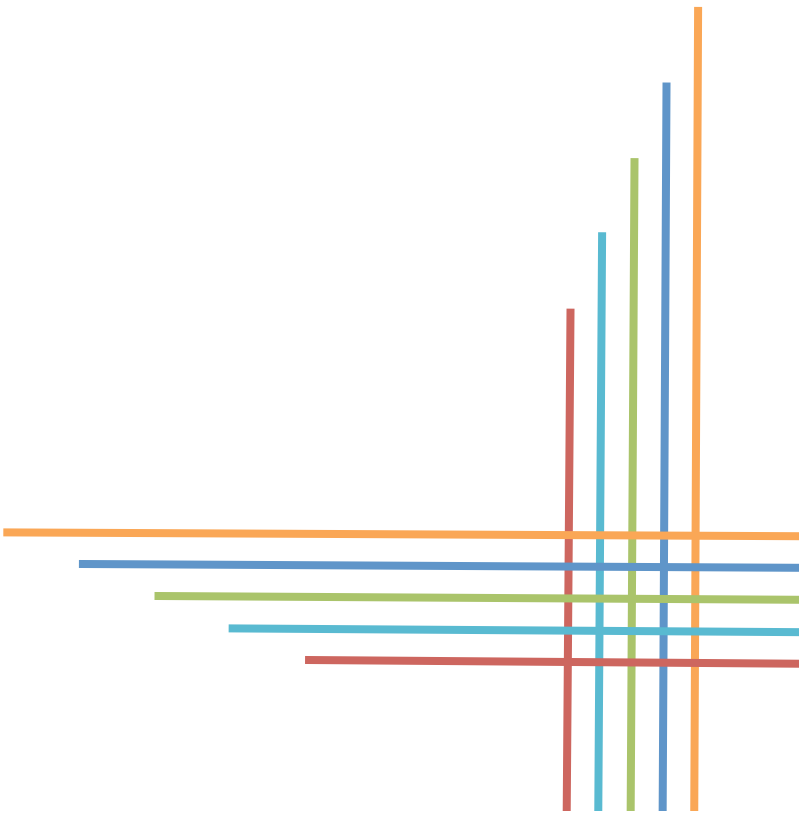
Volume 2, May 2013

ISSN 1927-2820 (Print)
ISSN 1927-2839 (Online)

UBC ΨUJP

University of British Columbia's

Undergraduate Journal of Psychology



Editor-in-Chief: Katharina Block

http://ubcujp.psych.ubc.ca

University of British Columbia's Undergraduate Journal of Psychology

Volume 2 May 2013

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

UBC's Undergraduate Journal of Psychology

Volume 2 **May 2013**

Contents

University of British Columbia's Undergraduate Journal of Psychology (UBCUJP) is an annual, student-run, peer-reviewed journal. Our goal is to provide a platform for psychology undergraduates at UBC to showcase their research. We believe that months of dedicated work that undergraduates put into their research papers should result in more than a mark for a class and then quickly forgotten about. Instead, these research papers provide a fantastic opportunity for undergraduates to experience the peer-review process while also being a valuable resource for faculty and students to learn about the research happening next door.

Our focus is three-fold:

1) To undergraduate authors we offer a valuable and rare experience into the peer-review and publication process.

2) To our editorial board and reviewers, we offer the opportunity to develop reviewing, critical thinking and managerial skills that are essential for success in graduate studies and future careers. Being involved with UBCUJP is also a great opportunity to network with faculty, graduate students and other motivated undergraduates.

3) To graduate students and faculty, we offer the chance to engage and mentor undergraduate students.

We hope the journal itself will offer a unique peek into various developing projects around the research labs of UBC's psychology department.

UBCUJP (Print ISSN: 1927-2820, Online ISSN: 1927-2839) is generously supported by the Department of Psychology at the University of British Columbia, 2136 West Mall, Vancouver, B.C., Canada, V6T 1Z4, telephone: 604-822-2755, fax: 604-822-6923.

Electronic Access: Visit ubcujp.psych.ubc.ca to find the online version of our journal.

Contact: Email us at ubcujp@psych.ubc.ca

Editor's Note

Katharina Block

I am beyond excited to be able to present this second issue of the UBC Undergraduate Journal of Psychology to you. It has been a pleasure for me to work with all the committed undergraduate students who participated in the journal as submitting authors, reviewers, editors and formatters. Without all their dedication, there would not be another issue of UBCUJP.

After the success of the first issue and the great leadership of David Wu, we knew that we had a tough act to follow. Last year, the response from students was enormously positive and the amount and quality of submissions exceeded expectations. Hoping to repeat such as success seemed overly optimistic, sometimes even unrealistic to me at first.

I was taught otherwise when submissions started coming in. This year, we spread out submissions to two cycles (one in each semester) and thereby gave authors a chance to get feedback on papers in the first semester and revise their papers accordingly to reach a level fit for publication. I was very pleased to see that several authors who were rejected in the first semester took this opportunity and transformed their already good papers into excellent ones.

Once again, we were delighted by the amount of great work UBC Psychology students produced in the course of a year. The number of submissions and range of topics we see in this publication is evidence for a department with active and passionate undergraduate researchers. We are proud to be able to present this research to you. From research on the effects of threats to meaning to a study on neural circuit integration in an animal model, our journal offers topics from almost every major area of psychology.

Importantly, I want to thank all those who have dedicated their time to UBCUJP this year for their help. I had the chance to work with a number of highly involved and inspiring individuals, which made my work so much more enjoyable. I want to especially thank Charlie, Jenn, Simon, Sophia, Setareh, Meghan and Bri for doing a fantastic job as section editors. Furthermore, I want to thank Dr. Michael Souza for being immensely supportive and always having an open ear for me as well as Dr. Sunaina Assanand whose help has also been important for this endeavour.

Katharina Block
Editor-in-Chief, UBCUJP

Social
Research Report

The Empathy Paradox: Exploring SES Related Differences in Empathy, Perspective Taking & Health

Ashley V. Whillans[1]
[1]Department of Psychology, University of British Columbia

Edited by: Setareh Shayanfar, Department of Psychology, University of British Columbia. Received for review September 23rd, 2012, and accepted March 7, 2013.

Abstract

It is often believed that empathy and perspective taking are inherently positive behaviors. However, recent research indicates that these abilities do not always result in positive health outcomes for the actor. As individuals of low socioeconomic status (SES) empathize with others more often and have more social network stress, empathy and perspective taking may be one way that SES "gets under the skin" to affect physical health. The current study explored the relationship between SES, empathy and perspective taking and cardiovascular risk factors, including blood pressure (BP) and the inflammatory markers Interleukin-6 (IL-6) and C-reactive protein (CRP). Healthy adult participants (n = 222) reported how often they engaged in empathy and perspective taking, venipuncture was performed, and BP and SES were measured. Although there was no relationship between SES and empathy/perspective taking, data showed that perspective taking was significantly and positively related to higher systolic and diastolic blood pressure. These results provide preliminary evidence that perspective taking may not always be the best for one's health.

Keywords: *socioeconomic status, empathy, perspective taking, CVD, inflammation, health*

Can emotions generated in response to every day social interactions, such as empathy, affect our physical health? Defined as the ability to understand and to feel sympathy for others (Davis, 1983), empathy is an important part of our daily lives. Whether we are comforting our spouse after a long day at work, or providing advice to a friend – empathy, together with perspective taking, allows us to succeed in our relationships and to navigate and negotiate our complex social worlds. While it is often assumed that empathy and perspective taking are inherently positive behaviors, the possession of these abilities may not always lead to positive health outcomes for the actor.

For example, research indicates that individuals of lower socioeconomic status (SES) are more likely to empathize with others (e.g., Piff et al., 2010). In addition,

Corresponding Author:
Ashley V. Whillans
E-mail: ashleywhillans@psych.ubc.ca

individuals of lower SES have worse health outcomes than higher SES individuals (Marmot, Shipley, & Rose, 1984). Given this research, empathy and perspective taking may provide one novel route by which the experience of low social status "gets under the skin" to affect physical health. Furthermore, low SES individuals experience more stress in their social networks than high SES individuals (e.g., Gallo, Bogart, Vranceanu, & Matthews, 2005). This research suggests that one factor that may influence the proposed relationships between SES, empathy and worse health is the amount of social network stress experienced by low SES individuals.

SES & Health Status

Socioeconomic status is one of the best predictors of morbidity and mortality around the world (Adler et al., 1993). In the late 1970s, epidemiological studies discovered a negative inverse relationship between SES and health. Specifically, studies found a graded relationship, whereby individuals of higher SES had lower rates of morbidity and mortality, while individuals of lower SES had higher rates of death and disease (e.g., Marmot, Shipley, & Rose, 1984). Since these initial studies were conducted, researchers have recognized the role of socioeconomic factors such as income and education in predicting the health status of individuals (Backlund, Sorlie, & Johnson, 1996; Ecob & Davey Smith, 1999). Currently, SES is linked to a variety of health outcomes including diabetes (e.g., Illsey & Baker, 1991), cancer (Pincus, Callahan, & Burkhauser, 1987), and cardiovascular disease (Marmot, Shipley, & Rose, 1984). These SES related health disparities are found in countries all over the world, regardless of access to health care (e.g., Adler & Ostrove, 1999).

SES, Psychosocial Variables & Health

A variety of mechanisms have been proposed to explain this socioeconomic gradient in health, such as differences in education and material living conditions (see Braveman, Ergeter, & Williams, 2011 for a review). Yet, these factors do not fully account for the relationship between SES and health, prompting a search for other mediators. To date, much of the work on socioeconomic status has focused on individual or personality factors, such as negative emotion (i.e., anger) to account for these differences (see Gallo & Matthews, 2003). However, social factors, such as relationships and interpersonal processes should also be taken into consideration when assessing the relationship between SES and risk factors for disease (Miller, Chen, & Cole, 2011).

Empathy/Perspective Taking & Health

Two unexplored psychosocial factors that may account for the relationship between low SES and negative health outcomes are empathy (feelings of sympathy for others) and perspective taking (the tendency to adopt the viewpoints of others) (Davis, 1983). Empathy and perspective taking involve the recognition of another individual's emotions, and result in being affected by another's emotional or arousal state (see DeWaal, 2008 for a review). To date, researchers have focused on the beneficial uses and outcomes of these behaviors. Counseling psychologists consider empathy a skill that should be cultivated and acquired (Barone et al., 2005), social psychologists use empathy interventions to reduce aggression (Richardson, Hammock, Smith, & Gardener, 1994), and an extensive line of research has

linked empathy with positive outcomes such as altruism (Batson & Moran, 1999), moral reasoning (Kohlberg, 1976), and social competence (Davis, 1983). Despite these findings, recent research suggests there may be a dark side to walking a mile in another's shoes.

Under certain circumstances, empathy may incur costs for the actor. For example, high levels of empathy are negatively related to physical and mental health, and can predict the development of burnout symptoms (e.g., Miller, Stiff, & Ellis, 1988). In the health care literature burnout is well documented, and studies suggest that empathy plays a key role in the development of negative outcomes including depression and physical exhaustion (e.g., Showalter, 2010). In a representative study of paramedics, individuals who reported more empathic interactions with clients experienced greater affective arousal (fear), and more sleep disturbance than those who were less empathic (Regeher, Goldberg, & Hughes, 2002). In another study of volunteer trauma workers, empathy moderated the relationship between past traumatic experiences and secondary traumatic stress (MacRitchie & Leibowitz, 2010). This line of research indicates that empathy may lead to negative health outcomes through the shared experience of distress (McCann & Pearlman, 1990).

Empathy and perspective taking can also predict the onset of depressive symptoms for people with high levels of social network distress – a measure of stress of close social network members (Schieman & Turner, 2001). In a study of Native American older adults, Kirby (2008) found a strong, positive relationship between empathy, social network stress, and depressive symptoms. In this study, participants who reported the highest levels of empathy were more likely to experience depressive symptoms when they had a close social network with high levels of stress, whereas individuals with low levels of empathy experienced fewer depressive symptoms regardless of stress within their social network (Kirby, 2008). This study provides initial evidence that empathy is related to the transmission of stress from the social environment to the individual – an important step to consider in understanding the relationship between SES, empathy, and health.

SES & Empathy/Perspective Taking

As described, research suggests that empathy can lead to worse health outcomes through the shared experience of distress. However, not everyone engages in empathy and perspective taking equally. Interestingly, experimental research shows that individuals with more social power (e.g., the ability to influence others and to control resources) are less likely to take the perspective of or to empathize with others (e.g., Gonzaga, Keltner, & Ward, 2008). In one study, participants were randomly assigned to experience high or low social power (Galinsky, Magee, Inesi, & Gruenfeld, 2006). Relative to participants in the low power condition, participants in the high power condition were less likely to take the perspective of others and were less accurate at perceiving the emotions of others in an ambiguous situation (Galinsky et al., 2006). This study suggests a power-induced impediment to engaging in empathy and perspective taking.

Lower and high status individuals also show distinct physiological outcomes during social interactions that involve engagement

in perspective taking and empathy. In the study mentioned above, participants who scored higher on ratings of social power engaged in greater emotional regulation and showed physiological responses indicative of a relaxed state upon hearing their partner tell them a distressing story (van Kleef et al., 2008). Low power participants did not show this response. In sum, although social power and SES are distinctly different constructs (Keltner, Gruenfeld, & Anderson, 2003) this research suggests that high-power individuals are better able to control their emotional and physiological responses to the distress of those around them, whereas lower status individuals are more affected by their environment as a result of engaging in more empathic behaviors. Together this research suggests that low SES individuals may engage in more perspective taking and empathic behaviors, which may result in worse health outcomes for the actor.

SES & Social Network Distress

One reason that increased empathic and perspective taking behaviors may lead to worse health is because of the stress that low SES individuals face in their close social relationships. Research indicates that low SES individuals are more likely to experience stresses and strains in their close social relationships (Gallo, Bogart, Vranceanu, & Matthews, 2005). These strains are due in part to the experience of day-to-day demands and overlapping social roles (Stephens, Townsend, Martire, & Druley, 1997). In addition, low SES individuals are more likely to have roles that need or demand their attention at the same time – which is theorized to cause stress for the individual as it places a drain on their time and resources (Martire & Stephens, 2003). In turn, individuals of low SES may not only experience more stress themselves, but may have more social network stress. Together, increased social network stress coupled with a heightened emotional response and greater feelings of distress for the concerns of others may provide a plausible explanation for the proposed relationship between empathy, perspective taking, and worse health outcomes for low SES individuals.

SES, Empathy & Perspective Taking & CVD Risk factors

As mentioned, socioeconomic status is one of the best predictors of disease risk in the world, and is related to various health outcomes including cardiovascular disease (CVD) (Marmot, Shipley, & Rose, 1984). As such, it is important to assess how the social environment and related psychosocial variables, such as empathy and perspective taking, contribute to CVD risk for low SES individuals. As empathy is linked to short-term feelings of distress for lower SES individuals, and to long term health problems in general, it is reasonable to believe that empathy and perspective taking contribute to risk factors for CVD.

One well-established risk factor for CVD is high blood pressure (BP). High blood pressure is part of a constellation of symptoms called metabolic syndrome (obesity, insulin resistance, triglycerides and elevated cholesterol) that significantly predicts the development of CVD (Ford, Giles, & Dietz, 2002). CVD is also associated with elevated levels of inflammatory markers such as C-reactive protein (CRP) and interleukin-6 (IL-6). IL-6 has been shown to significantly predict the development of CVD 10-15 years after initial assessment and for certain individuals, levels of CRP have been found to be a better predictor of future

cardiovascular events than the assessment of traditional risk factors like high cholesterol (Ridker, Hennekens, Buring, & Rifai, 2000).

Low SES is also related to a greater prevalence of metabolic syndrome symptoms across the lifespan (Goodman, Daniels, & Dolan, 2007; Goodman et al., 2005), and higher levels of CRP and IL-6 (Pollitt et al., 2007). As SES influences important markers of CVD risk, and lower SES individuals experience greater stress in their social networks and greater responsiveness to stress, it is reasonable to believe that empathy is one path through which SES affects biological markers of health. Additionally, research indicates that social factors related to SES affect CVD risk. In a recent study, individuals who had more negative daily social encounters showed increased risk on a composite score of metabolic syndrome over two years, controlling for depression and personality traits (Ross, Martin, Chen, & Miller, 2011). These findings show that negative social interactions, such as vicarious distress in response to an upset friend or family member, may accelerate CVD progression.

Hypothesis. Based on the research mentioned above, we hypothesize that individuals of lower SES will report higher levels of empathy and perspective taking compared to higher SES individuals, and that these traits will be related to CVD risk factors such as IL-6, CRP and BP (Lakka et al., 2002). We also hypothesize that higher SES individuals will report engaging in less empathy and perspective taking, which will correspond to a healthier biological profile for these individuals, as measured by lower levels of IL-6, CRP, and lower BP ratings. Furthermore, we predict that social network stress, or the stress of close friends and family, will be related to empathy and health outcomes for low SES individuals. Specifically, we predict that the more empathy and perspective taking a low SES individual engages in and the more social network stress that this individual experiences, the more likely they will be to have worse health outcomes (increased IL 6, CRP and BP).

Method

Participants

Two hundred and forty-two healthy adults between 34 and 64 years of age (M = 46, SD = 5.38) were recruited from the Vancouver, BC community through transit, radio, and newspaper advertisements. Seventy-seven percent were females; 60% were Caucasian, 25% were Chinese or other Asian descent, 6% were Indian, 5% were Latin American, and 4% were of varied ethnicities (2% Aboriginal/First Nations, 1% African, and 1% Other). Data were collected as part of a two-year longitudinal study evaluating socioeconomic status and cardiovascular disease risk in families with adolescent children.

Eligibility Criteria

Individuals were eligible to participate if they were (a) fluent in English; (b) free of acute illness in the past two weeks1; (c) not pregnant, (d) without a history of chronic medical or psychiatric disorders, and (e) not taking any regular prescription medication. Eligibility was confirmed using an over the phone survey.

[1] Acute illness was defined as not having a cold, flu or infection two weeks prior to coming to the lab.

Procedure

Individuals who expressed interest in participating completed a brief phone screening. During this screening, individuals provided health, demographic, and availability information. Those who wished to participate and who met basic health criteria were invited to the laboratory for the first of two assessments, upon which this study is based. During this lab visit, individuals were provided with a review of the study procedures and were given the opportunity to ask questions before providing written consent. Participants then completed a clinical interview and questionnaires that assessed empathy and perspective taking behaviors, and socioeconomic status. Participants also underwent a blood draw and blood pressure (BP) measurements were taken. Upon completion of the lab visit, participants were reimbursed $125 for their time and travel to the study location.

Measures

Socioeconomic status. To date, a number of measures have been used to assess socioeconomic status. Some researchers have focused on prestige-based measures, such as years of education and occupation (Krieger et al., 1997), while others have focused on resource based measures related to material assets, such as family income (Winkleby et al., 1992). As different measures of SES may indicate different pathways to health, participants completed measures belonging to each SES category. To assess years of education, participants were asked to list the years of education completed over the course of their lifetime. To assess family income, participants reported their family's total gross income for the past 12 months before taxes. Subjective perceptions of SES were assessed using the MacArthur Scale of Subjective Social Status (see Goodman et al., 2001).

Empathy and perspective taking. Empathy and perspective taking were assessed using two subscales from the Interpersonal Reactivity Index (IRI) (see Davis, 1980). This questionnaire views empathy as a set of distinct constructs that are related but clearly discriminable from one another (Davis, 1983). The perspective taking subscale of this questionnaire includes seven items that measure the tendency to adopt the point of view of other people in everyday life (e.g., "I sometimes try to understand my friends better by imagining how things look from their perspective"). The empathic concern subscale, also seven items, measures the tendency to experience feelings of warmth, compassion, and concern for other people (e.g., "I often have tender, concerned feelings for people less fortunate than me"). Participants were asked to respond on a Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Each item yielded a positive score, and global scores were calculated for each subscale by averaging participants' responses.

To ensure that these two scales were measuring distinct constructs in our sample, the relationship between the perspective taking and empathic concern subscales was assessed using a Pearson's correlation. In the current sample, the inter-correlation between the two subscales was $r = .48$. The average inter-item correlation of the seven items of the empathy subscale was $\alpha = .67$, and the average inter-item correlation of the seven items of the perspective taking subscale was $\alpha = .77$. The fact that these subscales correlated less well with each other than they did within themselves

provided preliminary evidence of discriminant validity. We then conducted factor analysis using a principle axis factoring model with varimax rotation, and two factors emerged – attesting to the discriminate validity of these two subscales. Specifically, the two factor solution we found using orthogonal rotation indicated that these two factors were empirically distinguishable. Consistent with Davis (1980), these findings suggest that although there was some association between the cognitive (perspective taking) and emotional (empathic concern) subscales, they were not measuring identical constructs. Consequently, in the following statistical analyses, these subscales were assessed independently.

Social network stress. To quantify levels of household and social network stress, we administered modules of the UCLA Life Stress Interview (Hammen, 1991). This semi structured interview assesses the degree of acute and chronic stress experienced by participants over the last six months. While the UCLA interview probes chronic stress across major life domains (e.g., work), in the current analyses we focused on the Family and Friend domains. We focused on these two domains as we were hypothesizing that low SES individuals would have more stress in their social networks. To assess stress levels, a trained interviewer asked a series of open-ended questions and rated the level of chronic, ongoing stress experienced in each domain. Ratings range from 1 to 5, with higher numbers reflecting more severe and persistent difficulties. Reliability meetings were held monthly to insure that interviewers were all rating interviews similarly. During this process, coders were kept blind to the participants' socioeconomic status.

Blood pressure. To measure resting systolic blood pressure (SBP) and diastolic blood pressure (DBP), participants were seated in a chair, and a blood pressure cuff was placed on the participants forearm by a Research Assistant. Appropriately sized BP cuffs were selected according to the diameter of each participant's arm. Following a five minute rest period, four blood pressure readings, spaced two minutes apart, were collected using an automatic BP monitor (BPM-100, VSM MedTech, Coquitlam, BC). SBP and DBP were calculated by averaging the last three measures taken (the first reading is excluded as it tends to be elevated due to the novelty of the procedure). This device and protocol has been validated in adult populations and yields BP readings that meet the standards of the British Hypertension Society for accuracy and reliability (Mattu, Heran, & Wright, 2004).

CVD-related inflammatory markers. To assess systemic inflammation, a key predictor of cardiovascular disease risk, CRP and IL-6 were measured. As these inflammatory markers are found in peripheral blood, each participant underwent a blood draw (venipuncture). When participants first arrived in the lab, a topical anesthetic (APP, Schaumburg, Ill) was applied to minimize venipuncture discomfort, if requested. One hour later, participants underwent the venipuncture and peripheral blood was drawn into cell-preparation tubes containing sodium heparin (Becton Dickinson, NJ). These blood samples were analyzed *in-vitro* to determine levels of CRP and IL-6, as described below.

C - reactive protein (CRP). To measure CRP, whole blood samples were spun within one hour of the blood draw using centrifugation, at 1200 rpm for 10 minutes to separate blood serum from the rest of the sample. Serum levels of CRP were then measured using a commercially available enzyme-linked immunoabsorbant assay (ELISA) (R& D Systems, Minneapolis, MN). This assay used anti-CRP antibodies marked with an enzyme that acted as a fluorescent tracer. Fluorescent-marked complexes were then visualized under a microscope. Specimens were read with a spectrophotometer (Arlington, MA) which calculated the net color absorbency of each sample. In this measure, more color absorbency denoted higher serum levels of CRP. This test was capable of detecting CRP levels from 1 to 40 mg/L, and had a detection threshold of 0.20 mg/L (R & D Systems, 2008).

Interleukin-6 (IL-6). To measure IL-6, whole blood samples were spun within two hours of the blood draw using centrifugation, at 1200 rpm for 10 minutes, to separate serum from the rest of the sample. IL-6 was determined using an IL-6 specific ELISA (R&D Systems). Similar to the assay described above, anti-IL-6 antibodies bonded to IL-6 molecules, and an enzyme and substrate were added that changed the color of the IL-6/antibody complexes. Again, samples were read using a spectrophotometer, which allowed for the detection of IL-6 by calculating the net color absorbency of each sample. This test was capable of detecting levels from 0.45 to 10 mg/L and had a detection threshold of 0.40 mg/L (R & D Systems, 2008).

Statistical Design

To analyze the data, we used a correlational design as this was a non-experimental study and we were working with continuous variables. Tests of the four a priori hypotheses (see Figure 1) were conducted using Bonferroni adjusted alpha levels of .0125 per test (.05/4). This allowed us to correct for testing multiple correlation coefficients, which can increase the probability of Type 1 error. Throughout the analyses, we used two-tailed tests. Pearson's correlations were used to examine the relationship between SES, empathy and perspective taking, and the relationship between empathy, perspective taking, and IL-6, CRP, and BP. Pearson's correlations were also used to assess the relationship between SES, social network stress, and health. Participants who did not complete the IRI (n = 14), as well as six participants who did not complete blood draws were excluded from the analyses. Consequently, the following statistical analyses were based on 222 observations.

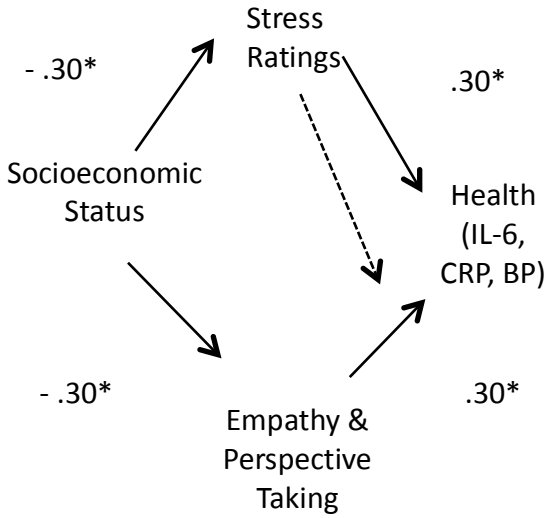


Figure 1. Expected results of the associations between SES, empathy & health.

Results

Participant's SES Characteristics

On average, participants had a university

education and an annual family income of $50,000-$74,999 as indicated by the information presented in Table 1. Table 1 also contains descriptive statistics for each SES measure e.g., years of education, annual family income, family savings, and perceived social status.

SES & Empathy/Perspective Taking

First, we assessed the relationship between participants' SES, and empathy and perspective taking. Shown in Table 2, SES measures and self-reported empathy (M = 22.16, SD = 4.27) and perspective taking (M = 19.16, SD = 4.48) were not significantly related, ps > .10. Contrary to the hypothesis, these findings suggest that SES was not associated with empathy or perspective taking in the current sample.

Empathy/Perspective Taking & Inflammatory Markers

Next, we evaluated the relationship between empathy and perspective taking and immunological markers of systemic inflammation. Controlling for age, gender, and ethnicity, we investigated the relationship between self-reported empathy and perspective taking and serum levels of the inflammatory biomarkers CRP and IL-6. Inconsistent with our hypothesis, empathy was not significantly related to serum levels of IL-6 (M = 13.75, SD = 1.76), r(216) = .10, p = .15, 95% CI [-.03, .23]. Perspective taking also was not significantly related to IL-6 levels, r(216) = .09, p = .23, 95% CI [-.05, .23]. Furthermore, there was no significant correlation between empathy and serum levels of CRP (M = 1.50, SD = 2.40), r(216) = .06, p = .41, 95% CI [-.08, .20] or between perspective taking and CRP levels, r(216) = .06, p = .42, 95% CI [-.08, .20].

Empathy/Perspective Taking & BP

Controlling for age, gender, and ethnicity we assessed the relationship between empathy, perspective taking, and diastolic and systolic blood pressure. Again, inconsistent with our hypothesis, empathy was not significantly related to systolic blood pressure (M = 110.25, SD = 11.97), r(216) = .11, p = .11, 95% CI [-.03, .25], or to diastolic blood pressure (M = 71.92, SD = 9.37), r(216) = .04, p = .59, 95% CI [-.10, .18]. Yet, perspective taking *was* significantly and positively correlated with systolic blood pressure, r(216) = .23, p = .001, 95% CI [.10, .36], and diastolic blood pressure ratings, r(216) = .17, p = .012, 95% CI [-.30, -.04].

