td>0.79 (.03)</td>
</tr>
<tr>
<td>Stand×Relevant</td>
<td>3.10 (.07)</td>
<td>0.82 (.04)</td>
</tr>
<tr>
<td>Stand×Irrelevant</td>
<td>3.16 (.08)</td>
<td>0.80 (.03)</td>
</tr>
</tbody>
</table>

Notes. n=60 for Valence, n=52 for Recognition Accuracy
FIGURE 1
INTERACTION EFFECT OF TYPE OF INFORMATION AND RELEVANCY ON RECOGNITION
APPENDIX A: EXPERIMENT STIMULI

Conceptual Relevant Stimuli

SKECHERS  
K•SWISS

Columbia  
Timberland

Conceptual Irrelevant Stimuli

AÉROPOSTALE  
LEVI’S

UNIQLO  
GAP
Perceptual Relevant Stimuli

Perceptual Irrelevant Stimuli
APPENDIX B: DEPENDENT MEASUREMENT QUESTION

Emotional Response: Valence

Please use the slider below to indicate the level of happiness or unhappiness you felt while viewing the previous image.

Memory: Recognition

Did this picture appear in the walking experiment?

- Yes
- No
APPENDIX C: Pre-Participation Health Screening Questionnaire

Physical activity and fitness testing are safe for most individuals. To ensure safe participation we would like to know some specific information about your health before you are included in this study. In some cases, we simply need to know more information (e.g., that you have a puffer for asthma) while in other situations, we might ask you to see a physician before participating in the study. Please check:

“Yes” beside all items that apply to you, and feel free to ask us to clarify if anything is unclear.

YES  NO

1. You have a diagnosed medical condition that prevents you from participating in intense exercise.

2. A doctor has ever told you that it would be unsafe to do intense exercise.

3. Anyone in your family has ever died of a sudden heart attack before the age of 35 years.

4. Anyone in your family has ever been diagnosed with a serious heart condition before the age of 35 years.

5. You have high blood pressure.

6. You have asthma and uses a puffer or inhaler.

7. You have diabetes.

8. You have epilepsy (seizures).

9. You have unexplained fainting or dizziness, especially with activity.

10. You have unexplained chest pain, breathlessness, or tiredness with activity.
<table>
<thead>
<tr>
<th>Questions</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Has your doctor ever said that you have a heart condition and that you should</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  Do you feel pain in your chest when you perform physical activity?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  In the past month, have you had chest pain when you were not performing any</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4  Do you lose your balance because of dizziness or do you ever lose consciousness?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5  Do you have a bone or joint problem that could be made worse by a change in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6  Is your doctor currently prescribing any medication for your blood pressure or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7  Do you know of any other reason why you should not engage in physical activity?</td>
<td></td>
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