SES & Life Stress Interview Ratings

Furthermore, we assessed the relationship between SES and social network stress, as well as the relationship between social network stress and health. Consistent with past research, LSI ratings of stress in the Family (M = 2.03, SD = .72) and Friend Domains (M = 2.38, SD = .97) were (for the most part) significantly and negatively related to the SES measures (See Table 3).

Life Stress Interview Ratings & Health Outcomes

Finally, we assessed the relationship between life stress ratings and health outcomes. Contrary to the hypothesis, there was no relationship between stress reported in the Family and Friend domains of the LSI and health outcomes such as BP, IL-6, and CRP (See Table 4). These results suggest that while SES was related to increased life stress, this reported life stress was not correlated with different physiological profiles in the current sample.

Because there was no relationship between SES and empathy in the current sample, or between life stress and health outcomes, we did not investigate whether life stress moderated the role between low SES and worse health outcomes for highly empathetic individuals.

Summary. Neither resource-based, prestige based, nor subjective measures of SES were significantly related to empathy or perspective taking. These finding suggest that, contrary to our hypothesis, individuals from lower SES backgrounds were no more likely to engage in empathy and perspective taking than high SES individuals in our sample. Empathy and perspective taking were not significantly related to the levels or production of inflammatory markers, CRP or IL-6. However, participants who reported engaging in more perspective taking showed significantly higher levels of systolic and diastolic blood pressure. These findings were *not* replicated for empathy – individuals who reported engaging in *more* empathetic behaviors were no more likely to have elevated blood pressure than individuals who reported engaging in fewer empathetic behaviors. Lastly, life stress was negatively related to SES, indicating that lower SES individuals had more stress in their family and friend relationships. LSI ratings did not relate to any of the health outcomes we measured. These findings indicate that SES was related to increased psychological distress, but that this distress did not manifest itself physically for individuals in our sample. Due to the lack of a significant relationship between SES and empathy and perspective taking, the moderating role of life stress on health outcomes for low SES was not assessed (see Figure 2).

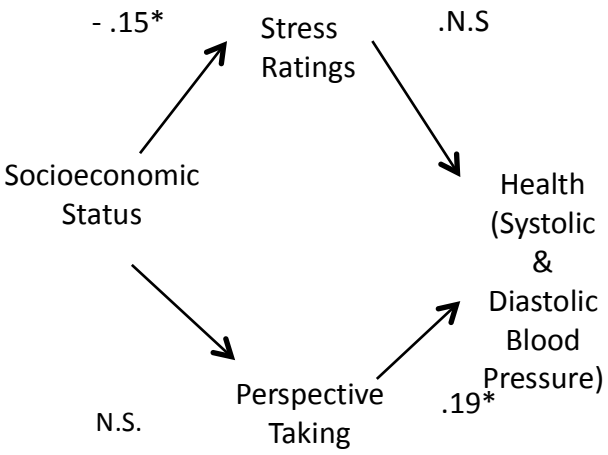


Figure 2. Obtained results of the associations between SES, empathy &health.

Note. * = p < .05 two tailed; controlling for gender, ethnicity and age. All significant correlations related to SES represent the average coefficient of the composite measures, for the purpose of the diagram.

Discussion

Together, our findings suggest that empathy and perspective taking may be unrelated to socioeconomic status. These data also provide preliminary evidence that engaging in perspective taking are related to higher levels of systolic and diastolic blood pressure. Further, these results show that SES and life stress may not *always* lead to negative health outcomes – as indicated by the null relationship between SES, life stress, and health. Our study emphasizes the need to examine the relationship between SES, empathy/perspective taking and health, and proposes interesting areas for future research.

SES & Empathy/Perspective Taking

Contrary to the hypothesis, we found no relationship between socioeconomic status, empathy and perspective taking. However, there are several explanations that may account for these null results. To date, past research has looked primarily at the relationship between empathy and perspective taking and social power – defined as "the ability of an actor to change the incentive structures of other actors to bring about desired outcomes" (Dowding, 1996). Nonetheless, the construct of socioeconomic status is conceptually distinct (Keltner, Gruenfeld, & Anderson, 2003). While social power relates to having control over *others*; SES relates to having control over *one's self*. Because socioeconomic status such as measures of material wealth, education and social standing emphasize the obtainment of resources and self-ability and not control over others they may not decrease other-oriented behaviors to the same extent as social power; although more research is needed to elucidate these conceptual relationships.

Another explanation for these null findings may be accounted for by the high SES of participants in our sample. The majority of individuals who participated in this study were well-educated, had a fair amount of savings, and steady work (See Table 1). For example, 93% of the sample had completed some college, and 62% of participants had a bachelor degree or higher at the time of the study. Because the majority of participants in this sample had a relatively high SES, we may have been unable to observe the proposed differences in empathy and perspective taking for individuals from low vs. high SES backgrounds. Future research should recruit a more diverse sample of participants from a wider range of socioeconomic backgrounds to provide a stronger and more reliable test of the hypotheses.

The study's design may have also contributed to the null findings by making it difficult to observe the proposed relationships between SES and empathy/perspective taking. Specifically, measurement error may have confounded our results. For example, we measured empathy and perspective taking using self-report. This may have created a response bias whereby individuals responded with how they thought they *should* answer, rather than reporting on their *actual* behavior. This could be a concern in our study as empathy and perspectives taking are regarded as desirable traits (e.g., Cohen, 2004).

This study may have also lacked psychological realism. Most research assessing behavioral differences related to power and SES, use experimental manipulations or observational designs. In a recent study, participants were asked to fill out the MacArthur ladder of perceived social status in a way that made them feel as if they were high or low social status. Using this paradigm, researchers found differential outcomes in helping behavior – whereby individuals assigned to the high SES condition were less likely to help others than individuals assigned to the low SES condition (Piff et al., 2010). Thus, utilizing experimental design and assigning participants to low or high SES conditions, instead of using self-reports, may have provided a direct test of the relationship between SES and empathy. Future research should employ experimental techniques and observe behavioral differences in a natural setting to more accurately test

when and how people of different SES backgrounds respond empathetically in everyday life.

Empathy, Perspective Taking & Health

Perspective taking and empathy were unrelated to most of the health outcomes we assessed. In particular, empathy/ perspective taking was unrelated to chronic inflammation (IL-6 and CRP). The insignificant findings between empathy and perspective taking and inflammation are not surprising considering we were assessing a healthy population. Research indicates that it is easier and more appropriate to assess psychosocial variables as they relate to health using diseased or chronically stressed individuals (Miller, Chen, & Cole, 2011). A stronger test of the relationship between empathy and health would be to study empathy and perspective taking in a chronically diseased population consisting of both low and high SES individuals. This would allow us to closely observe differential outcomes for high empathetic vs. low empathetic individuals and would make it easier to assess health related outcomes.

SES, Life Stress & Health

Despite a robust and well-documented relationship among SES, stress, and health, we also found a non-significant relationship between stress and health outcomes. Specifically, we documented a positive and significant relationship between SES and stress – whereby SES was negatively related to friend and family stress – meaning that higher SES individuals were less likely to report stress in their friendships and their family relationships. However, we found no significant relationship between measures of life stress and health measures (IL-6, CRP, and BP). We also found no significant relationship between SES and the health outcomes measured, although these correlations were not reported in the context of this manuscript. Together, these findings provide further evidence that there may not have been enough variability in our sample to detect distinct health outcomes based on socioeconomic status.

Moreover, differences in health between low and high SES (and low and high stressed individuals) are less apparent in samples that consist of healthy individuals under normal environmental conditions, compared to individuals undergoing periods of acute stress. It is easier to observe differential health outcomes for low SES and chronically stressed individuals who are also experiencing acute stress, in addition to the chronic stress they experience on a day-to-day basis, as measured by the LSI. This phenomenon is often referred to as "acute + chronic," and may help to explain why we observed no relationship between measures of physical health and SES and life stress for individuals in this study (see Marin, Chen, Munch, & Miller, 2009). Other research should manipulate acute stress in the lab to simulate this acute + chronic stress response, such as by having individuals listen to a distressing event of their spouse or family members. By using this kind of manipulation we may have been more likely to observe the proposed results and observe differential effects for empathy and perspective taking and health outcomes related to SES and life stress.

While most of our health markers (IL-6, CRP) were unrelated to empathy and perspective taking, there was a significant relationship between perspective taking and systolic and diastolic blood pressure in our sample. More research is needed to expand and confirm this relationship, and to

determine why empathic concern (which is the emotional component of empathy), was *not* significantly related to physiological reactivity (blood pressure measures), although perspective taking (the more cognitive component of this scale) *was* significantly related to systolic and diastolic blood pressure ratings.

One explanation is related to the structure of the IRI. While the perspective taking subscale questions focus less on the emotional aspects of empathy, the empathy subscale questions focus more on having compassionate feelings toward others– which some participants may feel uncomfortable reporting. More research is needed to elucidate the divergent effects of empathy and perspective taking on physiological arousal. To do so, it would be necessary to measure other aspects of empathy, to confirm the discriminate validity of the questionnaire we used, and to bolster the strength of the test by using additional empathy and perspective taking measures. This would allow us to tease apart the aspects of empathy (cognitive vs. emotional) associated with worse health outcomes such as increased systolic and diastolic blood pressure.

It is important to approach the interpretation of this data with caution due to its correlational nature – which cannot make statements about the causal relationships between variables. Other factors might account for the observed positive relationship between perspective taking and higher levels of systolic blood pressure. For example, individuals who rate high in perspective taking may gravitate towards jobs that are more stressful which could account for higher blood pressure ratings for these individuals. Subsequent analysis should control for occupation, personality factors and factors such as family history of hypertension. This would allow us rule out alternative explanations that may account for the relationship between perspective taking and systolic blood pressure.

Overall, this study's major limitation is its correlational design, as we cannot prove the existence of a causal relationship between *any* of the variables studied. Another limitation is the sample used in this study. Future research should study clinical populations, and seek out a more varied sample in terms of SES; as our sample was healthy, and relatively high SES. Future research would also benefit from using experimental methods to manipulate SES, presenting participants with an acute stressor during the laboratory test, using objective *and* subjective measures of empathy, and observing the effects of empathy and perspective taking on health in a chronically diseased population. Finally, this research should be used to create empathy interventions – the implementation of empathy and perspective taking reduction strategies – to provide a causal test of the current hypothesis.

In sum, this study suggests that more research is needed to contextualize the relationship between empathy, perspective taking, and health for low and high SES individuals. More research is required to confirm our findings that perspective taking is related to higher levels of systolic and diastolic blood pressure, and to elucidate how the different components of empathy (cognitive vs. emotional) may be differentially associated with SES and health factors related to CVD. Although methodological limitations may account for certain results and null-findings, these data

provide initial evidence that walking a mile in someone else's shoes may not always be the best for one's health.

Declaration of Conflicting Interests

The author declared they have no conflicts of interests with respect to their authorship or the publication of this article.

References

Acheson, D., Baker, D., & Illsley, R. (1998). Inequalities in health. BMJ: British Medical Journal, 317 (7173), 1659.

Adler, N. E., Boyce, W. T., Chesney, M. A., Folkman, S., & Syme, S. L. (1993). Socioeconomic inequalities in health. JAMA: The Journal of the American Medical Association, 269(24), 3140-3145.

Adler, N. E., & Ostrove, J. M. (1999). Socioeconomic status and health: What we know and what we don't. Annals of the New York Academy of Sciences, 896(1), 3-15.

Backlund, E., Sorlie, P. D., & Johnson, N. J. (1996). The shape of the relationship between income and mortality in the United States: Evidence from the national longitudinal mortality study. Annals of Epidemiology, 6(1), 12-20.

Barone, D. F., Hutchings, P. S., Kimmel, H. J., Traub, H. L., Cooper, J. T., & Marshall, C. M. (2005). Increasing empathic accuracy through practice and feedback in a clinical interviewing course. Journal of Social and Clinical Psychology, 24(2), 156-171. doi:10.1521/jscp.24.2.156.62275

Batson, C., & Moran, T. (1999). Empathy-induced altruism in a prisoner's dilemma. European Journal Of Social Psychology, 29(7), 909-924. doi:10.1002/(SICI)1099-0992(199911)29:7<909::AID-EJSP965>3.0.CO;2-L

Berinsky, A. J. (2004). Can we talk? Self-presentation and the survey response. Political Psychology, 25(4), 643-659. doi:10.1111/j.1467-9221.2004.00391.x

Bolger, N., DeLongis, A., Kessler, R. C., & Wethington, E. (1989). The contagion of stress across multiple roles. Journal Of Marriage & The Family, 51(1), 175-183. doi:10.2307/352378

Braveman, P., Egerter, S., & Williams, D. R. (2011). The social determinants of health: Coming of age. Annual Review of Public Health, 32(3) 311–3.18.

Butler, E., Wilhelm, F., & Gross, J. (2006). Respiratory sinus arrhythmia, emotion, and emotion regulation during social interaction. Psychophysiology, 43(6), 612-622.

Chen, E. (2010). Digging deeper: understanding the biological mechanisms that connect low socioeconomic status to poor health. Archives of Pediatrics & Adolescent Medicine, 164(5), 495-496.

Clark, M. S., Mills, J., & Powell, M. C. (1986). Keeping track of needs in communal and exchange relationships. Journal of Personality And Social Psychology, 51(2), 333-338. doi:10.1037/0022-3514.51.2.333

Cohen, S. (2004). Social Relationships and Health. American Psychologist, 59(8), 676-684. doi:10.1037/0003-066X.59.8.676

Cohen, S., & Herbert, T. B. (1996). Health psychology: Psychological factors and physical disease from the perspective of human psychoneuroimmunology. Annual Review Of Psychology, 47113-142. doi:10.1146/annurev.psych.47.1.113

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. Journal of Personality and Social Psychology, 44(1), 113-126. doi:10.1037/0022-3514.44.1.113

Davis, M.H. (1980). A multidimensional approach to individual differences in empathy. JSAS Catalog of Selected Documents in Psychology, 1980, 10, 85.

Davis, M. H., & Kraus, L. A. (1997). Personality and empathic accuracy. In W. Ickes, W. Ickes (Eds.) , Empathic accuracy (pp. 144-168). New York, NY US: Guilford Press.

De Waal, F. B. (2008). Putting the altruism back into altruism: The evolution of empathy. Annu. Rev. Psychol., 59, 279-300.

Dowding, Keith (1996). Power (Concepts in Social Thought). University of Minnesota Press. ISBN 0-8166-2941-2

Ecob, R., & Davey Smith, G. (1999). Income and health: What is the nature of the relationship? Social Science & Medicine, 48(5), 693-705.

Everson-Rose, S. A., & Lewis, T. T. (2005). Psychosocial factors and cardiovascular diseases. Annu.Rev.Public Health, 26, 469-500.

Figley, C. (Ed.). (2002). Treating compassion fatigue. New York, NY US: Brunner-Routledge.

Figley, C. (Ed.). (1995). Compassion fatigue: Coping with secondary traumatic stress disorder in those who treat the traumatized. Philadelphia, PA US: Brunner/Mazel.

Figley, C. R., Lovre, C., & Figley, K. (2011). Compassion fatigue, vulnerability, and resilience in practitioners working with traumatized children. In V. Ardino, V. Ardino (Eds.) , Post-traumatic syndromes in childhood and adolescence: A handbook of research and practice (pp. 417-432). Wiley-Blackwell.

Ford, E., Giles, W., & Dietz, W. (2002). Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. JAMA: The Journal of The American Medical Association, 287(3), 356-359.

Galinsky, A. D., Magee, J. C., Inesi, M. E., & Gruenfeld, D. H. (2006). Power and perspectives not taken. Psychological Science, 17(12), 1068-1074.

Gallo, L. C., & Matthews, K. A. (2003). Understanding the association between socioeconomic status and physical health: Do negative emotions play a role? Psychological Bulletin, 129(1), 10-51. doi:10.1037/0033-2909.129.1.10

Gallo, L. C., Bogart, L. M., Vranceanu, A., & Matthews, K. A. (2005). Socioeconomic Status, Resources, Psychological Experiences, and Emotional Responses: A Test of the Reserve Capacity Model. Journal Of Personality And Social Psychology, 88(2), 386-399. doi:10.1037/0022-3514.88.2.386

Gonzaga, G. C., Keltner, D., & Ward, D. (2008). Power in mixed-sex stranger interactions. Cognition And Emotion, 22(8), 1555-1568. doi:10.1080/02699930801921008

Goodman, E., Adler, N.E., Kawachi, I., Frazier, A.L., Huang, B., Colditz G.A (2001). Adolescents' perceptions of social status: development and evaluation of a new indicator. Pediatrics, 108(2):E31.

Goodman, E., Daniels, S., Meigs, J., & Dolan, L. (2007). Instability in the diagnosis of metabolic syndrome in adolescents. Circulation, 115(17), 2316-2322.

Goodman, E., McEwen, B. S., Huang, B., Dolan, L. M., & Adler, N. E. (2005). Social inequalities in biomarkers of cardiovascular risk in adolescence. Psychosomatic Medicine, 67(1), 9-15.

Hammen, C. (1991). Generation of stress in the course of unipolar depression. Journal Of Abnormal Psychology, 100(4), 555-561. doi:10.1037/0021-843X.100.4.555

Hammen, C., Shih, J. H., & Brennan, P. A. (2004). Intergenerational Transmission of Depression: Test of an Interpersonal Stress Model in a Community Sample. Journal Of Consulting And Clinical Psychology, 72(3), 511-522. doi:10.1037/0022-006X.72.3.511

Hoynes, H. W., Page, M. E., & Stevens, A. H. (2005). Poverty in America: Trends and Explanations. Journal of Economic Politics, 20(1), 47-68.

Joinson, C. (1992). Coping with compassion fatigue. Nursing, 22(4), 116-118.

Keltner, D., Gruenfeld, D., & Anderson, C. (2003). Power, approach, and inhibition.Psychological Review, 110(2), 265-284.

Kirby, H. L. (2008). The Relationship between Level of Empathy and Stress Contagion, Dissertation Abstracts: Section A, 61 (12), 4851A (UMI No. 9999321).

Kohlberg, L. (1976). Moral stages and moralization: The cognitive-developmental approach. Moral Development and Behavior: Theory, Research, and Social Issues, 31-53.

Kraus, M. W., & Keltner, D. (2009). Signs of socioeconomic status. Psychological Science, 20(1), 99.

Kraus, M. W., Piff, P. K., & Keltner, D. (2009). Social class, sense of control, and social explanation. Journal of Personality and Social Psychology, 97(6), 992.

Kraus, M. W., Piff, P. K., & Keltner, D. (2011). Social class as culture: The convergence of resources and rank in the social realm, Current Directions in Psychological Science, 100, 246 –250. doi:10.1177/0963721411414654

Krieger, N., Williams, D. R., & Moss, N. E. (1997). Measuring social class in US public health research: Concepts, methodologies, and guidelines. Annual Review of Public Health, 18(1), 341-378.

Lakka, H. M., Laaksonen, D. E., Lakka, T. A., Niskanen, L. K., Kumpusalo, E., Tuomilehto, J., & Salonen, J. T. (2002). The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA: The Journal of the American Medical Association, 288(21), 2709.

Lawrence, E. J., Shaw, P. P., Baker, D. D., Baron-Cohen, S. S., & David, A. S. (2004). Measuring empathy: Reliability and validity of the Empathy Quotient. Psychological Medicine: A Journal of Research In Psychiatry And The Allied Sciences, 34(5), 911-919. doi:10.1017/S0033291703001624

Lisabeth, L., Diez Roux, A. V., Escobar, J., Smith, M., & Morgenstern, L. (2007). Neighborhood environment and risk of ischemic stroke. American Journal of Epidemiology, 165(3), 279.

MacRitchie, V., & Leibowitz, S. (2010). Secondary traumatic stress, level of exposure, empathy and social support in trauma workers. South African Journal Of Psychology, 40(2), 149-158.

Marin, T. J., Chen, E., Munch, J. A., & Miller, G. E. (2009). Double-exposure to acute stress and chronic family stress is associated with immune changes in children with asthma. Psychosomatic Medicine, 71(4), 378-384. doi:10.1097/PSY.0b013e318199dbc3

Marmot, M. G., Shipley, M. J., & Rose, G. (1984). Inequalities in death--specific explanations of a general pattern? The Lancet, 323(8384), 1003-1006.

Martire, L. M., Stephens, M., & Townsend, A. L. (2000). Centrality of women's multiple roles: Beneficial and detrimental consequences for psychological well-being. Psychology And Aging,15(1), 148-156. doi:10.1037/0882-7974.15.1.148

Martire, L. M., & Stephens, M. (2003). Juggling parent care and employment responsibilities: The dilemmas of adult daughter caregivers in the workforce. Sex Roles, 48(3-4), 167-173. doi:10.1023/A:1022407523039

Mattu G.S., Heran B.S. & Wright, J.M. (2003). Overall accuracy of the BpTRU™, an automated electronic blood pressure device. Blood Pressure Monitor, (9) 47-52.

McCann, I., & Pearlman, L. A. (1990). Vicarious traumatization: A framework for understanding the psychological effects of working with victims. Journal Of Traumatic Stress, 3(1), 131-149. doi:10.1007/BF00975140

Miller, G., Chen, E., & Cole, S. W. (2011). Health psychology: Developing biologically plausible models linking the social world and physical health. Annual Review Of Psychology, 60501-524. doi:10.1146/annurev.psych.60.110707.163551

Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. Psychological Bulletin, 133(1), 25-45. doi:10.1037/0033-2909.133.1.25

Miller, K. I., Stiff, J. B., & Ellis, B. H. (1988). Communication and empathy as precursors to burnout among human service workers. Communication Monographs, 55(3), 250-265. doi:10.1080/03637758809376171

Ostrove J.M., Feldman P. (1999). Education, income, wealth, and health among Whites and African Americans. Annual NY Academy of Science, 896: 335–337.

Piff, P., Kraus, M., Côté, S., Cheng, B., & Keltner, D. (2010). Having less, giving more: the influence of social class on prosocial behavior. Journal Of Personality And Social Psychology, 99(5), 771-784.

Piff, P., Stancato, D., Côté, S., Mendoza-Denton, R., & Keltner, D. (2012). Higher social class predicts increased unethical behavior. Proceedings Of The National Academy Of Sciences Of The United States Of America, 109(11), 4086-4091.

Pincus, T., Callahan, L., & Burkhauser, R. (1987). Most chronic diseases are reported more frequently by individuals with fewer than 12 years of formal education in the age 18-64 United States population. Journal Of Chronic Diseases, 40(9), 865-874.

Pollitt, R. A., Kaufman, J. S., Rose, K. M., Diez-Roux, A. V., Zeng, D., & Heiss, G. (2007). Early-life and adult socioeconomic status and inflammatory risk markers in adulthood. European Journal of Epidemiology, 22(1), 55-66.

Porges, S. W., Doussard-Roosevelt, J. A., & Maiti, A. K. (1994). Vagal tone and the physiological regulation of emotion. Monographs of the Society for Research in Child Development, 167-186.

Regehr, C., Goldberg, G., & Hughes, J. (2002). Exposure to human tragedy, empathy, and trauma in ambulance paramedics. American Journal of Orthopsychiatry, 72(4), 505-513.

Richardson, D. R., Hammock, G. S., Smith, S. M., & Gardner, W. (1994). Empathy as a cognitive inhibitor of interpersonal aggression.Aggressive Behavior, 20(4), 275-289. doi:10.1002/1098-2337(1994)20:4<275::AID-AB2480200402>3.0.CO;2-4

Ridker, P. M., Hennekens, C. H., Buring, J. E., & Rifai, N. (2000). C-reactive protein and other markers of inflammation in the prediction of cardiovascular disease in women. New England Journal of Medicine, 342(12), 836-843.

Ridker, P., Rifai, N., Stampfer, M., & Hennekens, C. (2000). Plasma concentration of interleukin-6 and the risk of future myocardial infarction

among apparently healthy men. Circulation, 101(15), 1767-1772.

Ross, K., Martin, T., Chen, E., & Miller, G. E. (2011). Social encounters in daily life and 2-year changes in metabolic risk factors in young women. Development And Psychopathology, 23(3), 897-906. doi:10.1017/S0954579411000381

Sephton, S. E., Sapolsky, R. M., Kraemer, H. C., & Spiegel, D. (2000). Diurnal cortisol rhythm as a predictor of breast cancer survival. Journal of the National Cancer Institute, 92(12), 994-1001.

Schieman, S., & Turner, H. A. (2001). 'When feeling other people's pain hurts': The influence of psychosocial resources on the association between self-reported empathy and depressive symptoms. Social Psychology Quarterly, 64(4), 376-389. doi:10.2307/3090161

Shih, J.H., Eberhart, N., Hammen, C., & Brennan, P. A. (2006). Differential exposure and reactivity to interpersonal stress predict sex differences in adolescent depression. Journal of Clinical Child and Adolescent Psychology, 35, 103-115.

Showalter, S. E. (2010). Compassion fatigue: What is it? Why does it matter? Recognizing the symptoms, acknowledging the impact, developing the tools to prevent compassion fatigue, and strengthen the professional already suffering from the effects.American Journal Of Hospice & Palliative Medicine, 27(4), 239-242. doi:10.1177/1049909109354096

Snibbe, A. C., & Markus, H. R. (2005). You can't always get what you want: Social class, agency, and choice. Journal of Personality and Social Psychology, 88, 703-720.

Stephens, M., Townsend, A. L., Martire, L. M., & Druley, J. (2001). Balancing parent care with other roles: Interrole conflict of adult daughter caregivers. The Journals Of Gerontology: Series B: Psychological Sciences And Social Sciences, 56B(1), P24-P34.

Statistics Canada (2011, Oct 18). Mortality: Summary List of Causes. Retrieved from http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=84F0209X&CHROPG=1&lang=eng

van Kleef, G., Oveis, C., van der Löwe, I., LuoKogan, A., Goetz, J., & Keltner, D. (2008). Power, distress, and compassion: turning a blind eye to the suffering of others. Psychological Science,19(12), 1315-1322.

Winkleby M.A., Jatulis D.E., Frank E.M, Fortmann, S.P. (1992). Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. American Journal of Public Health, 82, 816-20.

Table 1. *SES Characteristics of Participants (N = 222).*

	Minimum	Maximum	Mean	SD
Years of Education	7.0	27.0	16.4	5.4
Annual Family Income[a]	1.0	9.0	5.6	1.8
Reported Family Savings[b]	1.0	9.0	4.77	2.5
MacArthur - Community	1.0	10.0	6.38	1.72
MacArthur - Canada	1.0	10.0	5.82	1.80

[a] Family income was coded from 1 to 9. The mean value for this sample corresponded to the category from $50,000 to $74,999.

[b] Family savings was coded from 1 to 9. The mean value for this sample corresponded to the category from $10,000 to $19,999.

Table 2. *Pearson Correlation Matrix among SES measures and empathy and perspective taking.*

		CC	CI
Empathy	**X Perspective Taking**	.51*	
	X Years of Education	.10	[-.03, .23]
	X Annual Family Income	-.00	[-.13, .13]
	X Family Savings	-.11	[-.24, -.02]
	X MacArthur Ladder Community	.10	[-.03, .23]
	X MacArthur Ladder Canada	.07	[-.06, .20]
Perspective Taking	**X Years of Education**	.07	[-.06, .20]
	X Annual Family Income	-.03	[-.16, .10]
	X Family Savings	-.06	[-.19, .07]
	X MacArthur Ladder Community	.08	[-..05, .21]
	X MacArthur Ladder Canada	.01	[-.12, .14]

Note. $N = 216$. * = $p < .0125$. All other correlations insignificant at $p > .0125$, two tailed; controlling for gender, ethnicity and age. CC, correlation coefficient. CI, 95 percent confidence interval.

Table 3. *Pearson Correlation Matrix among Life stress and SES measures*

	CC	CI
LSI Family Rating X LSI Friend Rating	.28*	
X Years of Education	-.09	[-.22, .04]
X Annual Family Income	-.12	[-.26, .00]
X Family Savings	-.18*	[-.31, -.05]
X MacArthur Ladder Community	-.15	[-.28, -.02]
X MacArthur Ladder Canada	.-13	[-.26, .00]
LSI Friend Rating X Years of Education	.01	[-.12, .14]
X Annual Family Income	-.17*	[-.30, -.04]
X Family Savings	-.22*	[-.34, -.10]
X MacArthur Ladder Community	-.20*	[-.32, -.07]
X MacArthur Ladder Canada	-.23*	[-.35, -.10]

Note. N = 216. ** = *p* ≤.012 All other correlations are insignificant at p > .0125, two tailed; controlling for gender, ethnicity and age. CC, correlation coefficient. CI, 95 percent confidence interval.

Table 4. *Pearson Correlation Matrix among Life Stress and Health Measures*

	CC	CI
LSI Family Rating X LSI Friend Rating	.28*	
X IL-6	-.02	[-.15, .11]
X CRP	-.05	[-.18, .08]
X Systolic Blood Pressure	-.02	[-.15, .11]
X Diastolic Blood Pressure	.06	[-.07, .19]
LSI Friend Rating X IL-6	.01	[-.12, .14]
X CRP	-.07	[-..20, .06]
X Systolic Blood Pressure	-.01	[-.32, -.07]
X Diastolic Blood Pressure	.07	[-.06, .20]

Note. N = 200. * = $p < .0125$ All other correlations are insignificant at $p > .0125$, two tailed; controlling for gender, ethnicity and age. CC, correlation coefficient. CI, 95 percent confidence interval.

Meaning Threats and their Potential to Trigger Enhancements in Working Memory

Clare Van Norden [1]
[1]Department of Psychology, University of British Columbia

Edited by: Setareh Shayanfar, Department of Psychology, University of British Columbia. Received for review October 13, 2012, and accepted April 13, 2013.

Abstract

Past research into the Meaning Maintenance Model (MMM) has shown that by violating the meaning frameworks individuals use to organize their understanding of the world, they can be primed to identify patterns in their environment. This study investigated whether exposure to meaning threats (i.e., stimulus that conflict with one's existing schemas) produces this priming by enhancing working memory performance. Participants were exposed to one of four conditions: an implicit meaning threat (a deck of cards in which the colour of the suits had been reversed), an explicit meaning threat (a mortality salience task), both types of threat, or two control conditions. Participants then completed a backward-digit recall task as a measure of working memory. Results of a planned orthogonal contrast indicated a slight improvement in performance on the backward-digit recall task in all three threat conditions relative to the control group ($t363 = 1.73$, $p = .085$). One possible explanation for why the double-threat condition did not produce a noticeable improvement relative to the single-threat conditions is that the presence of an explicit meaning threat may reduce the impact of exposure to an implicit meaning threat. If so, this could produce a confound in studies that attempt to generate effects via a combination of implicit and explicit meaning threats. Avenues for further research are also suggested.

Keywords: *meaning maintenance model, working memory*

The Meaning Maintenance Model (MMM) proposes that humans have an innate drive to find meaning in their environment. In this context, "meaning" refers to the mental representations of the relationships that exist between items or situations, such as causal, spatial, temporal, or teleological associations (Proulx & Heine, 2006). Over the course of their lives, people organize their observed meaning relationships into mental frameworks called schemas. They then use these schemas as guides to anticipate how various aspects of their environments will behave and interact with each other (Proulx & Heine, 2008). Meaning relationships are also used to explain events

Corresponding Author:
Clare Van Norden
E-mail: clare_van_norden@yahoo.ca

and make sense of seemingly random or contradictory occurrences. However, there will come a time when a person is confronted with information that contradicts their understanding of the world and is incompatible with their existing schemas. Such information is referred to as a meaning threat, and the mind utilizes three distinct tactics to deal with it.

One tactic people may employ is attempting to re-interpret the observed meaning threat in such a way that it becomes compatible with their existing worldview (Proulx & Heine, 2008). For example, in a study by Bruner and Postman (1949), participants were shown a series of playing cards and were then asked to identify them. Unbeknownst to the participants, some of the cards had been altered so that their colour no longer matched their suit (i.e., some diamonds and hearts were black and some clubs and spades were red). These altered cards acted as meaning threats by violating the expectations of participants' playing card schemas, which outlined very specific relationships between a card's suit and colour. When shown the altered cards, some participants responded by perceiving either the suit or the colour of the card in such a way as to remove the schema violations (e.g., black diamonds and hearts were seen as red, or else as suit was seen as being a club or a spade). This altered perception made the cards appear consistent with the participants' expectations, and as such they no longer constituted a meaning threat.

A second strategy people may utilize is that of modifying their understanding of the world and the rules that govern its functioning in order to incorporate the meaning threat within a new meaning framework (Proulx & Heine, 2008). In Bruner and Postman's (1949) study, some participants did become aware of the unusual cards, and subsequently revised their playing card schemas to include a category for cards that did not conform to the usual relationship between suit and colour.

However, some meaning threats cannot be accommodated with these two strategies: in such cases, a third response type known as fluid compensation (Proulx & Heine, 2008) must be used. When one schema is faced with a meaning threat, people may respond by confirming an unrelated schema that has not been threatened. This re-affirmation serves to relieve the mental anxiety triggered by the meaning threat, even though it does not directly address the cause of the distress (Proulx & Heine, 2006). For example, when asked to set a bail amount for a hypothetical prostitute, participants whose semantic schemas had been threatened by nonsense word pairs set higher bails than participants whose schemas had not been threatened (Randles, Proulx, & Heine, 2010). Since prostitution is illegal and considered immoral by a large segment of the population, and presumably by a large proportion of the sample as well, setting a higher bail for the prostitute allowed participants to re-affirm a moral schema by inflicting harsher punishments on those who acted in immoral ways, thus fluidly compensating for the earlier threat to their semantic schemas.

Just as there are many schemas one can re-affirm in response to a meaning threat, there are many kinds of information that can threaten one's schemas. Among the most salient kinds of meaning threats are reminders of one's own mortality and inevitable death. Terror Management Theory states that dying constitutes a major meaning threat, as it involves the

breakdown of the mental and perceptual systems through which we experience the world, as well as the end of our existence as self-aware entities (Proulx & Heine, 2006). In such a state, none of our existing meaning frameworks about the world are applicable. To cope with the discomfort these thoughts can trigger, people will utilize fluid compensation. While Terror Management Theory proposes that this fear of mortality underlies all instances of fluid compensation, the Meaning Maintenance Model argues that death-related cues are just one of many potential meaning threats. Mortality salience triggers have been used in a variety of studies on the Meaning Maintenance Model, and have produced results comparable to those of other forms of meaning threat (Landau, Greenberg, & Rothschild, 2009; Randles et al., 2010).

Meaning threats leave people highly motivated to re-establish their sense of meaning. As a result, after exposure to such threats, people become primed to seek out new meaning frameworks in their environment, generally in the form of patterns and other relationships between stimuli (Proulx & Heine, 2009). Several studies have examined the impact of meaning threats on implicit pattern learning, and have found that exposure to meaning threats can enhance both the ability to detect patterns and increase the odds of participants observing non-existent patterns in samples of random data (Proulx & Heine, 2009; Randles et al., 2010; Kay, Whitson, Gaucher, & Galinsky, 2009; Whitson & Galinsky, 2008). This increase in pattern perception can be triggered by both explicit and implicit meaning threats. Explicit meaning threats involve stimuli that participants are consciously recognize as bizarre and unusual in some way. For example, reading excerpts from absurd Kafka stories that feature strange and nonsensical events would constitute an explicit meaning threat, as individuals would recognize that the events in the story were unusual and unexpected (Proulx, & Heine, 2009). Implicit meaning threats involve stimuli that participants do not consciously recognize as strange or schema-defying. For instance, in a study by Proulx & Heine (2008), participants were greeted by one research participant who was later swapped with another, identically dressed person without the participant's knowledge. Only 10% of participants reported noticing the switch, yet fluid compensation was observed even among the unaware participants. Although participants were not consciously aware that there was anything unusual about the research assistant, their subconscious awareness of the change was enough to constitute a meaning threat (Proulx, & Heine, 2008). While we are now confident that both implicit and explicit meaning threats can improve one's likelihood of unconsciously detecting patterns in the environment, it remains uncertain whether they can influence or improve other cognitive processes related to pattern learning. In particular, exposure to meaning threats may increase pattern detection by improving working memory.

Working memory refers to a series of systems used to process and store information relevant to one's current task. According to Baddeley's Model (1974), working memory consists of three parts. The first component, called the phonological loop, is an information storage buffer used to retain auditory information (Baddeley, 2010). The visuo-spatial sketchpad is the second part of the working memory system. Like the phonological loop, the visuo-spatial sketchpad is used for the short-term retention of information, but holds visual

rather than auditory information. The third component of Baddeley's Model is the central executive, a subsystem which manages the addition or removal of information from storage. The addition of a fourth component to the model has been suggested. It is now suspected that a third information storage buffer, known as the episodic buffer, is responsible for holding multi-sensory, episodic information. The three storage buffers appear to be largely independent of each other, as utilizing one to its full capacity does not usually interfere with the functioning of the others (Coy, O'Brien, Tabaczynski, Northern, & Carels, 2011). There is some individual variation in the storage capacity of each working memory buffer, in addition to variation based on the exact type of information that is being stored. On average, the visual-spatial sketchpad has a maximum storage capacity of approximately five unique pieces of visual information (Miller, 1956; Baddeley, 2010), whereas the phonological loop can typically hold auditory sequences of up to two seconds in length, and the episodic buffer is thought to have a capacity of around four episodic "chunks" (Baddeley, 2010). While stored in working memory, retained information can be modified. (Baddeley, 2010). This is useful when attempting to organize stimuli based on the relationships between them, and research has found correlations between participants' scores on working memory evaluations and their ability to learn grammatical patterns (Ellis & Sinclair, 2010).

The assumption that meaning threats could enhance working memory may initially seem counter-intuitive, given the well-documented negative impacts of stress and anxiety on working memory and cognitive task performance in general (Hodges & Durham, 1972; Hadwin, Brogan, & Stevenson, 2005). Hodges and Durham (1972) found that increased levels of state anxiety, induced by negative feedback on task performance and measured by the State Anxiety Scale of the State-Trait Anxiety Inventory, led to impairments in working memory, as evaluated by performance on backward-digit recall tasks. Hadwin, Brogan, and Stevenson (2005) observed the same pattern in children. However, exposure to meaning threats does not appear to induce typical state anxiety, as measured by the Positive and Negative Affect Scale (PANAS) and the Spielberger State Anxiety Inventory (STAI) (Van Tongeren & Green, 2010).

Heightened levels of state anxiety are typically associated with noticeable signs of physiological arousal; however, the emotional arousal following a meaning threat is not accompanied by readily observable changes such as an increase in heart rate or skin conductance (Proulx & Heine, 2010). Mortality salience cues also fail to trigger typical signs of physiological arousal (Rosenblatt et al., 1989). Exposure to meaning threats has consistently been found to have no significant effect on the individual's consciously accessibly mood states, as measured by the Positive and Negative Affect Schedule (PANAS) (Proulx, Heine, & Vohs, 2010; Randles et al. 2010). In contrast, heightened levels of state anxiety typically lead to noticeable changes in one's scores on the PANAS (Crawford & Henry, 2004). Kay, Whitson, Gaucher, and Galinsky (2009) further examined this distinction by comparing the compensatory behaviour of participants instructed to visualize an anxiety-provoking situation either in combination with exposure to a meaning threat or with no further manipulations. Although both groups experienced heightened state anxiety, fluid compensation was only observed in the

group exposed to the meaning threat as well as the alarming visualization. Based on these findings, it is reasonable to assume that state anxiety is distinct from the emotional arousal triggered by meaning threats, and as such the two types of arousal may have different effects on the function of working memory. This distinction, combined with the role of working memory in pattern detection, leads us to hypothesize that exposure to meaning threats will improve the performance of participants on measures of working memory.

Method

The study involved participants who were recruited over the internet through the Amazon Mechanical Turk (MTurk) website. Data was gathered from a total of 421 participants (N = 421), all of whom were from North America. Fifty-four participants were disqualified prior to analysis for having completion times of less than 10 minutes (indicating that they were rushing through the experiment and likely not answering questionnaire items accurately or honestly), or more than 30 minutes (indicating that they were likely distracted or engaged in other tasks while working on the study). Three-hundred and sixty seven participants were included in the final analysis (140 men, 226 women, with a single participant opting not to identify their gender). Seventy-eight point two percent of participants identified themselves as Caucasian, 6.8% identified themselves as Hispanic or Latino, with the remaining 15% identifying themselves as members of other ethnicities. The mean age of participants was 33.08 years of age (SD = 11.42). All participants were paid 50 cents for completing the study.

Two different meaning threats were employed in our study, one implicit and the other explicit. The explicit threat consisted of a writing task, in which participants were asked to write a few paragraphs describing what would physically happen to their bodies after death, as well as a few additional paragraphs describing the thoughts and feelings they experienced during this reflection. Such tasks bring to mind one's own mortality and have been repeatedly demonstrated to trigger levels of fluid compensation comparable to those resulting from other forms of meaning threats (Randles et al., 2010; Proulx & Heine, 2008; Arndt, Greenberg, Pyszczynski, & Solomon, 1997; Rosenblatt, Greenberg, Solomon, Pyszczynski, & Lyon, 1989). The implicit meaning threat involved exposure to an altered deck of cards through a game of blackjack against a computerized opponent. The cards had been changed so that the colours of the suits were reversed, with diamonds and hearts presented as black while spades and clubs were red. This colour reversal contradicts the schemas people use for understanding decks of cards by violating the rules of association between a card's suit and its colour (Bruner & Postman, 1949). Our independent variable was which of the four possible combinations of meaning threats and controls participants were assigned to: a control group exposed to no meaning threat (n = 87), a group exposed only to the explicit meaning threat (n = 96), a group exposed only to the implicit meaning threat (n = 97), and a group exposed to both forms of threat (n = 87).

The study was administered via computer. Participants in all conditions began by providing basic demographic information. They then played a short game of blackjack against the computer. Instructions were provided to ensure all participants would be familiar with the rules of the game. Participants in the implicit

meaning threat condition played with an altered deck of cards, while those in the other conditions played with a standard deck.

All participants were then asked to complete a short writing task. Those in the explicit meaning threat condition were asked to write a few paragraphs regarding their own death (as described above). All other participant groups were asked to write about what would happen to them physically during a visit to the dentist. This scenario was chosen as a control because many people consider a trip to the dentist alarming or painful yet contemplating such instances of non-lethal physical discomfort does not produce the same kind of compensatory behaviour as consideration of one's own mortality (Arndt, Greenberg, Pyszczynski, & Solomon, 1997). Participants in all conditions then completed the Positive and Negative Affect Schedule (PANAS), a self-report measure designed to gauge individuals' current mood state. The PANAS is commonly used as a delay task between the threat stimuli and the dependant measures in studies involving threat compensation, and has not been found to interfere with meaning threat exposure or subsequent compensation (Burke, Martens, & Faucher, 2010). This was included in our study in order to demonstrate that exposure to the meaning threats did not induce changes in consciously accessible affect and that mood state changes were not responsible for the compensatory behaviour displayed by participants.

After finishing the PANAS, all participants completed a backward-digit recall task as a measure of working memory capacity. Scores on this task served as our dependent variable. Participants were shown a series of digits, ranging from one to nine, with each digit being displayed individually while a female voice read the numbers aloud. After all of the digits in a series had been displayed, participants were asked to enter the digits in the reverse of the order they had been shown (i.e., a number series displayed as "1, 2, 3, 4" would be entered as "4, 3, 2, 1"). The number series ranged in length from three to eight digits, with participants completing three number sequences of each length. These lengths were chosen based on the limits of human working memory span, which can hold an average of five distinct segments of visual information at a time (Miller, 1956; Baddeley, 2010), and a maximum of about two seconds worth of auditory information (Baddeley, 2010). The number sequences thus span a range from those that are easily recalled to those placing a great strain on working memory capacity, making it easier to see whether the threshold for errors varied across conditions. A single trial with a 12-digit sequence was also included in order to detect cheating, as this number greatly exceeds the normal limits of working memory capacity that it is nearly impossible for a person to enter it accurately without the use of external memory aids. In the unlikely event that a participant was able to recall a twelve digit sequence without cheating, their working memory capacity would be so far outside the normal range that our study would be unlikely to detect how it was impacted by meaning threats, and as such their data could be safely excluded from our analysis.

Once the backward-digit recall task was completed, all participants filled out a suspicion check. This included questions about whether or not they had observed anything unusual about the deck of cards used in the blackjack game. Participants were also asked if they had written any of the numbers down during the backward-

digit recall task, or if they had used any other techniques to improve their performance. The questions made it clear that answering honestly would not endanger the one's compensation for completing the study. Participants were then debriefed regarding the true nature of the study.

Results

We expected to find two patterns in our results. First of all, participants in the explicit threat and implicit threat groups were predicted to outperform those in the control group on the working memory task. Secondly, we expected that the double-threat group would outperform all of the other groups on the working memory task.

Planned orthogonal contrasts were used to test our main hypothesis, with the alpha level set to .05. We chose to use a planned comparison instead of ANOVA because we expected to find a specific pattern of results. ANOVA is more appropriate when any significant pattern of differences would be considered interesting; in our experiment any significant pattern other than the one we predicted would challenge our hypothesis, in the same manner as a null effect. Although failing to reach significance, both the implicit and explicit meaning threat conditions showed a trend towards improved performance on the working memory task relative to the control condition, with $t363 = 1.73$, $p = .085$. In a two-factor design such as ours, marginal means refers to the means of one factor averaged across all levels of the other factor. Our two factors were exposure to the explicit meaning threat or its control, and exposure to the implicit meaning threat or its control. The control condition had a marginal mean of 3.19 and a standard error of .18, while the implicit threat condition produced a marginal mean of 3.83 with a standard error of .17, and the explicit threat condition yielded a marginal mean of 3.42 with a standard error of .17.

The double-threat condition did not show the any significant improvement on the working memory task when compared to either the implicit or explicit threat condition, with $t363 = -.83$, $p = .41$. Its effects were almost identical to those of the explicit threat condition, producing a marginal mean of 3.44 with a standard error of .18. The double-threat condition also produced slightly worse performance on the working memory task than did the implicit threat condition. As is typical for studies using this paradigm, there were no significant differences on the PANAS for either positive or negative affect.

Discussion

Both the implicit and explicit threat conditions displayed a slight improvement in working memory relative to the control condition. Interestingly, the improvement in working memory observed in the double-threat condition did not differ significantly from the improvements observed in the implicit or explicit single-threat conditions. There are several possible explanations for these results. . Although MTurk allows for the rapid recruitment of many participants, it does have several shortcomings that can combine to obscure small effect sizes such as those relevant to this study. Twelve participants in the double-threat condition correctly entered the 12-digit number sequence backwards, indicating that some cheating did occur. Although we omitted fifty-four participants for cheating, any other cheaters we failed to identify may have inflated the scores in the control and single-threat conditions, thus reducing the degree

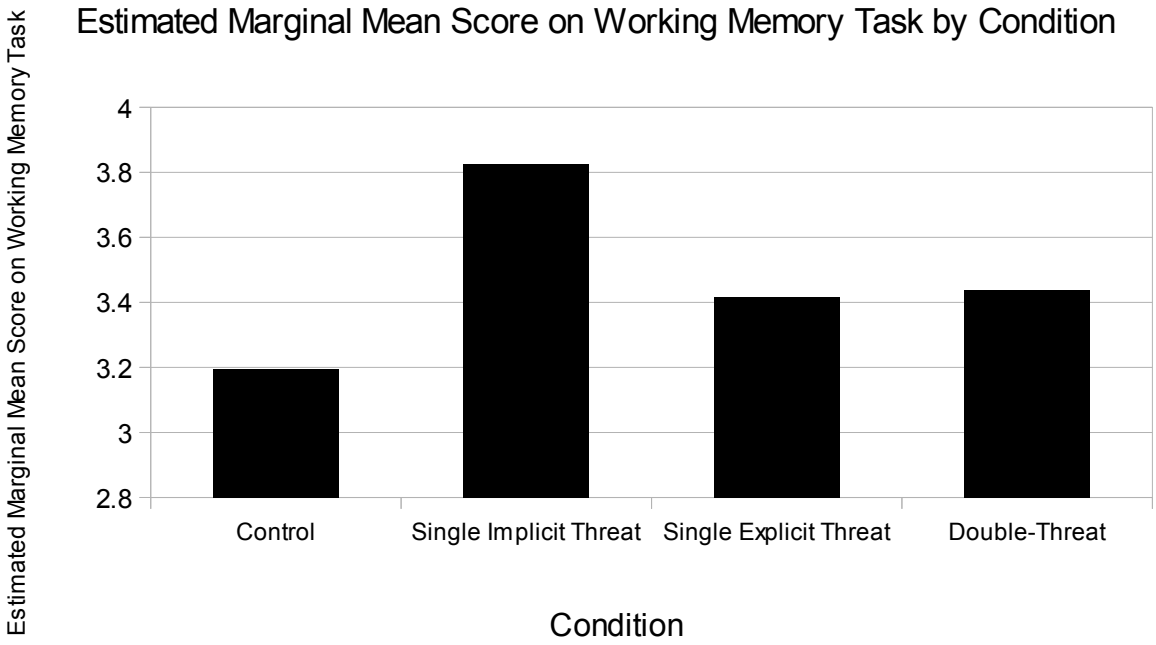


Figure 1.*Participant performance on the backward-digit recall task across the four conditions*

of improvement seen in the double-threat condition relative to the other conditions. However, due to the use of random assignment, it seems unlikely that the double-threat condition would receive a lower proportion of cheaters than the control or single-threat conditions, indicating that another explanation is required.

This leaves us with the possibility that the two meaning threats in the double-threat condition interfered with each others' effectiveness. There are two possible ways in which this might have occurred. If meaning threats only trigger very small, limited improvements in working memory, it is possible that a single meaning threat may have been sufficient to reach this limit. Either one of the single meaning threat conditions may be sufficient to produce the maximum-possible improvement in working memory, and as such the improvements caused by the double meaning threat condition would not be able to exceed those observed in the other conditions. However, this explanation does not shed light on why the implicit single-threat condition yielded greater improvements than the explicit threat condition, nor why the improvements produced by the double-threat condition more closely approximated those produced by the explicit single-threat condition.

This raises the possibility that the presence of an explicit meaning threat could have reduced the impact of the implicit threat. Part of what motivates people to seek out patterns in their environment after exposure to a meaning threat is the sense of unease and the “absurd” produced by the violation of mental schemas (Proulx & Heine, 2010). Participants in Bruner and Postman's (1949) study described a sense of “wrongness” triggered by viewing the altered playing cards, even when they were not consciously aware of what made the cards unusual. Meaning threat-induced arousal without an identifiable cause has been found to increase one's motivation to

preserve meaning through methods such as fluid compensation (Proulx & Heine, 2008). However, when dealing with explicit meaning threats, such as mortality salience, participants are well aware of the cause of their discomfort. Even if one is unfamiliar with the meaning maintenance model and the concept of meaning threats, it is generally recognized that contemplating one's death is an upsetting experience that is likely to cause distressing emotions, even if they are not strong enough to influence PANAS results. In the double-threat condition, participants may have misattributed the discomfort caused by the implicit threat to the explicit threat, thus reducing the impact of the implicit threat. This explanation is compatible with the observation that participants in the double-threat condition had working memory task scores comparable to those of participants in the single explicit threat condition, and lower than those of participants in the single implicit threat condition.

Past research findings support this explanation. In a study by Proulx and Heine (2008), participants were greeted by a research assistant and administered a questionnaire. Once the participants had completed it, the research assistant would open a large wardrobe under the pretence of retrieving another form for the participants to complete. Waiting inside the wardrobe was a second research assistant dressed identically to the first. The research assistant who greeted participants then swapped places with the one inside, with the door of the wardrobe positioned so as to block participants' view of the exchange. The new research assistant then closed the door and continued the study. Very few participants reported becoming consciously aware of the change (approximately 10%), yet the swap was enough to implicitly violate their perceptual schemas, regarding the organization of a person's facial features. Participant's whose perceptual schemas had been threatened by the swapped research assistants set higher bails for a hypothetical prostitute than the control group in which the research assistant remained the same throughout the session. If, prior to the test, participants were given a placebo disguised as an herbal tea that could supposedly induce emotional arousal, then participants set bails comparable to those of the control group despite exposure to a meaning threat. A similar phenomenon was observed in participants whose self-schemas had been threatened by recalling situations in which they lacked a sense of control over their environment (Kay et al., 2009). Normally, this kind of meaning threat prompted participants to engage in fluid compensate by believing more strongly in the existence of a controlling God and being more supportive of the decisions made by a controlling government (Kay et al., 2009). Yet when participants were given a placebo pill to which they could attribute their emotional arousal, these effects disappeared. This demonstrates that the ability to attribute the emotional arousal triggered by meaning threats to an identifiable source can mitigate the effects of the threat and reduce compensatory behaviours aimed at re-affirming unrelated schemas. Potentially, effects on working memory function may also be reduced by this misattribution.

Conclusion

While all three threat conditions displayed improved working memory performance relative to the control condition, the double-threat condition did not produce statistically significant improvements relative to the two single-threat conditions. The possible causes

for this failure are numerous, and suggest a variety of possible follow-up studies. To help rule out the possibility that small improvements in the double-threat condition were masked by noise in the sample, the study is being conducted again as described above. Participants will be recruited from the University of British Columbia human subject pool rather than through an online service. These changes will help rule out the possibility that participants are skimming through the mortality salience trigger too quickly for it to have a full effect. Additionally, participants will complete the study in a lab setting, making it easier for the researchers to detect signs of cheating that may interfere with the results.

Perhaps the most pertinent topic for subsequent research would be the potential for interference between multiple meaning threats, particularly between implicit and explicit threats. If misattributing arousal from an implicit threat to an explicit threat decreases or nullifies the impact of the implicit threat, then this could have implications for future research into the meaning maintenance model and the effects of meaning threats on human cognition. Studies utilizing multiple meaning threats in order to ensure that the desired state of uncertainty is triggered could run the risk of artificially reducing the strength of the observed meaning threat effects. One way of investigating this possibility would be to compare the fluid compensation behaviour of groups of participants exposed to two explicit meaning threats, groups exposed to two implicit meaning threats, and a group exposed to a single implicit and a single explicit threat. If the explicit threats were interfering with the impact of the implicit threats, then one would expect that the group exposed to both types of threat would demonstrate less fluid compensation than the groups exposed to only implicit or explicit meaning threats.

It is important to remember that working memory contains multiple information storage buffers, which are used to retain distinct types of information. The digits in our study were presented both as visual and auditory stimuli, as they were read aloud by a recorded voice as they appeared on screen. Our study thus did not control for which information buffer participants used to retain the information. It may be worthwhile to investigate whether presenting information exclusively via visual or auditory stimuli changes how well meaning threats can improve working memory capacity. No matter which buffer was used, participants in our study only worked at recalling and modifying digit sequences, and it is possible that working memory tasks are dependant upon different types of information may offer additional insight into the effectiveness of meaning threats as a source of memory enhancement.

Declaration of Conflicting Interests

The author declared they have no conflicts of interests with respect to their authorship or the publication of this article.

References

Arndt, J., Greenberg, J., Pyszczynski, T., & Solomon, S. (1997). Subliminal exposure to death-related stimuli increases defence of the cultural worldview. *Psychological Science, 8*(5), 379-385.

Baddeley, A. (2010). Working memory. *Current Biology, 20*(4), 136-140.

Bruner, J. S., & Postman, L. (1949). On the perception of incongruity: A paradigm. *Journal of Personality, 18*(2), 206-223.

Burke, B. L., Martens, A., & Faucher, E. H. (2010). Two decades of terror management theory: A meta-analysis of mortality salience research.

*Personality and Social Psychology Review, 14(*2), 155-195.

Coy, B., O'Brien, W. H., Tabaczynski, T., Northern, B., & Carels, R. (2011). Associations between evaluation anxiety, cognitive interference and performance on working memory tasks. *Applied Cognitive Psychology, 25*(5), 823-832.

Crawford, J. R., & Henry, J. D. (2004). The positive and negative affect schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *The British Journal of Clinical Psychology, 43*(3), 245-265.

Ellis, N. C., & Sinclair, S. G. (2010). Working memory in the acquisition of vocabulary and syntax: Putting language in good order. *The Quarterly Journal of Experimental Psychology, 49*(1), 234-250.

Hadwin, J., Brogan, J., & Stevenson, J. (2005). State anxiety and working memory in children: A test of processing efficiency theory. *Educational Psychology, 25*(4), 379-393.

Heine, S. J., Proulx, T., & Vohs, K. D. (2006). The meaning maintenance model: On the coherence of social motivations. *Personality and Social Psychology Review, 10*(2), 88-110.

Hodges, W. F., & Durham, R. L. (1972). Anxiety, ability, and digit span performance. *Journal of Personality and Social Psychology, 24*(3), 401-406.

Kay, A. C., Whitson, J. A., Gaucher, D., & Galinsky, A. D. (2009). Compensatory control: Achieving order through the mind, our institutions, and the heavens. *Current Directions in Psychological Science, 18*(5), 264-268.

Landau, M. J, Greenberg, J., & Rothschild, Z. K. (2009). Motivated cultural worldview adherence and culturally loaded test performance. *Personality and Social Psychology Bulletin, 35*(4), 442-453.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*(2), 81-97.

Proulx, T., & Heine, S. J. (2006). Death and black diamonds: Meaning, mortality, and the meaning maintenance model. *Psychological Inquiry, 17*(4), 309-318.

Proulx, T., & Heine, S. J. (2008). The case of the transmogrifying experimenter: Affirmation of a moral schema following implicit change detection. *Psychological Science, 19*(12), 1294-1300.

Proulx, T., & Heine, S. J. (2009). Connections from Kafka: Exposure to meaning threats improves implicit learning of an artificial grammar. *Psychological Science, 20*(9), 1125-1131.

Proulx, T., & Heine, S. J. (2010). The frog in Kierkegaard's beer: Finding meaning in the threat-compensation literature. *Social and Personality Psychology Compass, 4*(10), 889-905.

Proulx, T., Heine, S. J., & Vohs, C. D. (2010). When is the unfamiliar the uncanny? Meaning affirmation after exposure to absurdist literature, humor, and art. *Personality and Social Psychology Bulletin, 36*(6), 817-829.

Randles, D., Proulx, T., & Heine, S. J. (2010). Turn-frogs and careful-sweaters: Non-conscious perception of incongruous word pairings provokes fluid compensation. *Journal of Experimental Psychology, 47*(1), 246-249.

Rosenblatt, A., Greenberg, J., Solomon, S., Pyszczynski, T., & Lyon, D. (1989). Evidence for terror management theory: I. The effects of mortality salience on reactions to those who violate or uphold cultural values. *Journal of Personality and Social Psychology, 57*(4), 681-690.

Van Tongeren, D. R., & Green, J. D. (2010). Combating meaninglessness: On the automatic defense of meaning. *Personality and Social Psychology Bulletin, 36*(10), 1372-1384.

Whitson, J. A., & Galinsky, A. D. (2008). Lacking control increases illusory pattern perception. *Science, 322*(5898), 115-117.

Happiness and Longevity: Can Happiness Predict Life Expectancy?

Vlad Vasilescu[1]
[1]Department of Psychology, University of British Columbia

Edited by: Setareh Shayanfar, Department of Psychology, University of British Columbia. Received for review October 16, 2013, and accepted April 6, 2013.

Abstract

Although previous research has discussed the potential for a relationship between happiness and life expectancy, no mathematical modelling has been attempted. Some studies have speculated that happy individuals live longer, while others have gone a step further and used happiness to predict the quality of life in a given region. We propose a model that would enable researchers to predict the life expectancy of an individual based on the individual's average level of happiness, their mood reactivity, and the average life expectancy in the individual's area of residency. This could have potential implications for the design and implementation of public health policy. We created the model by modifying Stones and Kozma's (1991) Magical Model of Happiness and coupling it with additional mathematical manipulations that were inspired by the work of Veenhoven (1996) and Yang (2007). The model's output was compared to observed data on life expectancy at various happiness levels as acquired from the World Happiness Database and the CIA World Fact Book. Reduced chi and a paired-groups t-test were used to analyze the model for goodness of fit, finding that it could reliably predict life expectancy from happiness at the individual level (χ^2_{red} < 1). Caution, however, should be used when considering the application of the model to population level data.

Keywords: *happiness, longevity, psychological well being, model.*

The assumption that those who have a positive attitude in life and a lightness of spirit generally live longer has existed for millennia. The ancient Roman poet Juvenal is credited with stating "mens sana in corpore sano," which translated from Latin roughly means "a healthy mind in a healthy body" (Bjørnskov, 2008). This belief in a relationship between happiness (defined by Veenhoven (2007) as the appreciation of one's life as a whole) and life expectancy (treated by Veenhoven (2007) as a proxy for mental and physical health) has only recently come under rigorous scientific scrutiny (Mahon, Yarcheski, & Yarcheski, 2005). Thus, there are few studies on the exact relationship between one's level of psychological well being (PWB), or

Corresponding Author:
Vlad Vasilescu
E-mail: vladvasilescu@gmail.com

happiness, and one's longevity. As a result, this has become the focus of many researchers in recent decades (see Argyle, 1987; Argyle, 1997; Seligman, 2002).

The model proposed in this paper aims to provide a mathematically quantifiable way of predicting the longevity of a given individual based on their habitual happiness levels. The impetus that motivated the undertaking of this research was a study by Deeg and Zonneveld (1989) that suggested that happy individuals could expect more years of life than unhappy individuals. Our goal was to model this relationship mathematically in order to estimate a person's life expectancy from their happiness levels and compare it to the national average in one's geographical region.

Establishing a Link Between Happiness and Life Expectancy. Bjørnskov (2008) has previously looked at the association between happiness and life expectancy in various European populations. Like Deeg and Zonneveld (1989), Bjørnskov found that compared to unhappy individuals, happy individuals seemed to enjoy an additional 7 to 10 years of life. While he demonstrated that such a correlation exists, no attempt was made to generate a mathematical model that could be used to predict longevity based on happiness levels.

An extension of Bjørnskov's discussion of the relationship between happiness and life expectancy came from studies conducted by Veenhoven (1996) and Yang (2007). In these studies, researchers pioneered a methodology that determined a ratio of Happy Life Years (HLY) to total longevity. This was based on the average life expectancy in the participant's country and an evaluation of the participant's happiness level at a single point in time. As further elaborated in a subsequent study by Veenhoven (2005), this method was intended to generate estimates of how many years out of total lifespan an individual can expect to live happily. Therefore, their measure assessed the quality of life in a given nation, rather than providing a prediction of longevity based on happiness levels.

Inspired by the methodology for calculating HLY, we intended to develop a model that would predict longevity from happiness using a series of mathematical manipulations. If successful, this model would act as a powerful supplement to the existing research on the HLY to total longevity ratio for psychologists, sociologists, and public policy designers. By having the ability to assess how much longer individuals could expect to live compared to the national average, given their happiness levels, policy makers could accrue important data. This data could subsequently guide the development of public services aimed at increasing people's happiness, and ultimately, life expectancy.

As Veenhoven (2007) states, happy individuals can benefit from a cascade of desirable improvements in their lives. These are usually conducive to a panoply of life augmenting behaviors, such as the creation and maintenance of supportive social networks and the desire to make better life choices. A few examples of the positive benefits of leading a happy life include happy individuals' heightened inclination to watch their weight (Schultz, 1985), pay more attention to the prevention and treatment of illness (Ormel, 1980), improve their coping strategies (Aspingwall and Brunhart, 1996), be more active (Schultz, 1985), and engage in less life-shortening behaviors such as smoking (Ventegodt, 1997).

A Magical Model of Happiness. The question of how we could model this idea accurately persisted. Most importantly, it was critical that a value of one's happiness levels averaged over a long period of time could be obtained. Stones and Kozma (1991) attempted to assess how an individual's happiness at a future time could be predicted from an initial level of happiness through their Magical Model of Happiness. This model investigated the interaction of happiness with other factors such as the person's mood reactivity, and the influence of the environment on PWB. Using data acquired from personality inventories and happiness questionnaires, they were able to fit the obtained data to relatively simple nonlinear mathematical equations. This allowed the researchers to indicate an appropriate range of values to be used when working with mood reactivity (i.e., how sensitive one is to environmental changes), as well as to provide a range of values that would appropriately model transient and prevailing environmental impacts on happiness. Through the use of these equations, a deeper understanding of the complex relationships between the factors that affect one's PWB and their life outcome could be synthesized.

Current Modeling Efforts. Our goal was to improve and modify the Stones and Kozma's (1991) model in such a way that we could produce accurate values representing the habitual happiness levels of any individual, based only on several inputs – a one time snap-shot evaluation of one's happiness level, and an indicator of one's mood reactivity. If successful in using a limited series of mathematical manipulations, we could also modify the methodology behind the concept of HLY. This would enable us to use the output from our improved Stones and Kozma (1991) Magical Model of Happiness as an input in a second series of equations to generate a prediction of life expectancy.

Our research introduced a model that could be used to make concrete statements about how long one can expect to live, regardless of their geographical location, based on the average life expectancy in the region and the interaction of the individual's personality/mood reactivity with their environment. By building this mathematical model we aimed to show how individuals with higher happiness levels can benefit from added longevity over the average life expectancy in the nation in which they live. To achieve this, we first made use of Stones and Kozma's (1991) Magical Model of Happiness, and subsequently coupled the results of this model with a smooth function that could predict an individual's life expectancy. To assess the validity of the model, the output was then compared to data on happiness levels and life expectancy as provided by the World Happiness Database (Veenhoven, 1996) and the CIA's Fact Book statistics on worldwide life expectancy. These were deemed to be appropriate sources of comparative data, given that they are widely cited in Veenhoven's opus on happiness studies as well as the work of other researchers, such as Yang (2008).

Method

A basic piece of software was designed to generate data for a model of longevity based on one's average happiness levels. First, we created an environment that would allow us to estimate an individual's average happiness level over a period of 10 years. This was thought to be representative of one's habitual and thus persistent happiness

level. Using this value and a measure of average life expectancy (ALE) in the individual's country, a second series of equations was used to predict how long one could expect to live.

The fit of the model to the data was analyzed using two different tests – a reduced chi test and a paired-groups t-test. The use of the t-test was necessary due to the limited application of the reduced chi test and our desire to ensure the model's reliability. These limitations will be further discussed in the following sections.

Part 1 - Generation of Average Happiness Levels

Stones and Kozma (1991) proposed a model of PWB based on a logistic difference equation. The result was a nonlinear mathematical model dependent on an individual's initial happiness level, mood reactivity, and environmental effects (Stones & Kozma, 1991). The use of the logistic difference equation allowed for the generation of complex data from a simple equation, where one parameter could model a variety of conditions, ranging from a steady state (a stable equilibrium value that persisted over time) to apparent chaos (erratic oscillations between a number of different, random values). The specific form of the logistic differential equation used by Stones and Kozma is summarized in Equation 1.

$$H_{t+1} = M(1 - H_t)H_t + (I_p + I_e) \quad (1)$$

With the starting conditions inputted by the user, the model iterated Equation 1 numerous times, allowing researchers to gauge how one's happiness level varied over time. Ht+1 and Ht represent an individual's happiness level (at some future time, and the present time respectively), M is the individual's mood reactivity (i.e., how responsive one is to changes to the environment; also called the person parameter), Ip is the prevailing effect of the environment and Ie is an episodic environmental effect.

We first recreated the results of Stones and Kozma (1991) in order to produce a second sample of data that would allow us to identify any potential programming mistakes. This was crucial since the software was to be utilized in part two to predict one's life expectancy from one's levels of PWB. Our results were consistent with those presented by Stones and Kozma (1991), allowing us to gain confidence regarding the use of their model to reach our goals. Furthermore, the Stones and Kozma (1991) model was deemed appropriate for our purposes given a few key observations made by the researchers. Most importantly, they showed that: (1) PWB is dependent on previous states; (2) an equilibrium (either steady state or chaotic) is reached as Equation 1 is iterated; and (3) the person parameter M is crucial in determining the degree of environmental influences on an individual's happiness level ($0 < Ht+1, Ht < 1$).

It was found that the ability of the model to reach a steady state rather than chaotic equilibrium was dependent on the range of M, the individual's mood reactivity. Although values between $1.9 < M < 2.5$ will conduce individuals to reach a steady state equilibrium following environmental perturbations (compared to values of $M < 1$ or $M > 3$), $M = 2.2$ is the ideal value to be used in this model. This is due to the fact that $M = 2.2$ represents the central tendency in the population on measures of mood reactivity. Moreover, it is important to our purposes for it models the happiness levels

of normally functioning individuals, rather than those with a chaotic equilibrium, representative of psychopathological disorders (Stones & Kozma, 1991).

We modified Stones and Kozma's (1991) model in order to better represent one's level of happiness over a long period of time. Stones and Kozma suggested keeping Ip constant over the duration of 12 iterations (i.e., one program run), with Ie having an impact for only one iteration. Their goal, however, was only to test how long it would take an individual with a certain value of M to return to a steady state equilibrium after an environmental perturbation. Given that our goal was to generate an average value of happiness for a given individual, we made certain modifications to their model. By allowing Ip to change every 12 iterations (defined as one year), and allowing Ie to change every iteration, a better representation of reality was achieved. The range of values used for Ip and Ie are summarized in Table 1.

Table 1. The range of values between which Ip and Ie were allowed to vary. The variation was random - every 12 iterations, new values were chosen for Ip, and every iteration a new value was chosen for Ie.

Table 1
Range of values for I_p *and* I_e*:*

I_p	I_e
- 0.1 to 0.1	- 0.05 to 0.05

Since Ip varied every year, we were able to show how changes in one's prevailing environment impact PWB. This represented such changes as might occur in one's economic conditions, social relationships, and health. Given that Ie varied every month, we were able to demonstrate changes in one's PWB that arise as a result of less important and more temporary improvements/annoyances in one's life.

We thus ran Stones and Kozma's altered model for 10 years (120 iterations) for a variety of different M and Ht values (summarized in Table 2). An individual's typical level of happiness was determined by averaging their happiness levels over 10 years, yielding a value labeled Havg. The creation of this new variable was critical, as it would become the input value for the second part of our experiment.

Table 2. The range from 0.1 to 0.9 for H_t is the unadjusted happiness level, as required for Stones and Kozma's model (before multiplication with a factor of 10). Each *M* value was tested through the whole range of H_t values, with H_t increasing by 0.1 with each program run.

Table 2
Range of H_t *and* M *values tested:*

H_t	*M*
0.1 to 0.9	1.9, 2.2, 2.5

In order to utilize these figures in our comparisons as well as the subsequent modeling equations, we multiplied each individual's level of happiness by a factor of 10 to obtain a Havg value between 0 and 10. This allowed us to compare our results to data sets from the World Happiness Database, where happiness ratings are given in a range from 0 to 10. Since the Stones and Kozma (1991) model produced happiness values between 0 and 1, we assumed that our values differed only in that they had been multiplied by a factor of 10. We can assert this with confidence, given that the World Happiness Database gathered happiness data with similar scales as those on which Stones and Kozma based their model. Thus, this is an indication that their decision to produce values between 0 and 1

was solely intended to simplify computations (Stones & Kozma, 1991; Veenhoven, 1996).

Part 2 - Predicting Life Expectancy From One's Average Level of PWB

Unlike Yang (2007) and Veenhoven (1996), the purpose of the current model was to predict one's longevity rather than to assess the quality of life in a given nation (i.e., the number of HLY one can expect to live). Our model was developed such that it could accurately reflect how long an individual could expect to live based on the average life expectancy (ALE) in one's nation as well as one's average level of happiness.

To arrive at the two equations used to model life expectancy from the Havg figures previously generated, a few factors were taken into account. First, it was observed that Stones and Kozma's (1991) corrected happiness averages were between 0 and 10. It was decided to arbitrarily label anyone under 3 as unhappy (with individuals with Havg < 1 being extremely unhappy), everyone over 7 as very happy, and individuals in between as being neither happy nor unhappy – a medium level of happiness. We used the optimistic estimate proposed by Bjørnskov (2008) that happy individuals will live 10 years longer than unhappy individuals, and divided this decade evenly among the interval from 3 to 7. This allowed us to create a linear relationship where each increment in 1 happiness unit would result in an additional 2.5 years of life. By treating 5 as the median level of happiness (i.e., the point where one would need to score on a life satisfaction/happiness questionnaire to live up to the national ALE figure), we determined that someone with a happiness level of 0 would live at least 12.5 years less than the ALE in the region.

This relationship is embodied in Equation 2. The slope of 2.5 represents the linear increase in life expectancy per one unit increase in Havg levels. As a reminder, it is important to note that based on the changes to which the Stones and Kozma (1991) model was subjected in Part 1, the value of Havg in Equation 2 (and subsequently, in Equation 3) is averaged from 120 iterations (10 years) of Equation 1. The intercept for Equation 2 with the Life Expectancy axis is found by subtracting 12.5 from the ALE figure in the nation or area where one lives.

$$\text{LifeExpectancy} = \begin{cases} 2.5H_{avg} + (ALE - 12.5) & 1 \le H < 10 \quad (2) \\ 10\ln H_{avg} + (ALE - 10) & H < 1 \quad (3) \end{cases}$$

Although the linear Equation 2 accurately reflects the impact of happiness on life expectancy for the range of happiness values from 1 to 10, a logarithmic function is a better representation of what happens to life expectancy for highly unhappy individuals (i.e., those scoring in the 0 to 1 range on life satisfaction/happiness scales). The choice for a logarithmic function was based on the idea espoused by the substantial amount of research that highly unhappy individuals display behaviors vastly different from the rest of the population (for example, see Deeg & Zonneveld, 1989). As demonstrated in prior research (see Bjørnskov, 2008; Stones & Kozma, 1991; Veenhoven, 1996; and Yang, 2007; Deeg & Zonneveld, 1989), individuals with very low levels of happiness (Havg < 1) were more likely than those with Havg ≥ 1 to have a dramatic drop in life expectancy from the expected national ALE. This drop was explained through the findings that such unhappy individuals adopt detrimental, life shortening habits, or even resolve to suicide (Deeg & Zonneveld, 1989). Because

logarithmic functions are often used in the life sciences for the modeling of quantities changing in an exponential fashion, it was decided that such a function would better represent the reality of longevity for individuals with very low levels of life satisfaction. This information is summarized in Equation 3.

Thus, in the second part, we modified the outputted average happiness values from the altered Stones and Kozma (1991) model (Part 1). We did this according to either Equation 2 or 3, depending on which range of the smooth function the generated happiness levels fell. Comparisons of our program's outputted values were made with values of national happiness levels as obtained from Veenhoven's World Happiness Database and the corresponding life expectancy values for each of those nations as given in the CIA's Fact Book Statistics. Although these values expressed a nation's average life expectancy based on the nation's happiness levels, they were treated as appropriate proxies for our individual level model, as will further be explained in the concluding remarks of this paper.

Results

The output data on life expectancy at different happiness levels from our model was compared with the aforementioned collected data summarized in the CIA's Fact Book Statistics on life expectancy and Veenhoven's World Happiness levels. Because we used national level data as a comparative proxy for our model's output, the user inputted ALE used in our model was equal to the averaged national value for life expectancy from all the available data in the CIA Fact Book Statistics, yielding an average life-expectancy value of 75.18. Our expected data as given by our model's output values, and the observed data on life expectancy are summarized in Table 3.

Table 3. Comparisons between the model's output and collected data. The model's output (life expectancy one can expect to live) is based on the manipulations undertaken with Equations 2 and 3 when the user inputs an average happiness level. The observed life expectancy figures have been adapted from the CIA World Fact Book (2011) and Veenhoven's World Happiness Database (2010).

Raw Model Output and Observed Data

H_{avg}	Model Output	Observed
4.3	72.45	68.60
4.4	72.74	66.29
4.5	72.99	73.59
4.6	73.22	77.41
4.7	73.50	73.90
4.9	74.00	75.24
5.5	75.52	74.79
5.6	75.67	74.74
5.8	76.26	79.05
5.9	76.49	75.92
6.0	76.75	71.27
6.1	77.04	72.18

Because the sensitivity of the Stones and Kozma (1991) model ensured that any deviation towards the extreme ranges of happiness levels would be brought back towards a more moderate range (Havg = 4 to Havg = 7), the final averaged happiness levels outputted by our model fell between the range of 4.3 and 6.1. In order to gain confidence in our model, the results were initially analyzed using a reduced chi squared test (χ^2_{red} (10, N = 12) = 0.21, χ^2_{red} < 1), which is often employed to determine the goodness of fit for a model to observed data. As discussed by Andrae, Shulze-Hartung, and Melchoir (2010), this measure is appropriate when trying to determine whether a model has a "good-fit" to observable data, with the

criterion being that good models will have $\chi^2_{red} \cong 1$. Based on these findings, our model over-fits the data, indicating that the model is not only fitting the observed data but is also fitting the noise by over-estimating the error variance. However, Andrae et al. (2010) have cautioned against using this statistic without due consideration, for it is only applicable to linear models. Since our model relies on linear and non-linear components, additional statistical tests were performed to determine the suitability of the aforementioned results.

To eliminate the doubt injected through the findings from the χ^2_{red} statistic, we also ran a paired-groups t-test, with the expectation of finding no significant difference between the model output and the real, observed data. We predicted that this test would better deal with the noise present in the data, and allow us to either discredit or corroborate the findings obtained in the χ^2_{red} calculations. The t statistic showed that there was no significant difference between the model's output (M = 74.72, SD = 1.73) and the observed data (M = 73.58, SD = 3.58), $t(11) = 1.75$, $p > 0.05$. This result indicates that our model's output is not statistically different from the observed data. By combining this finding with the results of the χ^2_{red} test above, we can confidently conclude that (1) the model is a good fit for observable data and (2) the indicated over-estimation of the error variance is likely due to the application of a statistical test intended for linear models to a model that also contained non-linear components. It is thus reasonable to present our model as an accurate tool for predicting life expectancy based on happiness levels.

In addition to this set of data, Figure 1 shows the pervasive impact of an individual's mood reactivity (the M parameter in Equation 1) on the resulting life expectancy values. As can be seen therein, the variations in one's final, averaged happiness level come mostly from differences in the M parameter, rather than an acute sensitivity to initial happiness levels, Ht. Therefore, we can conclude that, as stated by Stones and Kozma, an individual's level of mood reactivity can protect the individual against external environmental shocks.

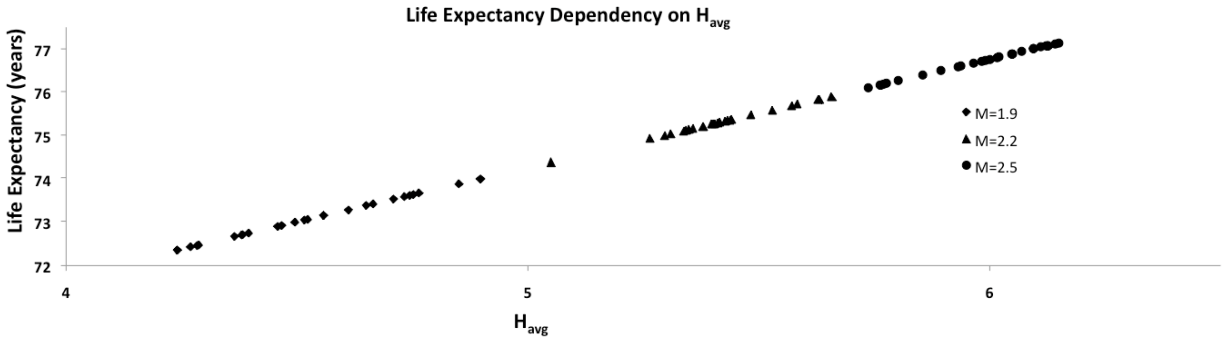
Discussion

We proposed a rudimentary model that could predict how much longer than the national ALE an individual could expect to live based on their average level of happiness over a period of 10 years, where this average was thought to be representative of one's omnipresent happiness. To do this we made use of Stones and Kozma's (1991) Magical Model of Happiness and implemented a few modifications of our own.

First, we allowed environmental factors to vary freely, within a set range of values, in order to increase the reality factor of the model. We argued that this would improve predictions of one's future happiness levels given that in real life rarely do environmental influences remain constant over time. Even the most stable environmental impacts can change in magnitude and direction – there might be an economic depression, death of a very important member in one's closest social circles, or the onset of a life threatening disease.

Second, a single, averaged value of happiness was obtained that represented

Figure 1. When Equation 1 was run through the model with various *M* values, it was observed that the outputted H_{avg} would tend towards equilibrium at a higher level as *M* increased. Subsequently, when this obtained H_{val} value was inputted in Equations 2 and 3, it predicted a longer life expectancy than for those with lower *M* and H_{avg} values (*M* = 1.9, 2.2, 2.5).



one's habitual level of happiness. This assumption was implemented as a result of Stones and Kozma's observations that happiness evaluations of individuals tend to be quite consistent over time (Stones & Kozma, 1991).

Lastly, inspired by Veenhoven's (1996) methodology for determining HLY, the averaged happiness value was multiplied by a factor of 10. This allowed for predicting an individual's longevity based on ALE in a given country and the individual's average level of happiness.

Our model was found to be consistent with observed data from the World Happiness Database and the CIA Fact Book Statistics. As a result, we have now provided a mathematically meaningful way of predicting the life expectancy of an individual based on their usual level of happiness in daily life. This is important because despite Argyle's (1997) brief mention of the interplay between happiness and life expectancy, no clear predictive relationship has been suggested in the literature. Although our model accurately predicts one's longevity in quantifiable terms, there are some concerns that should be addressed in further research.

While previous research indicates no gender differences in happiness (Mahon, Yarcheski, and Yarcheski, 2005), there are differential rates of life expectancy between the two genders. A study by Raleigh and Kiri (1997) found that female life expectancy exceeded male life expectancy by 5.4 years. It would not be surprising if this finding applied in varying degrees to the global population. Thus, one of the limitations of our model is that it does not provide differential estimates of life expectancy based on gender. This could be alleviated at a future time, when composite data becomes available to differentiate the national average life expectancies of males and females.

Because of the scarcity of data on the relationship between longevity and happiness, we were forced to use global life expectancy rates and happiness levels as proxies for the levels one would expect to find in a given population. It would be interesting to compare our model's predictions to real data at the individual level, when it becomes available. It might also be worthwhile to further develop Stones and Kozma's (1991) model such that rather than using only two variables for the environmental factors, one could use a larger array of variables that discretely take into account economic, social, and health factors (Argyle, 1997). Furthermore, Stones

and Kozma's (1991) model offered two environmental variables that made no use of any weights to differentiate their impact. We suggest that by having smaller values for the episodic than for the prevailing environmental impact we can provide a good differentiation between the two.

It must also be noted that our results are only valid at the individual level, and thus should not be used to predict how much longer, on average, all individuals in a given country can expect to live if the national level of life satisfaction rises. This cautionary note comes from Bjørnskov's (2008) observation that in countries where individuals are generally happier, people in the aggregate don't necessarily live longer. This is due to the fact that when people are in good health and high spirits, they are less likely to invest in proactive behaviors such as preventive health care expenditures (Bjørnskov, 2008). Moreover, such individuals will be more prone to adopting health-compromising behaviors such as drinking or smoking, given that they are living under the pretence that these behaviors will not affect their health status in the long run.

In conclusion, we are confident that, for now, our model can be used as a successful tool for predicting life expectancy based on one's average level of happiness, at the individual level. Perhaps in the years to come models will be produced that can also quantify life expectancy changes based on happiness levels at the population level. Indeed, these would be invaluable tools in the design and implementation of public health policy. By assessing how individuals and communities fare in terms of life expectancy, and calculating the prevailing happiness levels of individuals in a certain area, preventive public health measures can be implemented. These could come in the form of educational and skill-building seminars meant to ameliorate skills relevant to daily living (e.g., realism, determination, social competence, resilience, and personal growth), which have been shown to improve an individual's happiness (Veenhoven, 2007). Given that our model demonstrated how happiness is conducive to improved life expectancy estimates, such institutions could lead to a better, longer and happier life for all.

Declaration of Conflicting Interests

The author declared they have no conflicts of interests with respect to their authorship or the publication of this article.

References

Andrae, R., Schulze-Hartung, T., & Melchior, P. (2010). Dos and Don'ts of Reduced Chi-squared. *arXiv preprint arXiv:1012.3754*.

Argyle, M. (1997). Is Happiness a Cause of Health? *Psychology and Health, 12,* 769-781.

Aspinwall, L. G., & Brunhart, S. M. (1996). Distinguishing Optimism from Denial: Optimist Beliefs Predict Attention to Health Threads. *Personality and Social Psychology Bulletin, 22,* 993-1003

Bjørnskov, C. (2008). Healthy and Happy in Europe? On the Association between Happiness and Life Expectancy over Time. *Social Science & Medicine*, *66,* 1750-1759.

Central Intelligence Agency. (2011). The World Factbook. Retrieved April, 2012 from *URL: https://www.cia.gov/library/publications/the-world-factbook/*

Deeg, D., J. H., & Zonneveld, R. J. von. (1989). Does Happiness Lengthen Life?. In R. Veenhoven (Ed.), *How Harmful is Happiness?*

Mahon, N. E., Yarcheski, A., & Yarcheski, T. J. (2005). Happiness as Related to Gender and Health in Early Adolescents. *Clinical Nursing Research*, *14,* 175-190.

Ormel, J. (1980). Moeite met leven of een moeilijk leven? *Groningen: Konstapel*

Raleigh, V.S., & Kiri, V. A. (1997). Life Expectancy in England: Variations and Trends by Gender, Health Authority, and Level of Deprivation. *Journal of Epidemiology and Community Health*, *51,* 649-658.

Schulz, W. (1985). Quality of Life in Austria. *Report Institut Fur Soziologie der Sozial und Wirtschaftswissenschaftliche Fakultat der Universitat Wien.*

Stones, M. J., & Kozma, A. (1991). A Magical Model of Happiness. *Social Indicators Research*, *25*, 31-50.

Veenhoven, R. (1996). Happy Life-Expectancy: A Comprehensive Measure of Quality-of-Life In Nations, *39*.

Veenhoven, R. (2005). Apparent Quality-of-Life in Nations: How Long and Happy People Live. *Social Indicator Research*, *71,* 61-86.

Veenhoven, R. (2008). Healthy Happiness: Effects of Happiness on Physical Health and the Consequences for Preventive Health Care. *Journal of Happiness Studies*, *9,* 449-469.

Veenhoven, R. (2010). World Database of Happiness (Erasmus University, Rotterdam). Retrieved April, 2012 from *URL: http://worlddatabaseofhappiness. eur. nl*.

Ventegodt, S. (1997). *Livskvalitet og omsteandigheder tidligt I livet.* Forknigscenter for Livskvalitet, Kobenhaven, Denmark.

Yang, Y. (2000). Long and Happy Living: Trends and Patterns of Happy Life Expectancy in the U.S., 1970-2000. *Social Science Research, 37*, 1235-252.

Social
Research Report

Are Five Teachers Better Than One? The Effect of Multiple Models on Cultural Transmission

James Wai Chuen Loke[1]
[1]Department of Psychology, University of British Columbia

Edited by: Meghan Buckley, Department of Psychology, University of British Columbia. Received for review January 30th, 2013, and April 10, 2013.

Abstract

Cultural technologies are too complex for the individuals of a community to develop from scratch. Thus, they require knowledge transmitted by their culture to make use of them optimally. We are looking at whether having more models to learn from provides an advantage in learning cultural technologies. In this study, the nature of the experience was manipulated such that the participants learn a complicated task – computer game *"Desktop Tower Defense"* - from a single model (Individual Condition) or multiple models (Group Condition), and then teach the next generation. We predicted that participants in the Group Condition would perform better. We also expected to see prestige bias happen in the Group Condition. The results showed that there was an effect of cumulative cultural improvement in the Group Condition but not in the Individual Condition. These results may help explain why cultures with big populations are more likely to survive than those with small populations.

Keywords: *Multiple models; cumulative cultural evolution; cultural technology; prestige bias*

Humans are both a cultural and social species. Being a social species suggests that we rely on social learning at a significant level on a day-to-day basis (Henrich & McElreath, 2003). We learn many values, customs, techniques, and technologies from other human beings as cultural technologies such as weapons, building construction, writing, and art are too complex for a single individual to learn by himself or herself. It is also too difficult for individuals to develop and invent such technologies from scratch (Henrich, 2004). Therefore, we require knowledge accumulated from previous generations to order to utilize them effectively. Similarly, each generation will also contribute to this pool of knowledge through the further development of these pre-existing technologies.

Richerson and Boyd (1985) coined the term "cumulative cultural evolution" or CCE to describe the mechanism by which humans accumulate, improve, and transmit cultural knowledge from one generation to another. This progress is driven by the adaptive accumulation and adjustment of transmitted behaviors (Caldwell & Millen, 2008), thus increasing the likelihood of a

Corresponding Author:
James Wai-Chuen Loke
E-mail: james_waichuen@hotmail.com

culture's survival (Henrich, 2004). The process of cumulative cultural evolution involves not only innovation and creation, but also faithfully passing the cultural technologies on (Tomasello, 1999). The inability to pass on such accumulated improvement faithfully might lead to stagnancy or the downfall of the cultural technology (Henrich, 2004).

Cumulative Cultural Evolution as Uniquely Human Characteristic

Cumulative cultural evolution is one of the most important factors that has allowed the human species to exploit their environments to a greater extent than any other species (Boyd & Richerson, 1996). With the ability to pass down accumulated knowledge, humans have developed powerful cultural technologies that has allowed them to live longer (Boyd & Richerson, 1995). Previous research comparing non-human primates with human infants suggests that cumulative cultural evolution may be a uniquely human characteristic. Although non-human primates show a sufficient capacity to reproduce human behaviour, their imitation is inexact when compared with the accuracy demonstrated by human children. (Whiten et al., 2009). Surprisingly, children have also been shown to over-imitate the behaviour of the others. (Whiten & Flynn, 2010). Human children reproduce demonstrated actions, even when there is no obvious benefit to doing so. (Nielsen & Blank 2011).This illustrates the aptitude human infants possess in learning cultural technologies. In contrast, non-human primates do not exhibit this characteristic and only reproduce behaviours that have a causal link to a beneficial outcome (Whiten et al., 2009). The explanation for this counterintuitive phenomenon lies within the mechanism of cumulative cultural evolution.

Tomasello, Kruger, and Ratner (1993) suggested that true imitation is necessary for cumulative cultural evolution. Unlike children, non-human primates are not true imitators but are instead emulators (Tomasello 1996). Emulators only learn and understand the results of others' actions within the environment. Whiten et al. (2009) suggested that although non-human primates *can* observationally learn cultural technologies and skills, they are quickly crystallized and become habitual. This nature increase the dependency of non-human primates on the technique, which in turn reduces their flexibility in modifying their approach to tasks encountered later on (Hrubesch et al., 2009). Children who imitate the entire behaviour repertoire faithfully are able to upgrade and modify this original knowledge in the future. For example, Whiten et al. (2009) showed that children have a greater tendency to attempt more advanced and effective techniques for solving similar tasks in contrast to non-human primates. This suggests that the readiness to modify learned cultural technologies might lead to cumulative cultural evolution (Henrich, 2004).

Number of Teaching Models

The present study examines the relationship between the number of teaching models and cumulative cultural improvement. In this study, "teacher" is defined as the individual who instructs the next generation while "student" is defined as the individual who is acquiring knowledge from the previous generation. It is hypothesized that having more teachers to learn from will provide an advantage in learning, eventually increasing the likelihood of cumulative cultural improvement. Previous research by Caldwell and Millen (2010) suggests that having more teachers *does not* provide an

advantage in learning cultural technologies, showing that students learning to fly paper airplanes from three models performed worse than those learning from two models (Caldwell & Millen, 2010). This implies that learning from a larger group does not increase the likelihood of cumulative cultural improvement. This finding is inconsistent with the model developed by Henrich (2004), which predicts that populations with access to a larger group of teachers will perform better and have greater chances of generating cumulative cultural evolution than those will less access to teachers.

Cultural learning is an imperfect process that involves some maladaptive loss of skill (Henrich, 2004). However, Henrich (2004) demonstrated that having a bigger group would generate prestige bias and thus alleviate these effects. Prestige bias refers to the human tendency to learn and copy from models that have high social status or expertise in a particular skill (Mesoudi, 2011). Natural selection favors the most adaptive cultural technologies and thus social attention should be directed towards the most skillful teachers during group learning (Henrich & McElreath, 2003). As a result, students who learn the most adaptive skills from the most prestigious teachers will be better able to develop and modify these cultural technologies and will generate cumulative adaptation as this process repeats (Caldwell & Millen, 2009). In the long term, the effects of prestige bias will outweigh the maladaptive lossof skills in teaching and learning. The net result is the advancement of the cultural technologies in the population (Henrich, 2004). In contrary, having a small population limits the number of prestigious teachers available, increasing the likelihood of skill loss through cultural transmission. This inability to generate cumulative cultural improvement leads to a decline of the sophistication and complexity of the cultural technologies (Henrich, 2004).

Transmission Chain Method

The current study attempts to create a micro-culture in order to examine the importance of the number of teaching models on cumulative cultural evolution within a laboratory setting. Participants were instructed to learn how to play a computer game – *Desktop Tower Defense* – in order to teach the task to the next generation. The game required a high level of strategic planning; however, the strategies to perform well in this task were able to be culturally transmitted. In this study, the transmission chain method was used to examine how traits change across ten generations. The transmission chain method involved the presentation of a stimulus to the first participants of the chain. They then passed the learned information on to the next generation using certain a medium of communication (writing and video in this case). One of the benefits of the transmission chain method is the ability to identify both content bias and guided variation in cultural transmission (Mesoudi et al., 2006). Content bias is the process by which certain kinds of information are more likely to be learned, remembered, and transmitted than other kinds (Mesoudi, 2011). The content that is transmitted is analogous to the successful survival of such knowledge in the process of evolution. In contrast, guided variation occurs when individuals modify information that is acquired before passing it on to the next generation. This type of modification can be detected through the distortion or transformation of information along the chain (Mesoudi, 2011).

Methods

Participants

Participants were recruited on campus at the University of British Columbia through the Human Subject Pool. The participants were given 1.5 course credits in exchange for their participation. 100 participants were assigned to two conditions: Individual (*n*=50*)* and Group Conditions (*n*=50). There were 10 generations of 5 participants for each condition (see Appendix). Their mean age was 20.36 years (*SD*=2.43, *youngest*=18, *oldest*=31). 41% of the participants were male.

Materials

Desktop Tower Defense is a strategic computer game that can be found online. (viewable at http://www.kongregate.com/games/CasualCollective/desktop-td-pro). The game is played on a square map with two entrances and two exits. A set number of enemies enter from the two different entrances. The participants need to eliminate the enemies before they reach the exit points by building and upgrading different towers. Each set of enemies has different characteristics such as higher speed or immunity to certain tower. The participants must neutralize these characteristics by ensuring the right towers are built. Each participant begins with 20 lives and loses one for each enemy that successfully reaches the exit point and the path of these enemies is determined by the location of the towers. A longer path increases the time the enemies wander on the map, therefore one of most effective strategies is building a maze that exposes the enemies to more and longer attacks from the towers. *Camstudio* software was used to record the performance of participants.

General Procedure

Participants were assigned to one of two conditions: the Individual Condition (involving a single model) or the Group Condition (involving multiple models). Standardized instructions were given to all participants in both conditions. Participants started with answering a background questionnaire. The questionnaire was given to ensure that individuals with prior experience in playing *Desktop Tower Defense* were not allowed to participant.

The study was divided into two phases, a learning phase and a test phase. During the learning phase, participants went through a tutorial in order to learn the mission of the game. Then, participants in the first chain of transmission (first generation) watched two strategy videos demonstrating high scoring strategies. They were then given approximately 20 minutes to learn on their own.

During the test phase, participants were given 20 minutes to achieve the best possible score. Their performances were recorded using *CamStudio*., and these videos were used as the strategic learning aides for participants in the next generation (students). They were also required to write notes for the next generation. This process of learning and teaching was repeated until the end of the transmission chain.

Individual Condition

Participants only had access to the video and notes from one participant from the previous generation in their own group. They did not interact with anyone during the experiment.

Group Condition

Participants had access to the videos and notes from all five participants in the previous generation from five different groups. The participants were required to watch the video of best performer from the previous generation and were encouraged to interact and work with other participants in the same transmission chain.

The independent variables were the number of individuals in each generation of the transmission chain and the amount of interactions between these individuals. The Group Condition allowed for more interactions between participants as it had more participants in each generation. The dependent variable was the performance score of each participant in the test phase. We predicted that being in the Group Condition would provide an advantage by transmitting the accumulated knowledge more effectively. In addition, having the participants watch the video of the best performer ensured that only the best strategy was being transmitted (prestige bias). It is important to note that CCE does not necessarily cause result in higher scores. Instead, CCE occurs when performance scores improve significantly across each generation of the transmission chain. In other words, CCE should cause a positive relationship between the generation and the performance scores.

Results

Independent-samples T-test indicated that the mean score of participants in the Group Condition (M = 680.91, SD = 336.58) were not significantly different from those in the Individual Condition (M = 728.08, SD = 565.52), $t(98) = 0.50$, $p = 0.62$, d = 0.10.

A Pearson correlation analysis was carried out on generations and the mean performance scores of participants in both conditions. The test revealed that there was a significant and moderately strong positive correlation between generation and mean score in the Group Condition, $r(48)=0.31$, $p=0.03$. There was only a marginally significant and weak correlation between generation and mean score in the Individual Condition, $r(48) = 0.25$, $p = 0.07$.

Table 1

Mean Scores and Maximum Scores of Participants Over Ten Generations

	Mean Score		Max. Score	
Condition	*M*	*SD*	*M*	*SD*
Group	680.91	336.58	821.26	360.12
Individual	728.08	565.52	880.44	673.21

Table 2

Correlation Between Performance Scores and Generations

	Mean Score		Max. Score	
Condition	*Pearson R*	*p*	*Pearson R*	*p*
Group	0.31	0.03	0.34	0.02
Individual	0.25	0.07	0.26	0.07

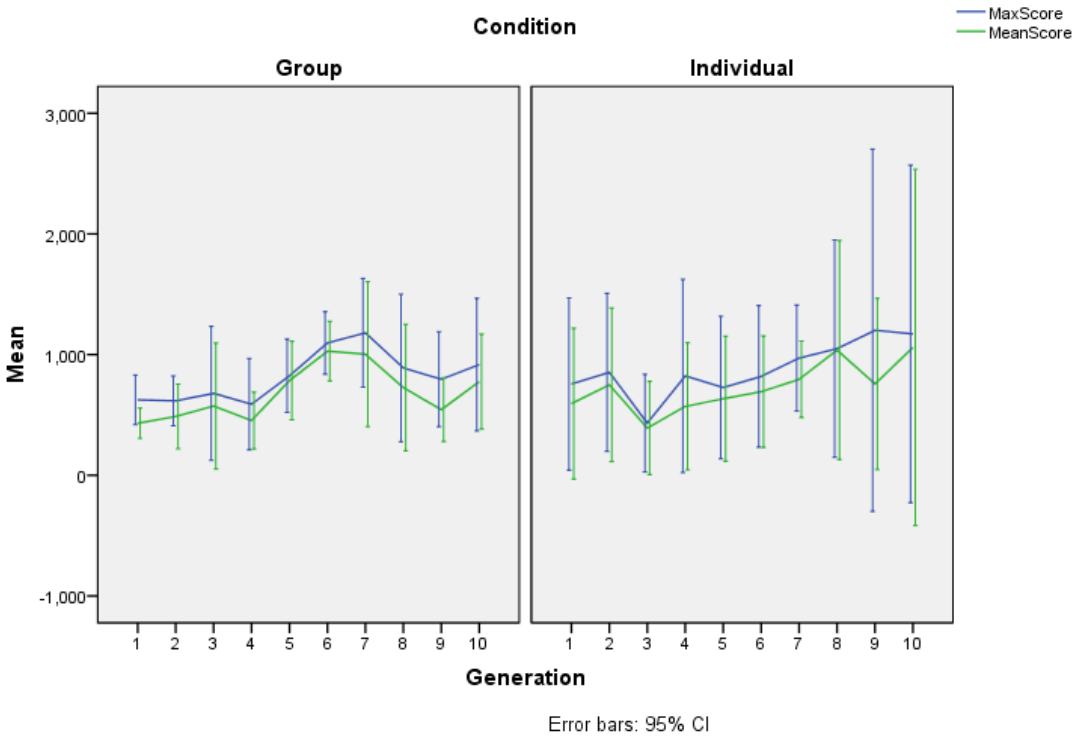
	Mean Score		Max. Score	
Condition	*Spear. Rho*	*p*	*Spear. Rho*	*p*
Group	0.31	0.03	0.34	0.02
Individual	0.18	0.22	0.18	0.20

The error bars with 95% confidence interval for performance scores of participants in the

Individual Condition were far wider than those in the Group Condition (see Graph 1). These wide error bars implied the non-normality of scores in the Individual Condition. Shapiro-Wilk normality tests indicated that mean scores of participants from the 10th generation in the Individual Condition were not normally distributed at a significant level (W = 0.70, p = 0.01). In contrast, the scores of participants in the Group Condition were normally distributed across all generations.

Discussion

Our findings are consistent with the hypothesis that having more teachers to learn from will provide an advantage in learning and hence lead to cumulative cultural improvement. Although there was no significant difference between the Group Condition and the Individual Condition in terms of their overall performance, we found a significant effect of cumulative cultural evolution over generations in the Group Condition.



As the normality of data did not hold in the Individual Condition, non-parametric a Spearman's rank correlation test was conducted. Spearman's rank correlation indicated that generations and mean score were moderately correlated at a significant level in the Group Condition, $r_s(48) = 0.31$, $p = 0.03$. In contrary, there was no significant Spearman's rank correlation between generations and mean score, $r_s(48) = 0.18$, $p = 0.22$ in the Individual Condition.

We did not find evidence of cumulative cultural evolution in the Individual Condition. These findings are consistent with the results predicted by Henrich's model (2004) and have important implications for the survival of cultural technologies. As predicted by the model, participants in the Group Condition had a greater tendency to direct their attention to the most prestigious teachers. As mentioned before, prestige bias ensures that only the best strategies are

transmitted. Poorly constructed strategies are more likely to be neglected as they decrease the survival of the next generation. As speculated by the model, prestige bias alleviated the effect of maladaptive losses of cultural technologies and produced the net results of cumulative improvement (Henrich, 2004).

These findings are inconsistent with previous research that found no effect of cumulative improvement for learning in a larger group (Caldwell & Millen, 2010). One of the possible explanations for this contradiction may be the complexity and difficulty of the task. Caldwell & Millen (2010) used a simpler task to represent a cultural technology – flying paper airplanes. This task is relatively less sophisticated compared with the task introduced in the current study. *Desktop Tower Defense* is easy to learn but can be augmented by powerful and complicated strategies. These strategies allow an individual to perform much better and can be culturally transmitted.

Another possible reason would be the medium of communication used in transmitting the cultural technologies. In the previous study, participants observed and learned from others. However, the participants in the current study had access to the full videos of previous performances as well as written notes from their teachers. Participants could always revise these videos and notes during the learning phase. Moreover, the participants in the current study had more time to learn and perform. The previous study (Caldwell & Millen, 2010) took approximately 10 minutes while current study took 1.5 hours to complete. Thus, the participants in the current study had less time constraints and could make greater use of all the information available.

Nevertheless, our study has several limitations. First, students in the Group Condition were encouraged to interact and work with others who were in same transmission chain. It is hard to identify whether students learned more from teachers coming from the previous generation or their peers in the same generation. Social interaction alone may contribute substantially to the learning improvement of students. Second, this study attempted to create a micro-culture in the laboratory setting and accordingly might lack external validity. Although it reflects how human strategies improve and evolve over time, the computer technologies used in this study are relatively new in comparison with other cultural technologies such as cooking, knot tying, and weapons. Third, our study only involved university students who might not be representative of the greater population that we are interested in. Their performances might be positively skewed, as university students are more educated, knowledgeable, and wealthy in comparison to the general population.

Future replications of this study should introduce a condition where students have access to information from multiple teachers but are not allowed to interact and communicate with peers in the same generation. This may rule out the possibility that students improve through social interaction alone. In addition, future research may attempt to transmit other cultural technologies (e.g. building construction and weapons making) that have been long developed within human history. Alternative tasks such as these are worth further exploration in order to better under the process of cumulative cultural evolution within the human species.

Conclusion

The experimental comparison of the performance scores between the Group and Individual conditions support the argument that population size is crucial for the survival of cultural technologies. It is possible to conclude that having a larger population increases the likelihood of a culture's survival by facilitating the transmission of accumulated knowledge. Having a larger group allows for the mechanism of prestige bias, which ensures only the best knowledge is passed down the transmission chain. This is consistent with the evolutionary maxim "survival of fittest". This helps explain not only the downfall of certain cultural technologies, but also the survival of human species.

Declaration of Conflicting Interests

The author declared they have no conflicts of interests with respect to their authorship or the publication of this article.

References

Boyd, R. & Richerson, P. J. 1985 Culture and the evolutionary process. Chicago, IL: University of Chicago Press.

Boyd, R. & Richerson, P. J. 1994 Why does culture increase human adaptability? *Ethology and sociobiology. 16*, 125–143.

Boyd, R. & Richerson, P. J. 1996 Why culture is common, but cultural evolution is rare. *Proceedings of British Academy. 88*, 77–93.

Caldwell, C. A., & Millen, A. E. (2008). Review. studying cumulative cultural evolution in the laboratory. *Philosophical Transactions of the Royal Society of London.Series B, Biological Sciences, 363*(1509), 3529.

Caldwell, C. A., & Millen, A. E. (2009). Social learning mechanisms and cumulative cultural evolution. is imitation necessary? *Psychological Science, 20*(12), 1478-1483.

Caldwell, C. A., & Millen, A. E. (2010). Human cumulative culture in the laboratory: Effects of (micro) population size. *Learning & Behavior, 38*(3), 310-318.

Flynn, E. (2008). Investigating children as cultural magnets: Do young children transmit redundant information along diffusion chains? *Philosophical Transactions of the Royal Society of London.Series B, Biological Sciences, 363*(1509), 3541-3551.

Henrich, J. (2004). Demography and cultural evolution: How adaptive cultural processes can produce maladaptive losses: The tasmanian case. *American Antiquity, 69*(2), 197-214.

Henrich, J., & McElreath, R. (2003). The evolution of cultural evolution. *Evolutionary Anthropology: Issues, News, and Reviews, 12*(3), 123-135.

Hrubesch, C., Preuschoft, S., & van Schaik, C. (2009). Skill mastery inhibits adoption of observed alternative solutions among chimpanzees (pan troglodytes). *Animal Cognition, 12*(2), 209-216.

Mesoudi, A. (2011). *Cultural evolution: How darwinian theory can explain human culture and synthesize the social sciences*. Chicago: University of Chicago Press.

Mesoudi, A., Whiten, A., & Laland, K. N. (2006). Towards a unified science of cultural evolution. *Behavioral and Brain Sciences, 29*(4), 329-347.

Nielsen, M., & Blank, C. (2011). Imitation in young children: When who gets copied is more important than what gets copied. *Developmental Psychology, 47*(4), 1050-1053.

Richerson, P. J., Boyd, R., & Bettinger, R. L. (2009). Cultural innovations and demographic change. *Human Biology; an International Record of Research, 81*(2-3), 211-235.

Tomasello, M., Kruger, A., & Ratner, H. (1993). Cultural Learning. *Behavioral and Brain Sciences, 16*(3), 495-511.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, Mass: Harvard University Press.

Whiten, A., & Flynn, E. (2010). The transmission and evolution of experimental microcultures in groups of young children. *Developmental Psychology, 46*(6), 1694-1709.

Whiten, A., McGuigan, N., Marshall-Pescini, S., & Hopper, L. M. (2009). Emulation, imitation, over-imitation and the scope of culture for child and chimpanzee. *Philosophical Transactions of the Royal Society of London.Series B, Biological Sciences, 364*(1528), 2417-2428.

Appendix

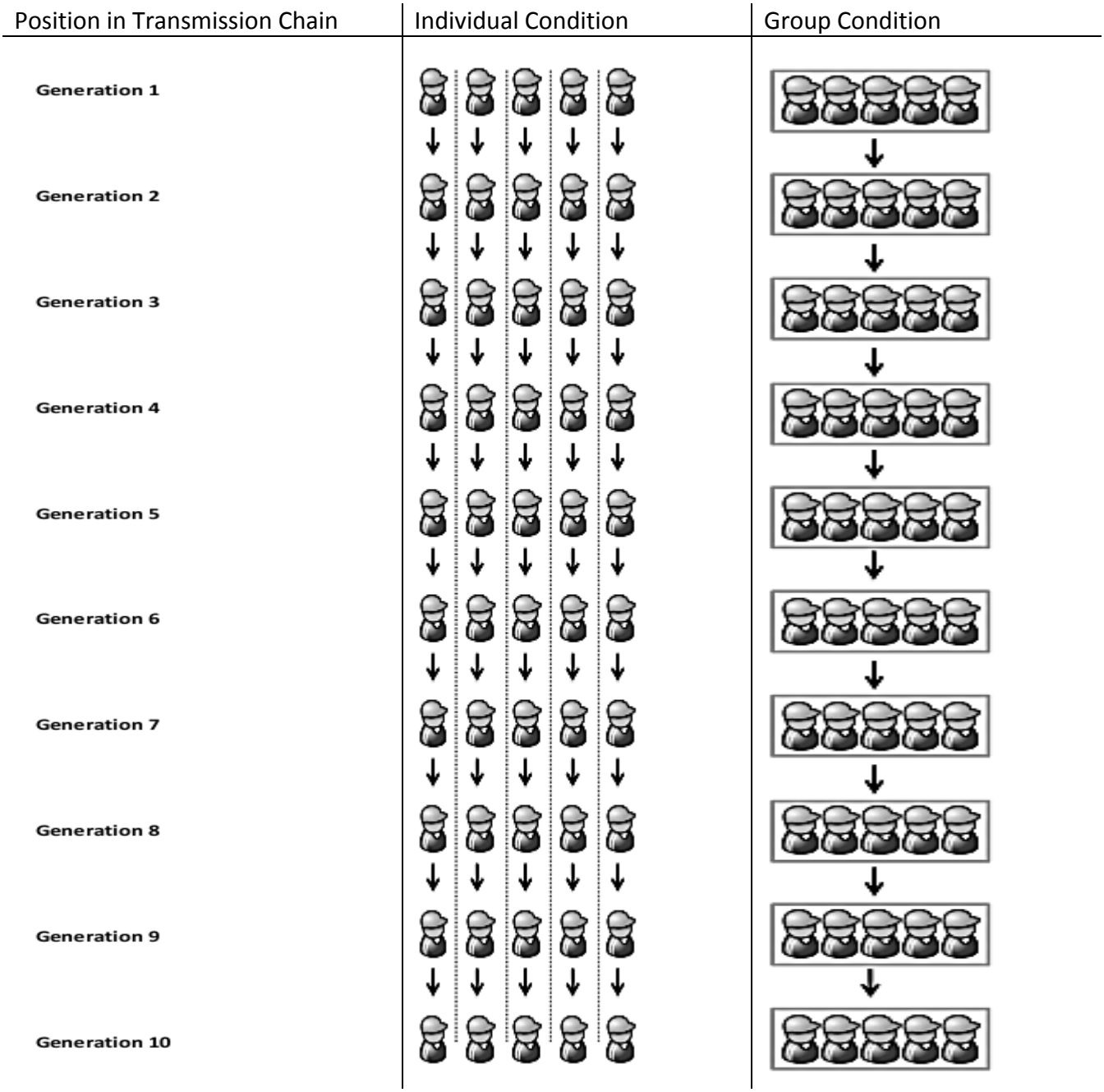


Figure 1. Illustration of micro-culture creation of current study. It shows how cultural technologies are transmistted from one generation

Health
Literature Review

Treating the Obesity Epidemic: Is Nudging the Cure?

Nathan A. Dhaliwal[1]
[1]Department of Psychology, University of British Columbia

Edited by: Xiaolei Deng, Department of Psychology, University of British Columbia. Received for review October 7th, 2012, and accepted March 7th, 2013.

Abstract

An imbalance between energy input and energy output is the primary contributor to the obesity epidemic. One way to solve such a problem is to reduce the amount of energy consumed by decreasing the amount eaten and by eating less energy-dense foods. Examined in this paper is how people can be nudged to both consume less and eat a healthier diet. Nudging refers to the act of subtly influencing peoples' decisions with environmental stimuli. While overt health interventions, such as placing taxes on unhealthy foods and providing health information to consumers, have proven less then effective, nudging shows promise for improving individuals' eating decisions. But while empirical investigations of nudging show its ability to change eating behaviour, the question remains as to how effective it is at ending the obesity epidemic. This review highlights the need for a systematic investigation of the magnitude of impact nudging can have on solving this current health crisis.

Keywords: *nudge, obesity epidemic, eating behaviour*

You have just paid for your lunch at the school cafeteria. As you look at your tray of food you realize that you opted for no ice cream today. You also chose to have a salad but poured on less dressing than you usually do. What you do not realize is that these decisions were influenced by the design, or choice architecture (Thaler, Sunstein, & Balz, 2010), of the cafeteria. The ice cream had been recently moved from a freezer with a clear lid to one with an opaque lid. The cafeteria had just recently implemented trays which led you to add a salad to your main dish. And the dressing had been moved so that it was slightly more difficult to reach with the serving spoon. All these subtle changes led to your choice of a meal. You were nudged, subtly influenced in your behaviours without your direct awareness.

The focus of this paper is to review the literature on nudging to evaluate how effective it is as a tool for improving eating behavior and ultimately ending the obesity epidemic. The need for a tool to address poor eating habits could not be more pressing. Currently Canada faces an epidemic of obesity; one out of four Canadians is obese (OECD, 2012). The rates are even higher in the United States where

UBC UJP

Corresponding Author:
Nathan A. Dhaliwal
E-mail: nathanarjundhaliwal@gmail.com

more than one third (35.7%) of the population is obese (Ogden, Carroll, Kit, & Flegal, 2012). The obesity epidemic is also not limited to adults. In 2010, 40 million children worldwide were overweight (WHO, 2012) with 12% of Canadian children reported as being obese (Roberts, Sheilds, Groh, Aziz, & Gilbert, 2011).

Being obese carries serious consequences. Kanaya and Vaisse (2011) divide the health consequences of being obese into three groups. First, there is the psychological response to society's view that obesity is unattractive. Second, joints and organs endure the increased pressure from higher levels of adipose mass. And third, the increasing circulation of free fatty acids leads to a slow down of metabolism. Such consequences increase the likelihood of developing certain chronic and often life threatening diseases (Kanaya and Vaisse, 2011). As a result, being overweight or obese is the fifth leading cause of death in the world (WHO, 2012)

One of the leading causes of the obesity epidemic is poor eating behaviour (Hill, Wyatt, Reed, & Peters, 2003). Swinburn, Sacks, and Ravussin (2009) calculated that the increase in the amount of food intake in the United States between 1970 and 2000 is more than sufficient to explain the obesity epidemic. Other research supports this finding; Hill, Wyatt, Reed, and Peters (2003) found, from compiling data from national surveys, that an energy imbalance of 100 kilocalories per day accounts for majority of the weight gain in the population of the United States. Such an imbalance could be eliminated with people taking a few less bites at each meal. For example, an average adult in the United States consumes 2000 to 2500 kilocalories a day, which means a mere 4 to 5% decrease in energy intake could eliminate the imbalance.

While approaches to reduce obesity, such as taxing unhealthy foods and providing health information to consumers, have been examined, the effectiveness of such methods remains unclear (e.g. Galizzi, 2012; Heike and Taylor, 2012; Mytton, Clarke, & Rayner, 2012). For example, a recent review indicates that although taxing may prove effective in reducing poor eating behaviour, the tax increase needed may be as much as 20% (Mytton, Clarke, & Rayner, 2012). Furthermore, the issue of governments not wanting to implement additional taxes (Marshall, 2000) and the fact that the poor, of whom many also happen to be obese, will endure a far greater tax burden than the rich (Leicester & Windmeijer, 2004) makes such an intervention technique somewhat difficult to implement.

Other research has looked at the effectiveness of nutritional labels, with details about the ingredients and caloric value of food, on improving eating behaviour (see Heike and Taylor, 2012, for a review). But according to two extensive reviews (Galizzi, 2012; Heike and Taylor, 2012), the evidence for the effectiveness of information-based interventions is inconclusive. Heike and Taylor (2012) highlight numerous topics that need addressing in order to gain a clearer understanding of the effectiveness of intervention based techniques. For example, the question of whether cognitive ease or detailed information is more important to pursue when labeling, although many studies have investigated the topic, remains unanswered. And regardless of which style of information based techniques proves most effective, Heike and Taylor (2012) make clear that all

is contingent upon people being at least somewhat concerned about their health and interested in knowing the nutritional content of what they are eating. If the consumers do not care, such methods do not show much promise for being effective.

Given the uncertainty of such methods for improving eating decisions, the question arises about how effective nudging is at accomplishing such a goal. Reviewed in this paper is (1) what nudging is (2) the science behind nudging and (3) the experimental work investigating the effectiveness of nudging as a way to improve eating behaviour. This paper concludes by highlighting the need for a systematic investigation into how effective nudging can be in solving the obesity epidemic.

What is Nudging?

The term nudge was first coined by Thaler and Sunstein (2008), in their bestselling book *Nudge: Improving Decisions about Health, Wealth, and Happiness*. They explain that a nudge is any aspect of our environment that attracts our conscious or subconscious attention and, without coercion, alters behaviour in a predictable way. The concept of nudging is based on research in cognitive psychology, social psychology, and behavioural economics (e.g. Kahneman & Tversky, 1979) that has revealed how people's behaviour does not resemble the rational agent model put forth in classical and neoclassical economics. As Thaler (2000) puts it, we are *Homo sapiens* not *Homo economicus*. In other words, we do not act as hyper-rational beings constantly calculating the best choice for our welfare. Rather we rely on heuristics and biases, which take less effort and often are quite useful but sometimes lead us to act in direct opposition to how a rational agent is expected to act (Kahneman, 2011). Stanovich and West (2000) refer to this way of thinking as System 1: a fast thinking, low effort mode of being, which we spend most our day in. Without switching to System 2—a slow thinking, effortful mode of analysis—we are prone to fall prey to the numerous biases of our mind. Such biases include: the anchoring heuristic (Tversky & Kahneman, 1974), the endowment effect (Thaler, 1980), framing effects (Tversky & Kahneman, 1981), loss aversion (Tversky & Kahneman, 1991), the status quo bias (Samuelson & Zeckhauser, 1988), and the unit bias (Geier, Rozin, & Doros, 2006). Nudging exploits this tendency to operate in System 1 with the goal of helping people make decisions that are in their best interests (Thaler & Sunstein, 2008).

A concept central to nudge theory is *choice architecture* (Thaler, Sunstein, & Balz, 2010). Choice architecture is a phenomenon in which the environment influences our choices. The obvious example of choice architecture comes from an example of a building. The fact that the entrance to a building was made on the east side and not the west, influences people's behaviour; they all end up walking to the east side of the building. And there was no way of avoiding this nudge; the entrance had to go somewhere. Although architecture is the obvious example, choice architecture is not limited to buildings per se, but is embedded in situational design that requires making a choice. Anything from a restaurant menu to a grocery store shopping cart contains choice architecture and influences people's decisions. In fact, neutral choice architecture does not exist. For example, even if the default option in a decision situation is not to make a change,

choice is still being influenced; people will simply make the choice not to make a change (Johnson et al., 2012). Or, to use the example from the opening paragraph, the cafeteria could either provide trays or not. When trying to nudge people to eat healthier meals, the goal is for people to experience an environment that will encourage them to make healthy, rather than unhealthy, choices.

The Science behind Nudging

While nudging is a relatively new concept, it is based on years of empirical research in psychology that has identified the numerous heuristics used by the human mind. One heuristic that many nudges are based on is the anchoring heuristic (Tversky & Kahneman, 1974). When first exposed to a certain stimulus, subsequent decisions can be influenced due to being 'anchored', or compared, to the original stimulus, which acts as a kind of standard in peoples' minds. The anchoring heuristic functions through two mechanisms: adjustment and suggestion (Kahneman, 2011). A study by Wansink, Kent, and Hoch (1998) provides an interesting example of adjusting. The researchers found that when a sale promotion at a supermarket advertised soup with the statement NO LIMIT PER PERSON, people responded by buying on average 4 soup cans. When the advertisement instead read LIMIT OF 12 PER PERSON, people purchased 7 cans. In the first condition there was no anchor and people ended up buying a lower number of cans. But in the second condition, people were anchored to a relatively high number and as a result bought a larger number of cans.

Anchoring also functions through suggestion rather than adjustment. Suggestion operates when the anchor is absurdly high or low (Mussweiler & Strack, 1999). In such cases, peoples' subsequent decisions are still affected because, regardless of the absurdity of the stimulus, System 1 still tries to make sense of it. Although people are not *adjusting* from the anchor directly, the stimulus still activates associative memories and thus can still influence behaviour (Mussweiler & Strack, 1999).

Another heuristic that is commonly exploited with nudging is the status quo bias (Samuelson & Zeckhauser, 1988). People like to stick with the status quo. So much so, that if the default on an organ donation form is that you would like to donate your organs when you die, it is likely that you will become an organ donor (Johnson & Goldstein, 2003). The status quo bias has also been exploited to increase retirement savings. Mandrian and Shea (2001) found that when workers were automatically enrolled in a retirement savings plan, 98% remained enrolled after 36 months. On the other hand, when workers had to opt in to contribute to a retirement savings plan, enrollment peaked at only 65%.

The status-quo bias explains another psychological phenomenon known as the endowment effect (Thaler, 1980). The endowment effect occurs when a person places more value on an item once they own it as opposed to before owning it. For example, people tend to find it very difficult to give up buying a food item after they have been buying it for a long time, but if they have not been buying it for that long, giving up buying it is not as difficult (Dhar & Wertenbroch, 2000; Kahneman, Knech, & Thaler, 1990).

Much like how people prefer not to deviate from the status quo, people also do not feel the need to deviate from unit

sizes—a heuristic known as the unit bias (Geier, Rozin, & Doros, 2006). In other words, when people are presented with a unit of some good they automatically perceive that as the accurate amount for a person. Geier, Rozin, and Doros (2006) conducted a study where all participants were free to have as many servings of a food item as they wanted. The only difference between groups was that some people were given smaller servings while others were given larger servings. The result was that those who were given smaller servings ate less food.

The understanding that losses loom larger than gains is also used when designing nudges (Tversky & Kahneman, 1991). This tendency to value losses more than gains, a heuristic termed loss aversion, is illustrated by this classic example:

Question 1: Which do you choose?
Get $900 for sure OR 90% chance to get $1,000?

Question 2: Which do you choose?
Lose $900 for sure OR 90% chance to lose $1,000?

Most people prefer the sure gain on the first question but prefer the gamble on the second question. This response illustrates that people are more willing to take a risk to avoid a loss than to achieve a gain. The most common nudge that is derived from the knowledge of loss aversion is a framing nudge. Framing effects occur when a person makes a different decision, not because of a change in the content of the question, but rather because of how the question is framed (Tversky & Kahneman, 1981). For example, a question can be framed as loss and it will likely elicit a much different reaction for people as opposed to if it was framed as a gain (as the above example illustrates). But framing effects are not limited to semantic questions; environments and objects can also be framed in such a way to elicit a different response.

Two other related areas of research in psychology are largely relied upon when designing nudges: priming and social norms. In fact, priming often times functions because of the aforementioned heuristics. For example, the anchoring effect sometimes functions as a priming effect when the anchor is absurdly high or low. In such cases priming occurs because System 1 has subconsciously let the anchor influence subsequent decisions. But priming can also function without an anchor but instead because of the mere subconscious intake of some cue. A classic example of this effect comes from Bargh, Chen, and Burrows (1996) who found that simply having participants unscramble sentences that related to elderly people led them to subsequently walk slower.

Knowing that people prefer not to deviate from social norms has also been used quite successfully when nudging. For example, both reducing electricity use and increasing tax compliance has been accomplished by nudging people with social norms. Researchers investigated what would happen when people received their monthly electricity bill which included, along with their own rating, an average of their neighbours' ratings (Ashby et al., 2012). As expected, those who had a rating above the average of their neighbours decreased their usage the following month. Wanting to be like your neighbors can also cause you to pay your taxes. Researchers working for the UK government found that

when they included in their letter to violators the fact that the majority of their fellow residents pay their taxes, most violators began to pay their taxes (Behavioural Insight Team, 2011).

Nudging You to Eat Better

As seen, nudging is based on a number of findings in the behavioural sciences that have revealed how the human mind functions. Collectively, these findings serve as the framework for designing nudges. Nudging with food packaging is one example where a nudge can be implemented to address poor eating behaviour. In one study, participants ate a quarter less of a food item if it was divided and packaged in four 100-calorie packages instead of one 400-calorie package (Wansink, Payne, & Shimizu, 2010). An additional finding showed that overweight participants ate half the amount when the food was divided and placed in the 100-calorie packages (Wansink, Payne, & Shimizu, 2010). In addition, individuals who check energy content on food packages can be influenced with a simple change in the units used. Researchers found that when food is labeled in kilojoules instead of kilocalories individuals make healthier choices because joules make the unhealthy food items appear to have larger energy content (Panderlaere, Briers, & Lembregts, 2011).

Depictions of *The Last Supper* show a 65.6% increase in plate size over the last millennium (Wansink & Wansink, 2010). Could the size of our plates be leading us to eat more? According to a recent study, the size of a plate can dictate how much is served (Van Ittersum & Wansink, 2012). Researchers found that using smaller plates significantly decreased how much a person served without decreasing the individual's satisfaction (Van Ittersum & Wansink, 2012). The researchers argue that smaller plates sizes lead people to feel satisfied while eating less (Van Ittersum & Wansink, 2012). The size of the plate dictating how much is served may also explain why depictions of *The Last Supper*, along with the increase in plate size, have also shown a 23.1% increase in the size of the bread and a 69.2% increase in the size of the main dish (Wansink & Wansink, 2010).

Moreover, serving sizes are influenced by the color of the plate. People are likely to place less food on plates with colors that highly contrast with the color of the food (Van Ittersum & Wansink, 2012). Also, a decrease in the contrast between the tablecloth and the plate decreases how much is served (Van Ittersum & Wansink, 2012). Another study also suggests the area of the plate where food is placed influences an individual's preference for it (Zampollo et al., 2012). In addition to where the food is on the plate, people are also influenced by where the food is listed on the menu. Dayan and Bar-Hillel (2011) found that when foods were displayed at the beginning or end of their category on the menu they were 20% more likely to be chosen compared to when they were in displayed in the middle of the category.

Menu design, then, can also influence choices by having healthy foods divided among many categories on a menu and unhealthy foods grouped into one category (Fox, Ratner, & Lieb, 2005). Researchers have found that people tend to allocate resources as equally as possible across categories (Fox, Ratner, & Lieb, 2005). Thus, when healthy foods are divided among many categories, peoples tend to choose multiple healthy foods. On the other hand, when there is only one category of unhealthy foods, people tend to consume

less of such foods (Fox, Ratner, & Lieb, 2005). A similar phenomenon can be applied in a grocery store. Researchers taped a yellow line in grocery carts designating the area for only fruits and vegetables (Wansink, Soman, Herbst, & Payne, 2012). The result: an increase in the purchases of fruits and vegetables.

Concerning the specific problem of childhood obesity, researchers have discovered that simply rearranging the layout of a cafeteria influences children to make far healthier choices (Hanks, Just, Smith, & Wansink, 2012). Recommendations to entice children to make healthier choices in the cafeteria include giving healthy foods more enticing names (Wansink, Just, & Smith, 2011b) and placing healthier food at the beginning of the line (Wansink & Just, 2011). Other work by Rozin et al. (2011) showed that increasing the difficulty of reaching unhealthy food decreases the consumption of these unhealthy foods. In addition, it was discovered that having fruit in bowls instead of stainless steel trays increased fruit consumption by more than 50% (Wansink, Just, & Smith, 2011a).

The mere presence of certain foods in a cafeteria can also cause children to make different choices. Researchers found that some foods serve as "trigger foods" leading children to change their preference for other, seemingly unrelated, foods (Hanks, Just, & Wansink, 2012). For example the presence of green beans and bananas was found to lead children to decrease their consumption of unhealthy foods. The researchers refer to these types of foods as *positive trigger foods*. The researchers also indentified *negative trigger foods*: foods that lead people to increase their consumption of unhealthy foods. An example of a negative trigger food, the researcher discovered, was fruit cocktail, which the mere presence of led children to increase their purchases of other sugary foods. Finally, if one wants to discourage the eating of ice cream and increase the eating of salads, cafeterias should provide trays and store ice cream in opaque freezers (Just & Wansink, 2009). The lack of trays led children to eat 21% less salad, but did not decrease the consumption of ice cream, while opaque freezer lids decreased the amount of ice cream purchased in the cafeteria (Just & Wansink, 2009).

The presented evidence points towards nudging as a potentially effective strategy for improving eating behavior. Nonetheless, contentions exist about whether nudging can truly bring about the necessary change. Specifically, can nudging not only change immediate eating behaviors but also change societal norms around eating?

A Potential Problem with Nudging

It seems evident that nudging is effective at influencing behaviour. Furthermore, it appears that all other methods tried to date have either produced inconclusive results or are quite difficult to implement. And precisely because these other methods are not greatly effective it is important to let further research determine if nudging can produce the intended result of solving the obesity epidemic.

One concern that arises regarding the effectiveness of nudging in truly solving such a great problem is the inability of nudging to alter existing social norms (Mills, 2012). For example Yeung (2012) asks, if a person is nudged to choose, for example, the salad over the lasagna because of the choice architecture that person

experienced, will that behaviour simply be reversed where such choice architecture does not exist? Klick and Mitchell (2005) worry that contributing to such a potential problem is that while social norms are not being changed, people are being prevented from learning from their mistakes and in turn not acquiring the skill to decipher what they like and do not like. The specific concern raised by Klick and Mitchell (2005), is not warranted based on the available evidence. Nudging does not cause people to never make mistakes in their decisions; it just causes them to make unfavorable decisions less often—a result I do not see many people objecting to. On the other hand, the argument that nudging may be able to influence behaviour when one is actually being nudged, but is not robust enough to truly change social norms is a valid concern and highlights a topic of future research. Although concerns have been raised that nudging is not strong enough a technique to change social norms (e.g. Mills, 2012; Yeung, 2012), neither a mathematical modeling nor an empirical analysis of such a claim has yet been conducted.

Conclusion

The question of whether nudging can solve this health crisis remains unanswered, but based on the empirical work up to this point, the potential looks promising. And even if nudging does not hold the capacity to change social norms, this may not devalue the technique altogether. Of course changing the social norms to such that people deliberately choose and prefer healthier foods would be ideal, but such a norm may not be necessarily needed to solve this current health crisis. As mentioned, Hill, Wyatt, Reed, and Peters (2003) found that even a minor decrease in energy intake could reverse the current energy imbalance that has led to the obesity epidemic in the United States. And Rozin et al. (2011) have calculated how the small effects of nudging people to eat healthier foods can have a significant effect on limiting weight gain over time. Nudging has indeed proven to be effective at decreasing energy consumption by both decreasing portion sizes and replacing energy dense foods with less energy dense foods. And given that correcting for energy imbalance is the ultimate goal, nudging shows potential to be quite effective. Thus, in my opinion, nudging may have a large enough effect to significantly reduce weight problems, even if it does not solve them entirely. A more practice-focused and detailed empirical investigation of such potential is the next step in understanding if nudging can indeed be the cure for the obesity epidemic.

Declaration of Conflicting Interests

The author declared they have no conflicts of interests with respect to their authorship or the publication of this article

References

Ashby, K., Forster, H., Ceniceros, B., Wilhelm, B., Freibel, K., Henschel, R., Samiullah, S. (2012). Green with envy: Neighbor comparisons and social norms in five home energy report programs. *ACEEE summer Study on Energy Efficiency in Buildings, 7*, 22-34.

Bargh, J.A., Chen, M., Burows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. *Journal of Personality and Social Psychology, 71*(2), 230-244.

Behavioural Insights Team. (2011). Annual Update 2010-11, UK, London: Cabinet Office.

Dayan, E., & Bar-Hillel, M. (2011). Nudge to nobesity II: Menu positions influence food orders. *Judgement and Decision Making, 6*(4), 333-342.

Dhar, R., & Wertenbroch, K. (2000). Consumer choice between hedonic and utilitarian

goods. *Journal of Marketing Research, 37*(1), 60-71. doi: 10.1509/jmkr.37.1.60.18718

Fox, C.R., Ratner, R.K., & Lieb, D., (2005). How subjective grouping of options influences choice and allocation: diversification bias and the phenomenon of partition dependence. *Journal of Experimental Psychology. General, 134*, 538-551.

Galizzi, M.M. (2012). Label, nudge or tax? A review of health policies for risky behaviours. *Journal of Public Health, 1*(5), 14-21.

Geier, A., Rozin, P., & Doros, G. (2006) Unit Bias: A new heuristic that helps explains the effect of portion size on food intake. *Psychological Science, 17*(6), 521-525.

Hanks, A.S. Just, D.R., & Wansink, B. (2012). Trigger foods: The influence of 'irrelevant' alternatives in school lunchrooms. *Agricultural and Resources Economic Review, 41*(1), 114-123

Hanks, A.S., Just, D.R., Smith, L.E., & Wansink, B. (2012). Health convenience: nudging students toward healthier choices in the lunchroom. *Journal of Public Health, 34*(1), 1-7. doi: 10.1093/pubmed/fds003

Heike, S., & Taylor, C.R. (2012). A critical review of the literature on nutritional labeling. *The Journal of Consumer Affairs, 46*(1), 120-156.

Hill, J.O., Wyatt, H.R., Reed, G.W., & Peters, J.C. (2003). Obesity and the environment: Where do we go from here? *Science 299*(5608), 853-855.

Johnson, E.J. & Goldstein, D. (2003). Do defaults save lives ?, *Science, 302*, 1338-1339.

Johnson, E.J., Shu, S.B., Dellaert, B.G.C., Fox, C., Goldstein, D.G., Haubl, G.,…Weber, E.U. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters, 23*, 487-504.

Just D.R., & Wansink, B. (2009). Smarter lunchrooms: Using behavioural economics to improve meal selection. *Choices, 24*(3).

Kahneman, D. (2011). *Thinking, Fast and Slow*. Doubleday Canada.

Kahneman, D., Knetsch, J.L., & Thaler, R.H. (1990). Experimental test of the endowment effect and the Coase theorem. *Journal of Political Economy, 98*(6), 1325-1348.

Kahneman, D., & Tversky, A. (1979). Prospect theory: an analysis of decision under risk. *Econometrica, 47*(3), 263-291. Retrieved from http://www.princeton.edu/~kahneman/docs/Publications/prospect_theory.pdf

Kanaya A.M., & Vaisse C. (2011). Obesity. In Gardner D.G., & Shoback D. (Eds.), *Greenspan's Basic & Clinical Endocrinology*, 9e. New York: McGraw-Hill.

Klick, J. & Mitchell, G. (2005). Government regulation of irrationality: Moral and cognitive hazards. *Minnesota Law Review 90*(1620). 1620-1663.

Leicester, A. & Windmeijer, F. (2004). The 'fat tax': Economic incentive to reduce obesity. *IFS Briefing Note No. 49*, 1-19

Mandrian, B.C., & Shea, D.F. (2001). The power of suggestion: Inertia in 401(k) participation and savings behavior. *The Quarterly Journal of Economics, 116*(4), 1146-1525.

Mussweiler, T. & Stack, F. (1999). Hypothesis-consistent testing and semantic priming in the anchoring paradigm: A selective accessibility model. *Journal of Experimental Social Psychology, 35*, 136-164.

Marshall, T. (2000). Exploring a fiscal food policy: the case of diet and ischaemic heart disease. *British Medical Journal, 320*, 301-304.

Mills, C. (2012). Why nudges matter: A reply to Goodwin. *Politics, 33*(1), 28-36.

Mytton, O.T., Clarke, D., & Rayner, M. (2012). Taxing unhealthy foods and drinks to improve health. *British Medical Journal, 344*, 1-7.

OECD. (2012). Obesity and the economics of prevention: Fit not fat. Key facts – Canada, update. Retrieved from http://www.oecd.org/els/healthpoliciesandata/49712071.pdf

Ogden, C.L., Carroll, M.D., Kit, B.K., & Flegal, K.M. (2012). Prevalence of obesity in the United States. NCHS Data brief, 82. Retrieved from http://www.cdc.gov/nchs/data/databriefs/db82.pdf

Pandelaere, M., Briers, B., & Lembregts, C. (2011). How to make a 29% increase look bigger: the unit effect in option comparisons. *Journal of Consumer Research, 38*(2), 308-322. doi: 10.1086/659000

Roberts, K.C., Sheilds, M., Groh, M., Aziz, A. & Gilbert, J. (2011). Overweight and obesity in children and adolescents: Results from the 2009 to 2011 Canadian Health Measures Survey. Retrieved from http://www.statcan.gc.ca/pub/82-003-x/2012003/article/11706-eng.htm

Rozin, P., Scott, S., Dingley, M., Urbanek, J.K., Jiang, H., & Kaltenbach, M. (2011). Nudge

to nobesity I: Minor changes in accessibility decrease food intake. *Judgement and Decision Making, 6*(4), 323-332.

Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty, 1*(1), 7-59.

Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate. *Behavioral and Brain Sciences, 23*, 645–665.

Swinburn, B., Sacks, G. & Ravussin, E. (2009). Increased food energy supply is more than sufficient to explain the US epidemic of obesity. *American Journal of Clinical Nutrition, 90*(6), 1453-1456.

Thaler, R.H. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior and Organization, 1*, 39-60.

Thaler, R.H. (2000). From Homo Economicus to Homo Sapiens. *Journal of Economic Perspectives, 14*(1), 133–141.

Thaler, R.H., & Sunstein, C.R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press.

Thaler, R. H., Sunstein, C. R., & Balz, J. P. (2010). Choice Architecture. Available at SSRN: http://ssrn.com/abstract=1583509 or http://dx.doi.org/10.2139/ssrn.1583509

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: heuristics and biases *Science, 185*(4157), 1124-1131.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice *Science, 211*(4481), 453-458.

Tversky, A., & Kahneman, D. (1991). Loss aversion and riskless choice: A reference dependent model. *Quarterly Journal of Economics, 106*(4), 1039-1061.

Van Ittersum, K., & Wansink, B. (2012). Plate size and color suggestibility: the Delboeuf illusion's bias on serving and eating behaviour. *Journal of Consumer Research*, 39(2), 215-228.

Wansink, B. & Just, D. (2011). Healthy foods first: Students take the first lunch room food 11% more often than the third. *Journal of Nutrition Education and Behaviour 43*(4), S9.

Wansink, B., Just, D., & Smith, L. (2011a). Move the fruit: Putting fruit in new bowls and new places doubles lunchroom sales. *Journal of Nutrition Education and Behaviour 43*(4), S1.

Wansink, B., Just, D., & Smith, L. (2011b). What's in a name? Giving descriptive names to vegetables increases lunchroom sales. *Journal of Nutrition Education and Behaviour 43*(4), S1.

Wansink, B., Kent, R.J., Hoch, S.J. (1998). An anchoring and adjustment model of purchase quantity decisions. *Journal of Marketing Research, 35*(1), 71-81.

Wansink, B., Payne, C.R., Shimizu, M. (2011). The 100-calorie semi-solution: sub-packaging most reduces intake among the heaviest. *International Journal of Obesity, 19*, 1098-1100. doi: 10.1038/oby.2010.306

Wansink, B., Soman, D., Herbst, K.C., & Payne, C.R. (2012). Partitioned shopping carts: assortment allocation cues that increase fruit and vegetable purchases. Cornell University. Working paper.

Wansink, B., & Wansink, C.S., (2010). The largest last supper: depiction of food portions and plate size increased over the millennium. *International Journal of Obesity, 34*, 943-944. doi: 10.2038/ijo.2010.37

WHO. (2012). Obesity and overweight. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/

Yeung, K. (2012). Nudge as fudge. *The Modern Law Review, 75*(1), 122-148.

Zampollo, F., Wansink, B., Kniffin, K.M., Shimizu, M., & Omori, A. (2012). Looks good enough to eat: how food plating preferences differ across cultures and continents. *Cross-Cultural Research, 46*(1), 31-49. doi: 10.1177/106939711141842

Combination Therapies For Generalized Anxiety Disorder

Bri Glazier[1]
[1]Department of Psychology, University of British Columbia

Edited by: Xiaolei (Charlie) Deng, Department of Psychology, University of British Columbia. Received for review January 31, 2013, and accepted April 3, 2013.

Abstract
Generalized Anxiety Disorder (GAD) is a prevalent disorder with various treatment options. Psychotherapies such as cognitive behavioural therapy (CBT) can be effective, as are pharmacotherapies including azapirones, benzodiazepines, serotonin-norepinephrine reuptake inhibitors (SNRIs), and selective serotonin reuptake inhibitors (SSRIs). Combinations of psychotherapy and pharmacotherapy are also commonly recommended for those with GAD (Black, 2006). This discussion provides an overview of the disorder and the current treatment options. Furthermore, this paper aims to explore whether combined psychotherapy and pharmacotherapy is more effective than either therapy alone. Combination therapy has been found to be effective for major depressive disorder (Ganasen, Ipser, & Stein, 2010) as well as some anxiety disorders (Hohagen et al., 1997), suggesting it may be efficacious with GAD. Unfortunately, there is a dearth of studies examining combination therapies as a treatment for GAD, despite the prevalence of the disorder and the frequency of combined treatments. This paper offers possible explanations for the conflicting results from the available studies and proposes future directions for research.

Keywords: *anxiety, generalized anxiety disorder, psychotherapy, pharmacotherapy treatment, efficacy*

Generalized Anxiety Disorder (GAD) is a prevalent disorder with psychological and pharmacological treatment options. Combinations of psychotherapy and pharmacotherapy are also commonly recommended. This discussion provides an overview of GAD and current treatment options. Furthermore, this paper aims to explore whether combined psychotherapy and pharmacotherapy is more effective than either therapy alone. Past research suggests that combination therapy may be effective with GAD, but there are few studies examining such treatment, despite the prevalence of the disorder and the frequency of combined treatments. Finally, this paper offers possible explanations for the conflicting results from the available studies and proposes future directions for research.

Generalized Anxiety Disorder (GAD) is characterized by "excessive anxiety and worry…about a number of events or activities" (American Psychiatric Association [APA], 2000). This unreasonable anxiety is

Corresponding Author:
Bri Glazier
E-mail: briglazier@gmail.com

diffuse and shifting; it is not focused on any particular concern and shifts between different domains of life. A diagnosis of GAD from the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; APA, 2000) further requires that the person have difficulty controlling his worry and experience at least three of six associated symptoms: "restlessness or feeling keyed up or on edge, being easily fatigued, difficulty concentrating or mind going blank, irritability, muscle tension, [or] sleep disturbance." Some patients may also experience somatic symptoms and an exaggerated startle response (APA, 2000). GAD causes role impairment comparable to major depressive disorder; examples of such role impairment include poor emotional health, low occupation level, and increased risk for suicide (Crits-Christoph et al., 2011). This prognosis is further worsened by a high comorbidity with major depressive disorder and other anxiety disorders (Wittchen & Hoyer, 2001).

GAD is a commonly diagnosed form of anxiety disorder. In anxiety disorder clinics, individuals with GAD as a primary or comorbid disorder account for 25% of patients (APA, 2000). Despite the high incidence of GAD in clinical settings, most individuals initially present to their general physician and only 13% cite anxiety as their main complaint (Crits-Christoph et al., 2011). Instead, patients are more likely to report somatic symptoms, pain, sleep disturbance, or depression (Crits-Christoph et al., 2011; Wittchen & Hoyer, 2001). Lifetime prevalence for GAD in the general population is 5%; however, if the wider diagnostic criteria of the International Classification of Diseases are used, lifetime prevalence rises to 6.5% (Wittchen & Hoyer, 2001). Prevalence rates also rise with age, as GAD commonly onsets during late adolescence to late 20s (Kessler, Keller, & Wittchen, 2001). GAD occurs somewhat more frequently in women; approximately 55-60% of patients are female (APA, 2000). Diagnosis can also vary cross-culturally due to cultural differences in anxiety expression. For example, in Asian populations, individuals report somatic symptoms more frequently than psychological symptoms, while the opposite is true in Western cultures (Hoge et al., 2006). These disparities can be explained by cultural differences in emotionality or stigmatization; the manner in which emotions are expressed varies with culture, as does the value ascribed to certain emotions. Regardless, these differences are an important concern in comparing prevalence rates and making a diagnosis.

Research has distinguished few environmental risk factors for GAD. Those identified include current unemployment and previous marriage (Wittchen & Hoyer, 2001). Genetic factors are also an important component of GAD; current reports estimate 15-25% heritability for GAD (Stein, 2009). There is also evidence to support a genetic correlation with the personality trait of neuroticism (Stein, 2009). Genetic influence may operate through the expression of neurotransmitters but the neurobiology underlying GAD is not well understood and no specific genes have been suggested (Jetty, Charney, & Goddard, 2001). Functional imaging studies have also implicated changes in brain activity, such as increased cortical activity and decreased basal ganglia activity (Jetty et al., 2001). Stein (2009) reported that GAD patients often show increased activation in the right ventrolateral prefrontal cortex and in the amygdala. One explanation is that the frontal cortex is working to compensate for

overactive fear circuitry. Patients with the least severe symptoms show the strongest prefrontal cortex activation, which supports this hypothesis (Stein, 2009).

Treatment Options

GAD is a chronic disorder that waxes and wanes over time (Wittchen & Hoyer, 2001). Few patients remit without treatment (Wittchen & Hoyer, 2001) but fortunately both psychotherapies and pharmacotherapies are effective treatments (Gould, Otto, Pollack, & Yap, 1997). Pharmacological treatment options include tricyclic antidepressants, monoamine oxidase inhibitors, serotonin-norepinephrine reuptake inhibitors (SNRIs), selective serotonin reuptake inhibitors (SSRIs), azapirones, and benzodiazepines. Antipsychotics and β-adrenergic blockers are occasionally prescribed (Hoehn-Saric, 1998). According to Black (2006), pharmacotherapies are effective and convenient but may cause dry mouth, constipation, and other unwanted side effects. Benzodiazepines in particular carry a high risk for physical dependence and relapse is common after cessation of treatment (Black, 2006; Gorman, 2003). There is currently no standard pharmacotherapy for GAD; acute symptoms are often treated with benzodiazepines, while SSRIs are more commonly used for long-term treatment (Kuzma & Black, 2004). Unfortunately, pharmacotherapies also carry a high rate of attrition, which necessarily reduces potential efficacy (Mitte, 2005). Dropout rates are much lower for psychological therapies, suggesting they may be a more feasible treatment option (Mitte, 2005).

Psychological therapies for GAD include cognitive therapy, response prevention, exposure techniques, and cognitive behavioural therapy (CBT) (Black, 2006). Only CBT has received empirical support (Crits-Christoph et al., 2011). Cognitive therapy, response prevention, and exposure techniques each use only some of the techniques involved in CBT, which accounts for their lower effectiveness. CBT is effective in reducing main anxiety symptoms, associated depressive symptoms, and in improving quality of life for GAD patients (Mitte, 2005). The standard CBT components used for GAD treatment are psychoeducation, self-monitoring, symptom management, cognitive restructuring, worry exposure, and behaviour modification (Lang, 2004). Psychoeducation is often included in the first meeting between client and clinician to provide information about GAD and the treatment processes. Self-monitoring requires the client to record his subjective anxiety as well as the situational information. While this process itself may be therapeutic, the information gathered is also valuable for later work. A variety of techniques can comprise symptom management including relaxation strategies, progressive muscle relaxation, deep breathing patterns, and distraction. These techniques lessen the severity or impact of symptoms, rather than prevent symptoms from occurring. Cognitive restructuring adjusts the maladaptive thought patterns hypothesized to underlie anxiety. Once maladaptive cognitions are identified, the clinician assists the client in developing and employing alternative thoughts. Worry exposure decreases the potency of fear triggers through exposure without adverse consequences. Finally, behaviour modification is used to change maladaptive behaviours, such as avoidance, that support the continuance of anxiety. This may involve negative reinforcement, practicing skills, or scheduling 'worry time.' Because patients

acquire skills that persist after the end of treatment, CBT is associated with a lower level of relapse than pharmacological therapies (Mitte, 2005). Although efficacious, CBT and other psychotherapies can be lengthy and expensive, and require access to a qualified clinician (Black, 2006). These drawbacks may make psychotherapy less attractive to some patients, and encourage use of pharmacotherapy options.

Both psychological and pharmacological treatments show efficacy for approximately 60% of patients, but only 37% show full remission of symptoms (Crits-Christoph et al., 2011). One possibility for increasing effectiveness is through combining these therapies. Combination therapies may be able to compensate for the weaknesses of each individual treatment; psychotherapy takes time to be effective, while medication can begin to work more quickly (Watson, 2011). Moreover, combination therapies have been shown to be beneficial for the acute treatment of major depressive disorder (Ganasen, Ipser, & Stein, 2010), especially in severe cases (Otto, Smits, & Reese, 2005). Combined therapies have also shown efficacy for certain anxiety disorders. For example, Hohagen et al. (1997) found that patients suffering from obsessive-compulsive disorder experienced a greater reduction in obsessions with combined behaviour therapy and fluvoxamine, an SSRI, compared to behaviour therapy alone. Furthermore, it has been suggested that CBT and pharmacotherapy may operate via different mechanisms, therefore allowing an improved effect when combined (Ganasen et al., 2010). While pharmacotherapy is directed at lessening the anxiety response, psychotherapies aim to eliminate the underlying fear and avoidance. If the two treatments types operate on separate mechanisms, their effects could be additive.

Combination Therapies

Combination therapies are the most commonly recommended therapy for patients with GAD (Black, 2006). Patients with severe cases are particularly encouraged to receive both psychological and pharmacological treatment (Hoehn-Saric, 1998). Unfortunately, there have been "few studies systematically examining the combinations which commonly occur in practice" (Bond, Wingrove, Curran, & Lader, 2002, p. 267). GAD is especially under-studied in this regard. Ferrero et al. (2007) assigned 87 subjects with GAD diagnosis to three treatment groups using naturalistic assessment by a psychiatrist. This method allowed the study to be conducted without disrupting the daily clinical practice from which the subjects were drawn. The psychotherapy used was Brief Adlerian Psychodynamic Psychotherapy (B-APP) which focuses on three processes: "encouraging relationships, identifying the focus, and determining areas of possible change within the focus" (Ferrero et al., 2007, p. 532). A variety of SSRI and SNRI medications were used according to individual patient differences. Benzodiazepines were prescribed during the first two weeks if needed. The combined treatment group received B-APP sessions and medication. The Clinical Global Impression scale, Hamilton Rating Scale for Depression (HAM-D), and Hamilton Rating Scale for Anxiety (HAM-A) were used to assess symptom severity. The Social and Occupational Functioning Scale was used to measure subjects' functioning. Finally, the Verona Satisfaction Service Scale was administered to measure subjects' perception of treatment outcomes. Ferrero

et al. (2007) found that all groups showed improvements on all scales, but the combined treatment group had the highest rate of symptom remission at 12-month follow-up. This suggests that combined therapy is beneficial, however the sample size was small, and B-APP is a non-manualized psychotherapy that has not received empirical support for its efficacy.

In another study, 60 participants were randomly assigned to four treatment groups: buspirone and anxiety management training (AMT), buspirone and non-directive therapy (NDT), placebo and AMT, and placebo and NDT (Bond et al., 2002). Buspirone is a partial agonist at the serotonin receptor subtype 5-HT_{1A} that affects the cognitive aspects of anxiety disorders (Gorman, 2003). AMT is similar to CBT but does not include behavioural components and has lower efficacy (Gould et al., 1997). NDT allows participants to talk freely to a non-judgemental therapist; it was used as a control psychotherapy. Participants completed various self-report measures and were assessed by the clinician with the HAM-A. Bond et al. (2002) reported that anxiety scores were affected by treatment, but not by group, which suggests no benefit to combined therapy. Unfortunately, a large number of participants dropped out of the study, most commonly from the groups receiving buspirone due to side effects. Bond et al. (2002) also noted that the participants were severe cases; the baseline HAM-A scores had a mean of 28, while the mean for patients referred for psychological treatment is closer to 16. Power et al. (1990) conducted one of the earliest studies on combined therapies for GAD with 101 subjects. Diazepam, a benzodiazepine that operates quickly on the somatic aspects of GAD (Gorman, 2003), was given alone or in combination with CBT. A CBT only group was included, along with placebo and CBT with placebo groups. Participants assigned to receive medication began with one week of single-blind placebo wash-in followed by six weeks double-blind treatment, three weeks graded withdrawal from treatment, and finally one week of single-blind placebo to measure withdrawal symptoms. Although there was no formal monitoring of adherence to the CBT protocol, it focused on "the elicitation and modification of automatic thoughts and irrational assumptions" while also including progressive relaxation and graded exposure (Power et al., 1990, p. 271). The HAM-A, Symptom Rating Test, and General Health Questionnaire were used to assess symptoms. Power et al. (1990) found that the combination of diazepam and CBT produced the earliest treatment gains and the largest percentage of patients showing clinically significant change. Clinically significant change was defined as an outcome response "outside the range of the dysfunctional population by two standard deviations from the pretreatment mean of the population, in the direction of functionality" (Power et al., 1990, p. 279). At a six-month follow-up, it was found that only those participants who received CBT alone, in combination with placebo, or with diazepam had maintained their treatment gains; the majority of participants in the diazepam only and placebo groups received post-study treatment. Although this study used *Diagnostic and Statistical Manual of Mental Disorders* (3th ed.; *DSM-III;* APA, 1980) criteria rather than DSM-IV-TR or the Anxiety Disorders Interview Schedule, and had participants with short duration of current symptoms, it shows support for the benefit of combined therapy in both short- and long-term treatment of GAD.

Recently, Crits-Christoph et al. (2011) offered CBT to subjects in an 18-month relapse prevention study using the SNRI venlafaxine. During the first phase of the parent study, a six-month open-label venlafaxine trial, Crits-Christoph et al. (2011) randomly selected 77 subjects to be offered CBT treatment in addition to venlafaxine; 26 attended at least one CBT session and were included in analysis. Forty additional subjects were chosen to be included in the study, but not offered CBT; 35 received at least one dose of venlafaxine and were included in analysis. CBT components included applied relaxation, self-monitoring, cue hierarchy development, coping self-statements, identifying and challenging cognitions, and decatastrophization. Various assessments and self-report measures were used. The primary efficacy measure was the HAM-A. Crits-Christoph et al. (2011) found no significant differences between the groups on HAM-A scores or any secondary measure. This does not support improved efficacy of combined therapy. However, this could reflect the high response rate for venlafaxine alone, which may leave "little room for additional improvement" (Crits-Christoph et al., 2011, p.1092). Furthermore, not all participants offered CBT accepted and those who did accept may have been more treatment resistant.

Some studies involving combination treatments for paediatric populations have included patients with GAD as subjects, and have shown improvements associated with combined therapy (Emslie, 2009; Walkup et al., 2008). However, these studies did not examine effects separately by disorder and there have been no studies examining combination therapies for children with a focus on GAD. Thus, it cannot be determined whether efficacy differences are related to diagnosis or an age effect.

Future Directions

Although there is a dearth of evidence regarding combined therapies for GAD, current research shows mixed results. The consensus is that there is no clear benefit to combined therapies over monotherapy for GAD (Black, 2006; Kuzma & Black, 2004; Ganasen et al., 2010; Otto et al., 2005; Pull, 2007). This may be due to a client's lack of motivation for psychotherapy. When a client is aware he is receiving pharmacotherapy, which is the case during treatment, he may attribute his gains to the medication rather than the skills learned in psychotherapy (Crits-Christoph et al., 2011). This may reduce motivation to participate in therapy, and therefore decrease effectiveness. Such reliance on medication can also increase risk for relapse when medication is discontinued and self-efficacy for symptom management is low (Watson, 2011). Compliance with psychotherapy can also be affected when medication relieves anxiety symptoms rapidly and a client feels no need for further treatment (Watson, 2011).

Another explanation is that pharmacotherapies may interfere with psychotherapy via state-dependent learning (Otto et al., 2005; Watson, 2011). Memories learned in a certain context may not generalize to other contexts. Contexts can include physical surroundings, emotional states, and drug-induced states. Medications can produce an internal state that differs significantly enough from a non-medication state to prevent generalization of learned safety (Otto et al., 2005). Thus, when a client learns that a cue is not threatening while on medication, this learning may be lost when medication is discontinued. This theory helps explain why combination therapies

may not be beneficial as long-term treatments, but does not account for the lack of acute benefit.

Pharmacotherapy may also block the fear response necessary for effective psychotherapy (Black, 2006; Watson, 2011). Because anxiolytic medications reduce somatic and physiological arousal, they block the elevated anxiety that is required in order to habituate to stimuli during exposure-based therapies, including CBT (Watson, 2011). This hypothesis suggests an interesting possibility for other medications to act as 'cognitive enhancers' and facilitate psychotherapy. Exposure-based CBT is similar to animal models of extinction of conditioned fear; gradual exposure to stimuli without negative consequences reduces fear. In rodents, fear extinction involves N-methyl-D-aspartate (NMDA) receptors in the lateral and basolateral amygdaloid nuclei (Ganasen et al., 2010). Agents that act on NMDA receptors in these circuits are able to modulate fear extinction. D-cycloserine (DCS) is a partial NMDA receptor agonist at the glycine binding site, which leads to receptor desensitization with chronic use and facilitates fear extinction (Ganasen et al., 2010). Clinical trials have shown DCS to be effective in enhancing fear extinction during exposure therapy for patients with specific phobia (Ressler et al., 2004), obsessive-compulsive disorder, panic disorder, and social anxiety disorder (Ganasen et al., 2010) but has not been studied with GAD. This suggests that DCS may be beneficial for GAD, unlike anxiolytic medications.

More research is required on combination therapies for GAD. Most current studies have examined only one drug (Bond et al., 2002; Crits-Christoph et al., 2011; Power et al., 1990) and none has randomly assigned participants to different drug treatments. Research needs to address the comparative efficacy of multiple medications and multiple CBT packages. Long-term studies are also missing from the current literature, as are studies including patients with comorbid depression, despite the ubiquity of this pairing (Wittchen & Hoyer, 2001). Studies with younger populations would also be beneficial in order to identify whether results persist across age groups. Finally, novel combination techniques including cognitive enhancers have yet to be studied with GAD patients. DCS has been shown to be efficacious in various anxiety disorders but has not been tested with GAD patients. This new treatment possibility could improve treatment outcomes for many GAD patients who do not respond to current therapy options.

Declaration of Conflicting Interests

The author declared they have no conflicts of interests with respect to their authorship or the publication of this article.

References

American Psychiatric Association. (2000). 300.02 Generalized Anxiety Disorder (Includes Overanxious Disorder of Childhood). In *Diagnostic and statistical manual of mental disorders (4th ed., text rev.)*. Washington, DC: American Psychiatric Association.

Black, D. W. (2006). Efficacy of Combined Pharmacotherapy and Psychotherapy Versus Monotherapy in the Treatment of Anxiety Disorders. *CNS Spectrums, 11*(10 suppl 12), 29-33.

Bond, A. J., Wingrove, J., Curran, H. V., & Lader, M. H. (2002). Treatment of generalised anxiety disorder with a short course of psychological therapy, combined with buspirone or placebo. *Journal of Affective Disorders, 72*(3), 267-271.

Crits-Christoph, P., Newman, M. G., Rickels, K., Gallop, R., Gibbons, M.B. C., Hamilton, J. L., … Pastva, A. M. (2011). Combined medication and cognitive therapy for generalized anxiety disorder. *Journal of Anxiety Disorders, 25*(8), 1087-1094.

Emslie, G.J. (2009). Combination of cognitive behavioral therapy and sertraline is more effective than monotherapy for pediatric anxiety disorders. *The Journal of Pediatrics, 154*(5), 775-776.

Ferrero, A., Pierò, A., Fassina, S., Massola, T., Lanteri, A., Daga, G. A., & Fassino, S. (2007). A 12-month comparison of brief psychodynamic psychotherapy and pharmacotherapy treatment in subjects with generalised anxiety disorders in a community setting. *European Psychiatry, 22*(8), 530-539.

Blanchard, R., Kuban, M. E., Klassen, P., Dickey, R., Christensen, B. K., Cantor, J. M., & Blak, T. (2003). Self-reported head injuries before and after the age of 13 in pedophilic and non pedophilic men referred for clinical assessment. *Archives of Sexual Behaviour, 32,* 573-581.

Ganasen, K. A., Ipser, J. C., & Stein, D. J. (2010). Augmentation of Cognitive Behavioral Therapy with Pharmacotherapy. *Psychiatric Clinics of North America, 33*(3), 687-699.

Gorman, J. M. (2003). Treating Generalized Anxiety Disorder. *The Journal of Clinical Psychiatry, 64*(suppl 2), 24-29.

Gould, R. A., Otto, M.W., Pollack, M. H., & Yap, L. (1997). Cognitive behavioral and pharmacological treatment of generalized anxiety disorder: A preliminary meta-analysis. *Behavior Therapy, 28*(2), 285-305.

Hoehn-Saric, R. (1998) Generalised Anxiety Disorder: Guidelines for Diagnosis and Treatment. *CNS Drugs, 9*(2), 85-98.

Hoge, E. A., Tamrakar, S. M., Christian, K. M., Mahara, N., Nepal, M. K., Pollack, M. H., & Simon, N. M. (2006). Cross-Cultural Differences in Somatic Presentation in Patients With Generalized Anxiety Disorder. *The Journal of Nervous and Mental Disease, 194*(12), 962-966.

Hohagen, F., König, A., Rasche-Räuchle, H, Hand, I., Rey, E., Aldenhoff, J., & Berger, M. (1997). Behavior therapy and fluvoxamine versus behavior therapy and placebo: Results of a multicenter study. *Biological Psychiatry, 42*(1), 139.

Jetty, P. V., Charney, D. S., & Goddard, A. W. (2001). Neurobiology of Generalized Anxiety Disorder. *Psychiatric Clinics of North America, 24*(1), 75-97.

Kessler, R. C., Keller, M. B., & Wittchen, H. (2001). The Epidemiology of Generalized Anxiety Disorder. *Psychiatric Clinics of North America, 24*(1), 19-39.

Kuzma, J. M., & Black, D. W. (2004). Integrating pharmacotherapy and psychotherapy in the management of anxiety disorders. *Current Psychiatry Reports, 6*(4), 268-273.

Lang, A. J. (2004). Treating Generalized Anxiety Disorder With Cognitive-Behavioural Therapy. *The Journal of Clinical Psychiatry, 65*(suppl 13), 14-19.

Mitte, K. (2005). Meta-Analysis of Cognitive-Behavioral Treatments for Generalized Anxiety Disorder: A Comparison With Pharmacotherapy. *Psychological bulletin,131*(5), 785-795.

Otto, M. W., Smits, J. A. J., & Reese, H. E. (2005). Combined Psychotherapy and Pharmacotherapy for Mood and Anxiety Disorders in Adults: Review and Analysis. *Clinical Psychology: Science and Practice, 12*(1), 72–86.

Power, K. G., Simpson, R. J., Swanson, V., Wallace, L. A., Feistner, A. T. C., & Sharp, D. (1990). A controlled comparison of cognitive- behaviour therapy, Diazepam, and placebo, alone and in combination, for the treatment of generalised anxiety disorder. *Journal of Anxiety Disorders, 4*(4), 267-292.

Pull, C. B. (2007). Combined pharmacotherapy and cognitive-behavioural therapy for anxiety disorders. *Current Opinion in Psychiatry, 20*(1), 30-35.

Ressler, K. J., Rothbaum, B. O., Tannenbaum, L., Anderson, P., Graap, K., Zimand, E., … Davis, M. (2004). Cognitive Enhancers as Adjuncts to Psychotherapy: Use of D-Cycloserine in Phobic Individuals to Facilitate Extinction of Fear. *Archives of General Psychiatry, 61*(11), 1136-1144.

Stein, M. B. (2009). Neurobiology of Generalized Anxiety Disorder. *The Journal of Clinical Psychiatry, 70*(suppl 2), 15-19.

Walkup, J. T., Albano, A. M., Piacentini, J., Birmaher, B., Compton, S. N., Sherrill, J. T., … Kendall, P. C. (2008). Cognitive behavioral therapy, sertraline, or a combination in childhood anxiety. *The New England Journal of Medicine, 359*(26), 2753-2766.

Watson, H. J. (2011). Combined psychological and pharmacological treatment of pediatric anxiety disorders. In D. McKay, & E. A. Storch (Eds.), *Handbook of Child and Adolescent Anxiety Disorders* (pp. 379-402). New York: Springer New York.

Wittchen, H., & Hoyer, J. (2001). Generalized Anxiety Disorder: Nature and Course. *The Journal of Clinical Psychiatry, 62*(suppl 11), 15-19.

Developmental
Research Report

Cross-Cultural Differences in Children's Evaluations of Truths and Lies in Competitive Situations

Taylor Fleming[1]
[1]Department of Psychology, University of British Columbia

Edited by: Sophia Bobovski, Department of Psychology, University of British Columbia. Received for review October 15, 2012, and accepted April 1, 2013.

Abstract

Cross-cultural differences in the development of moral evaluations of verbal deception and truth telling were examined. Eight-, 12-, and 16-year-olds in Zhejiang, China, and New Brunswick, Canada were shown eight competitive scenarios representing national, school, class, and individual collectivity levels. In each scenario a character either told a lie to benefit a collective, or the truth that would harm it. Participants classified, judged, and justified their ratings of the story character's statement. Overall, on a 7-point Likert-scale, lies were rated negatively, and truths, positively. However, participants rated lies for country and class more positively with age ($p < .001$). Older Chinese participants were more positive than older Canadians ($p = .01$), representing an Asian tendency towards collectivism, and suggesting moral judgments—and by extension, moral development—reflects relative emphases on collectivities in these two cultures. This study furthers knowledge of contextual factors influencing evaluations of verbal deception in moral development.

Keywords: *cross-cultural, verbal deception, competition, moral development*

Children are often taught early in life that telling the truth is "right," and telling a lie is "wrong." As a result, they are able to accurately distinguish between the two from a young age (Bussey, 1999; Bussey, 1992). However, while they are able to accurately classify a statement as a truth or a lie, children's moral evaluations of lying and truthfulness are sensitive to cultural influences (Lee, Cameron, Xu, Fu, & Board, 1997). That is, morality is not only affected by objective knowledge of what is "right" and what is "wrong." The culture in which a child is socialized has been shown to influence their moral evaluations of lies and truths, and these differences follow either individualistic or collectivistic tendencies (Fu, Xu, Cameron, Heyman, & Lee, 2007; Lee et al, 1997).

Asian cultures, such as those in China, traditionally value collectivism, placing priority on social cohesion and the goals of the group (Fu et al., 2010). Western cultures, such as those in Canada, value

Corresponding Author:
Taylor Fleming
E-mail: taymfleming@gmail.com

individualism, and emphasize independence and self-reliance (Oyserman, Coon, & Kemmelmeier, 2002). Previous studies (Fu et al., 2010; Fu et al., 2007) have shown that people socialized in the Chinese, collectivistic culture rate lie telling that benefits a group more positively than would those raised in the more individualistic communities, such as in Canada. Conversely, on average, those raised in the more individualistic culture of Canada rate verbal deception that benefits an individual more positively than would someone raised in the Chinese culture (Fu et al., 2007).

In addition to being influenced by culture, ratings of the morality of truth- and lie-telling are also subject to more fine-grain contextual influences, discussed below. Lee et al. (2001) demonstrated that these cross-cultural differences in ratings of verbal deception (e.g. lying to protect their country's team) are also present when other related values or characteristics, such as modesty (self-effacement vs. self-aggrandizement), are called into question. Children from both Mainland China and Taiwan rated denying one's own good deeds more positively than admitting to them, while Canadian children more positively viewed acknowledging one's own good deeds than denying them (Lee et al., 2001). This further demonstrates the effects of culture on children's moral development, in that Mainland Chinese and Taiwanese children were more likely to conform to the cultural norm of modesty than the societal norm of self-promotion. The view of what is morally appropriate was adapted to align with collectivistic values when the two were in opposition.

This disparity between the moral ratings of lies and truths of Canadian and Chinese children has been shown to increase with age. In adolescence, Chinese children's moral ratings of truths and fabrications show stronger collectivistic tendencies (Fu et al., 2007). With age comes social experiences, which impart to children the knowledge of what is wrong and what is right within their own culture. With this knowledge they are inclined to consider alternative moral justifications (e.g. protecting a family member) for either lying or telling the truth (Bandura, 1991). However, differences in cultural exposure, and the resulting effects on situational qualifiers on moral judgments must also be taken into consideration. The culture of socialization has a direct impact on a child's social experiences, and thus affects moral knowledge and development. Therefore, disentangling the possibly different effects of both age and amount of exposure to cultural precepts will prove problematic in any cross-cultural developmental study.

Lee et al. (1997) previously investigated the relationship between culture and moral development using children's evaluations of lies and truths, finding that Chinese children favour lies that benefit the collective, and Canadian children favour those that benefit the individual. The results from this study have since been applied to other characteristics or cultural values, such as modesty (Cameron et al., in press; Lee et al., 2001). However, no past study has attempted to study this cross-cultural effect in competitive situations, in which the success of an individual or a group is at stake and a tangible positive reinforcer (e.g., a medal) is involved. Does the risk of losing a competition and the associated prize affect moral judgments? A preference for the success of a group may suggest collectivistic tendencies, while preference for the success of an individual may suggest individualistic tendencies. This area of study has implications in the understanding of

children's moral development across cultures, in that knowledge of factors that affect moral judgments throughout development may be extended.

In this study, children's judgments of false and truthful statements were investigated in competitive situations, to demonstrate the contextual factors that may affect moral judgment. The present study explores whether the above cultural differences in truth telling hold true for competitive situations. People come across competition in every day life—from sports, to academics, etc.—such that it is beneficial to know how these situations affect moral sentiments. Much of the existing literature on this aspect of moral development does not include older youth, and therefore information on verbal deception through adolescence is lacking (Fu et al, 2007; Lee et al, 1997). This study extends the included age range to older participants, to gain a deeper understanding of the progression of morality through to the teen years. Furthermore, as previous studies (Cameron et al., in press; Lee et al., 2001) have shown that moral judgments and evaluations can be context-dependent (i.e. varying with size of collective), this study will investigate the impact of collective or group size as a contextual factor affecting children's evaluations of truths and lies. We hypothesize that older Chinese children, aged 15-17, will be more likely to say that they would lie to help a team that they support win a competition, and will evaluate this more positively than both their younger counterparts (aged 7-9) as well as Canadian children of the same age. We further hypothesize that, amongst Chinese children, the larger the collectivity represented (e.g. national vs. local school), the more positive the evaluations of lying to aid a supported team in winning a competition, as larger group sizes are expected to be more salient for those individuals who already value collectivistic interests (Grant & Hogg, 2012).

Method

Participants

A total of 180 children participated in this study. The sample included children from Jinhua, Zhejiang, China: 30 8-year olds (M = 7.96 years, SD = .84; 15 females); 30 12-year olds (M = 11.94, SD = .96; 15 females); and 30 16-year olds (M = 16.19, SD = .87; 15 females). From Fredericton and Saint John, New Brunswick, Canada, Euro-Canadian children participated: 30 8-year olds (M = 8.23, SD = .87; 15 females); 30 12-year olds (M = 12.31, SD = 1.02; 15 females); and 30 16-year olds (M = 16.39, SD = .80; 15 females). All Euro-Canadian participants were Canadian-born.

We recruited participants from local elementary and high schools, and distributed consent forms at these schools, interviewing only those children whose parents had provided written informed consent

Materials

Experimenters showed eight scenarios, accompanied by illustrations on a laptop computer, to each child. Six of the eight scenarios involved a character witnessing a member of either a national, school, or class team cheating in a competition, and then being questioned by an authority figure about the transgression. The character then decided to lie about the cheating member, so that the team could win the competition, or was truthful, resulting in the team losing the competition. The remaining two scenarios acted as controls, and called for the character to either lie or tell the truth about their own transgression. There were

one lie and one truth scenario for each collective size (four lies and four truths; see Appendix for example scenarios). Presentation of the scenarios was counterbalanced for story type and order. All scenario characters' names used were culturally appropriate to the location of participants.

To ensure cultural appropriateness of scenarios in both locations, scenarios were generated simultaneously in both China and Canada, and exchanged for revision collegially. Final scenarios were decided upon through input from both cultures. They were then written in both languages, translated, and back-translated to ensure linguistic as well as cultural comparability.

Procedure

In approximately 20 minute long individual interviews, conducted in the language of the child's education, experimenters read the eight scenarios to each participant, after first explaining the use of a seven-point rating scale. After the reading, participants were first asked to specify what they would say to the scenario authority figure if they were the story character, and for what reason. Upon discovering the story character's response, children classified that response as a truth, a lie, or something else. Participants were asked "Is what s/he said good or bad?" then rated how good or how bad they thought the character's statement was using a 7-point rating scale: very, very bad (three black X's), very bad (two black X's), a little bad (one black X), neither good nor bad (a black circle), a little good (one star), very good (two stars), and very, very good (three stars). Children were then asked to justify their rating of the statement. Experimenters manually recorded children's answers to interview questions.

To minimize interviewer bias, all questions were standardized and researchers trained to articulate them in a common format. Judgment scores were all recorded on a standardized score sheet.

Results

A 2 x 3 two-way analysis of variance (ANOVA) involving the factors of culture (China and Canada) and age (8, 12, and 16 years) was performed on the judgment scores for scenarios in which participants rated lies to benefit, or truths to harm, the country, school, class, and self. Any significant two-way interactions were further explored through a post-hoc one-way ANOVA, while post-hoc analyses with Tukey HSD were performed to investigate any significant main effects for age.

Preliminary analyses of gender and story order are always run, although, over many studies gender and order effects have not been found (Cameron et al., in press; Fu et al., 2010; Fu et al., 2007). Therefore, discussions on gender and story order are not included in this paper.

Judgment scores for lie-telling scenarios

Table 1 presents the means and standard deviations of participants' judgments of lie-telling scenarios. A significant two-way interaction between age and culture for the lie-for-country scenario ($F(2, 174) = 3.50$, $p = .03$, $\eta 2 = .040$; see Figure 1) was established, where 16 year olds in Zhejiang, China rated lying for country significantly more positively than 16 year olds in New Brunswick, Canada ($F(1, 58) = 5.27$, $p = .01$). Furthermore, there was a significant main effect for age ($F(1, 174) = 8.01$, $p < .001$, $\eta 2 = .084$). Overall, 16 year olds rated the lies as more positive than both 8 year olds ($Q = .80$, $p = .01$) and 12 year olds ($Q = 1.07$, $p < .001$), and there were no significant differences between 8

year olds and 12 year olds (Q = .28, ns). There was no significant effect between cultures (F(1, 174) = .87, ns).

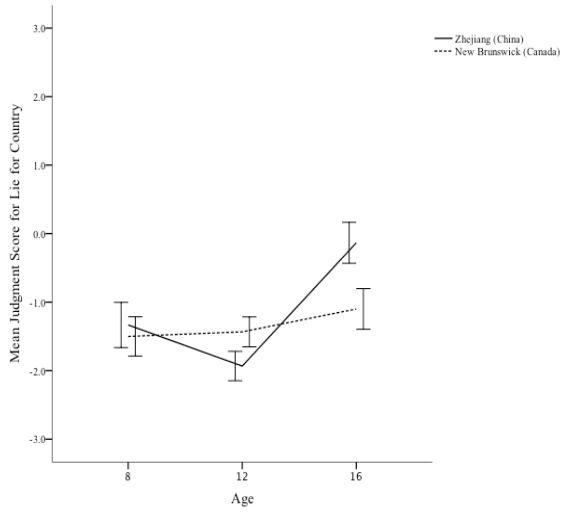


Figure 1. Mean judgment scores and standard error of Chinese and Canadian participants for each age group for the lie for country scenario. The minimum score is -3 (very, very bad), and the maximum score is 3 (very, very good).

The two-way ANOVA revealed no significant age or culture effects for the lie-for-school scenario (F(2, 174) = 1.54, ns, and F(1, 174) = .26, ns, respectively), nor was there a significant interaction between age and culture for this scenario (F(2, 174) = .41, ns). However, the two-way ANOVA of the lie-for-class scenario (see Figure 2) showed a significant two-way interaction between age and culture (F(2, 174) = 3.01, p = .05, η2 = .033), as well as a significant main effect for age (F(1, 174) = 7.76, p = .001, η2 = .082). Further analysis revealed that 12 year olds in Zhejiang, China rated lying-for-class significantly less positively than 12 year olds in New Brunswick, Canada (F (1, 58) = 7.95, p = .007). However, 16 year olds overall rated lying-for-class more positively than both 8 year olds (Q = .68, p = .03) and 12 year olds (Q = 1.02, p < .001). There were no significant differences between 8 year olds and 12 year olds (Q = .33, ns). No main effect for culture was observed (F(1, 174) = .003, ns).

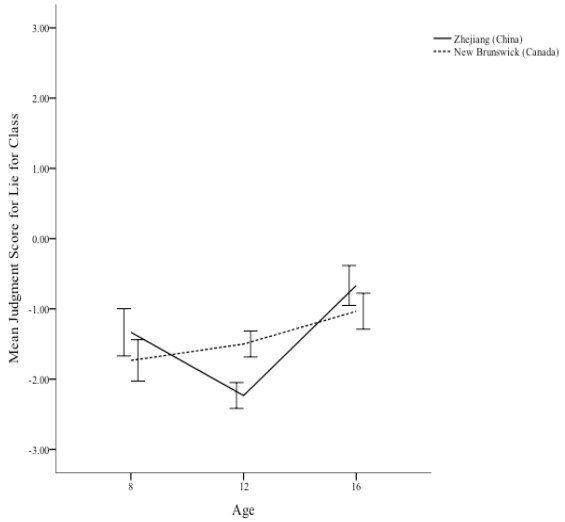


Figure 2. Mean judgment scores and standard error of Chinese and Canadian participants for each age group for the lie for country scenario. The minimum score is -3 (very, very bad), and the maximum score is 3 (very, very good).

In the lie-for-self scenario (see Figure 3) the two-way ANOVA revealed a significant interaction between age and culture (F (2, 174) = 5.17, p = .007, η2 = .056), with eight year olds in Zhejiang, China rating lying-for-self significantly more positively than 8 year olds in New Brunswick, Canada (F(1, 58) = 4.31, p = .04). However, these results were reversed amongst 16 year olds, with those in Zhejiang, China rating lying-for-self significantly less positively than those in New Brunswick, Canada (F(1, 58) = 7.61, p = .008). There were no significant main effects for age (F(2, 174) = .47, ns), nor were there for culture (F(1, 174) = .08, ns).

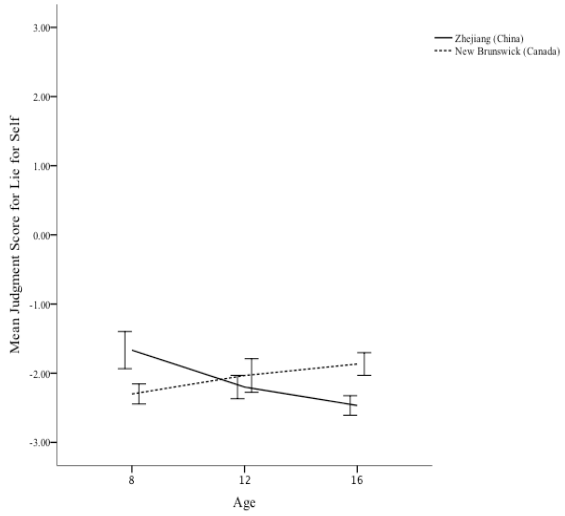


Figure 3. Mean judgment scores and standard error of Chinese and Canadian participants for each age group for the lie for self scenario. The minimum score is -3 (very, very bad), and the maximum score is 3 (very, very good).

Judgment scores for truth-telling scenarios

Table 2 presents the means and standard deviations of participants' judgment scores for truth-telling scenarios. A significant two-way interaction between age and culture in the truth-against-country scenario ($F(2, 174) = 3.13$, $p = .05$, $\eta 2 = .035$; see Figure 4) was established, in which 16 year old participants in China rated telling the truth against the country significantly less positively than Canadian 16 year olds ($F(1, 58) = 6.94$, $p = .01$). Also determined was a significant main effect for culture, in which participants in Zhejiang, China rated truthfulness against the country less positively than participants in New Brunswick, Canada ($F(1, 174) = 4.27$, $p = .04$, $\eta 2 = .024$). Furthermore, there was a significant main effect for age ($F(1, 174) = 11.55$, $p < .001$, $\eta 2 = .117$), with analyses revealing that 16 year olds rated telling the truth against the country significantly less positively than both 8 year olds ($Q = -1.17$, $p < .001$) and 12 year olds ($Q = -.93$, $p = .001$). Though, there were no significant differences between 8 year olds and 12 year olds ($Q = .23$, ns).

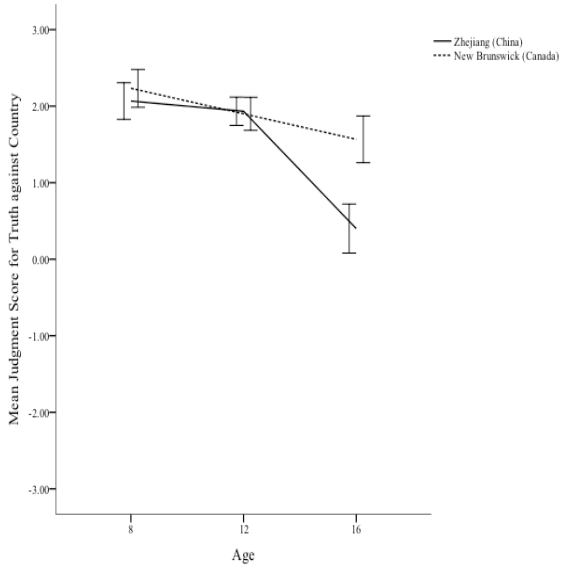


Figure 4. Mean judgment scores and standard error of Chinese and Canadian participants for each age group for the truth against country scenario. The minimum score is -3 (very, very bad), and the maximum score is 3 (very, very good).

In the truth-against-school scenario (Figure 5), participants in Zhejiang, China rated the truths significantly less positively than participants in New Brunswick, Canada ($F(1, 174) = 4.06$, $p = .04$, $\eta 2 = .023$). No significant effect was found for age ($F(2, 174) = 1.45$, ns), nor was there a significant interaction ($F(2, 174) = 2.02$, ns). Additionally, no significant effects were found in the truth-against-class scenario for age ($F(2, 174) = .88$, ns) or culture ($F(1, 174) = .07$, ns), nor was an interaction between age and culture found ($F(2, 174) = .42$, ns). No age, location, or interaction effects were found in the truth-against-self scenario, either ($F(2, 174) = 1.90$, ns; $F(1, 174) = 1.57$, ns; and $F(2, 174) = 1.48$, ns, respectively).

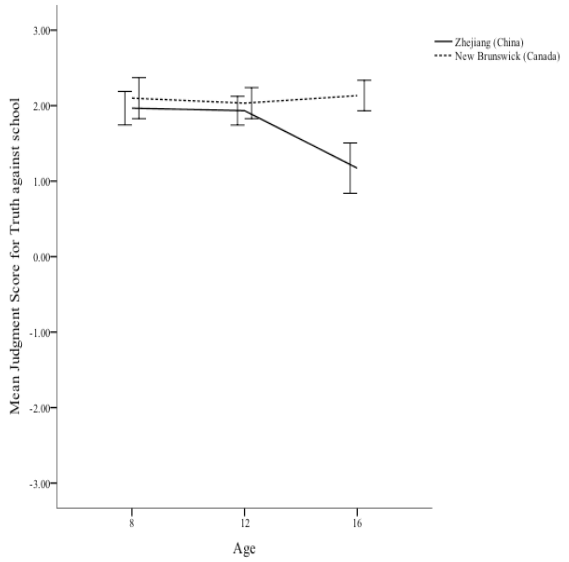


Figure 5. Mean judgment scores and standard error of Chinese and Canadian participants for each age group for the truth against school scenario. The minimum score is -3 (very, very bad), and the maximum score is 3 (very, very good).

Discussion

Our findings support or initial hypothesis that older Chinese children would rate deceptions benefiting the collective more positively, and truths against the collective more negatively than would older Canadian children, and also support the previous findings of both Cameron et al. (in press) and Fu et al. (2007). Overall, children rated lying negatively, and truth-telling positively. Though, older children—regardless of culture—tended to rate verbal deception that resulted in favourable outcomes more positively than younger participants. Additionally, older children—specifically Chinese children—displayed more collectivistic ratings of lies to benefit the country, and truths against the country, in that they rated them as being more or less positive, respectively. The present study furthers knowledge of contextual factors that influence children's evaluations of truth- and lie-statements, and how these may ultimately play a role in moral development.

When evaluating lie-for-county and lie-for-class scenarios, we found that ratings became more positive with age, regardless of culture. However, participants from each culture and of each age still rated lies as being negative overall. The variation in negative ratings of lies suggests that while recognizing that the untrue statements are universally morally "wrong", participants reflected the existence of other related factors that are influenced by age, such as social experiences, that affect how moral an untruthful statement is perceived to be.

It is interesting to note that the decrease in negative ratings of lie statements as children age was not observed in the analysis of moral evaluations of the lie-for-school scenario. There was no difference among judgment scores across ages or between cultures. The different types of scenarios (national, school, class, and individual) not only represented different sizes of collective, but also different types of in-groups with which youths may identify themselves during their youth. The significant age effects found upon analysis of the lie-for-country and lie-for-class scenarios suggest that the nation and the classroom may serve as stronger in-groups than a child's school. This is supported by research showing that national identity becomes more pronounced in children around 10 years of age, and as age and experience within the nation increase, so does preference for the nation as an in-group (Rutland, 1999). Regarding the lie-for-school and lie-for-class scenarios, when one's in-group identity is made distinct then group identification is strongest (Grant & Hogg, 2012). The cohort of students in a class are regularly working and interacting with each other, making this in-group

identity distinct from the school, which can be perceived as more of an assemblage than a distinct group with which to identify. With this stronger identification with the class as an in-group, we can postulate that this social identity strengthens with age, leading children to more positively rate lies that favour positive outcomes for the class.

The observed increase in positive ratings of lie-for-country statements with age was not consistent between cultures, with 16-year-old Chinese participants rating lying that resulted in favorable outcomes for their country less negatively than did Canadian 16-year-olds. This supported our hypotheses of increased collectivistic tendencies among older Chinese participants at the national level of scenario collectivity, and no differences in levels of individualism across different ages in Canadian participants. Fu et al. (2007) also observed an increase in collectivistic tendencies among older Chinese children when examining cross-cultural moral evaluations of truths and lies, although their study did not interview participants beyond age 11, and contextual factors that might affect moral evaluations were not included in the study. The present study extends participation to 16 year olds, allowing for broader developmental generality of results.

In a previous study examining cultural differences in in-group favouritism, Chen, Brockner, and Katz (1998) found that when the in-group performed well, members of collectivistic cultures favoured their in-group more than members of individualistic cultures. Taken together with the collectivistic cultural tendencies of the Chinese, the strength of the nation as an in-group, and the alternative moral explanations that accompany age, we can see how 16-year-old Chinese participants would rate lie-statements that favour the country as being less negative.

An alternative explanation for the observed effect relates to social cognitive theory (Bandura, 1991). This theory proposes that the continuous process of social learning allows for an endless cycle of modification and elaboration of personal values, standards, and attributes, as well as adoption of new ones (Bandura, 1991). Social cognitive theory implies that the observed interaction between age and culture is due to the accumulation of different social experiences throughout children's lives, and that these social experiences are informed by culture. For example, the greater numbers of Chinese cultural experiences favouring collectivism that occur with age would lead older Chinese children to rate more positively lie statements that favour collectivistic outcomes. Conversely, the accumulation of Canadian cultural experiences that favour individualism would cause older Canadian children to rate lie statements that favour collectivistic outcomes, such as the success of a supported team, less positively than would older Chinese children. In this way, social cognitive theory supports our findings from the lie-for-country and lie-for-class scenarios, in that the culturally informed social experiences and knowledge that come with age allow children to consider alternative moral justifications for lies.

While this study provides evidence for contextual factors that may interact with moral development, it also has some limitations worth mentioning. One such limitation is that we analyzed the data obtained from interviews with participants using multiple two-way analyses of variance (ANOVA), one for each scenario, rather than a multivariate analysis of variance (MANOVA), including all scenarios. Analyzing the data using a MANOVA would

have allowed for comparisons between the eight different scenarios included in this study. As a result, we are unable to draw comparative conclusions about the relative effects of collective size on cross-cultural moral evaluations of truth and lies in a competitive context.

Another limitation of this study is that we did not analyze participants' justifications for their moral evaluations of truth and lie statements. We found that ratings of lies generally became less negative with age in both Chinese and Canadian children. Based on previous research that did examine moral justifications (Fu et al., 2010; Fu et al. 2007; Lee et al., 2001), we chose to interpret more positive ratings of lie statements as an indication that participants were associating more closely with that group and displaying collectivistic tendencies. However, without examining children's justifications of their judgments, we cannot be certain that participants' moral evaluations are an accurate indicator of collectivism or individualism. For example, in the lie-for-country scenario we found that moral evaluations became less negative with age. Yet this age effect may not be due to strengthened national identity, as previously proposed. While Chinese children may be rating the lies as less negative for collectivistic reasons, justifying their judgments with statements such as "I did not want to let my country down", Canadian children may be doing this for individualistic reasons, and may be justifying their judgments with statements such as "I did not want everyone in my country to be mad at me." Analysis of participants' justifications will allow us more accurately to describe findings from analysis of judgment scores, and will lead to greater insight into the different ways our cultural tendencies are experienced and expressed.

Unlike the scenarios for national, school, and class collectives, the control scenario in this study did not involve competition, limiting that scenarios conceptual applicability to this study. Initially intended to be free from any group effects, and to provide a setting with which to observe individualistic tendencies, this scenario described characters having to choose to lie about their own transgression to avoid punishment, rather than win a medal. It is important to note that, not only is this scenario non-competitive, but it also that it included a negative reinforcer (avoiding punishment), whereas the other three types of scenarios include a positive reinforcer (gaining a medal). The disparity between types of reinforcers used in each scenario may have led to the observed differences in Chinese and Canadian children's moral evaluations in the lie-for-self scenario. With age, Chinese children's judgments became more negative, while those of Canadian children became more positive.

On initial inspection, these results appear to support previous studies' findings of Chinese collectivism and Canadian individualism (Fu et al., 2010; Fu et al. 2007; Lee et al., 2001). Younger children have been shown to lie to avoid punishment, but then when older they base their decision to lie or tell the truth on the anticipated evaluative reaction of another of that lie or truth (Bandura, 1991). The anticipated evaluative reaction of older Chinese children would be rather negative. Additionally, members of collectivistic cultures are more willing to accept punishment for their transgressions, so as to maintain group harmony (Hofstede, 2001). Despite the apparent agreement between the present study and previous studies examining both cross-cultural moral evaluations and

punishment, the use of a competitive control scenario that includes a positive reinforcer is advised in any follow-up studies, so that we may decouple any potential effect of reinforcer type from moral evaluations.

Future Directions

In the future, researchers should explore explicitly cross-cultural moral evaluations during the process of acculturation. The knowledge of how culture of heritage interacts with the new culture of residence—and all of the societal norms and intergroup relations that accompany it—to influence moral development would not only further our understanding of developmental aspects of acculturation, but may also contribute new perspectives of enculturation. Such studies may also examine generational aspects of acculturation and moral development, such as differences in moral evaluations between first-generation and third-generation immigrants.

Another direction that future studies may wish to explore is generational differences in moral evaluations and moral development. The technological advances within the past decade, specifically with the popularization and innovations of the Internet, allow for both greater connectivity within and between social groups, and greater depersonalization through the anonymity offered by the Internet (Larrain, Zegers, & Trapp, 2007; Willard, 1998). Jennings and Zeitner (2003) noted generational differences in the ways in which people incorporate the Internet into their media usage. Willard (1998) postulated that Internet and media advances have, and will continue to affect moral development, although current research on the topic is scarce. A longitudinal study incorporating follow-up interviews with participants, especially amongst the younger Chinese and Canadian children, would greatly advance our knowledge of the media's effect on moral development.

This study has implications related to schooling in times of increasing globalization and immigration. With the rapid increase in multiculturalism in many areas, understanding the different ways that culture may influence children's cognition is important in the formal education process. It is important that teachers understand the factors contributing to their student's moral development, and how these cultural influences may manifest, particularly during times of conflict or discipline, and when promoting an inclusive environment within peer groups. Additionally, this study has implications for courtrooms, especially custody cases. Children are sometimes made to testify in court, and the results of this study suggest that what a child says in court may be influenced not only by the context of the specific case, but also whether their cultural upbringing was geared towards collectivism or individualism. Courtroom testimonies, depending on the course of moral development, may favour protecting a parent over being truthful.

The present study demonstrates that Chinese and Canadian children's moral evaluations of lie and truth statements tend to follow cultural tendencies of collectivism or individualism, respectively. This is especially true for older Chinese children, who rated lies told to benefit the country and the class as more positive than older Canadian children, suggesting that moral judgment—and by extension, moral development—is affected by relative emphasis on the group or individual within

cultures. These findings both agree with earlier research, and add to our knowledge of the field. Previous studies have investigated cross-cultural evaluations of verbal deception simply in terms of collectivism versus individualism (see Fu et al., 2007), as well as through modesty contexts (in which these cultural differences arise when children are given the choice between self-promotion and self-effacement; see Cameron et al., in press). The main findings from these studies extend to the present study, which incorporates competition as a contextual factor.

Declaration of Conflicting Interests

The author declared they have no conflicts of interests with respect to their authorship or the publication of this article.

References

Bandura, A. (1991). Social cognitive theory of moral thought and action. In W.M. Kurtines & J.L. Gewirtz (Eds.). Handbook of moral behavior and development (Vol. 1), (pp. 45-103). Hillsdale, NJ: Erlbaum.

Bussey, K. (1992). Lying and truthfulness: Children's definitions, standards, and evaluative reactions. Child Development, 63(1), 129-137

Bussey, K. (1999). Children's categorization and evaluation of different types of truths and lies. Child Development, 70(6), 1338-1347

Cameron, C.A., Lau, C., Fu, G., & Lee, K. (in press). Development of children's moral evaluations of modesty and self-promotion in diverse cultural settings. Journal of Moral education, doi: 10.1080/03057240.2011.617414

Chen, Y., Brockner, J., & Katz, T. (1998). Toward an explanation of cultural differences in in-group favoritism: the role of individual versus collective primacy. Journal of Personality and Social Psychology, 75(6), 1490-1502

Fu, G., Brunet, M. K., Lu, Y., Ding, X., Heyman, G. D., Cameron, C. A., & Lee, K. (2010). Chinese children's moral evaluation of lies and truths: Roles of context and parental individualism-collectivism tendencies. Infant and Child Development, 19(5), 498-515.

Fu, G., Xu, F., Cameron, C.A., Heyman, G., Lee, K. (2007). Cross-cultural differences in children's choices, categorizations, and evaluations of truths and lies. Developmental Psychology, 43(2), 278-293

Grant, F., & Hogg, M.A. (2012). Self-uncertainty, social identity prominence and group identification. Journal of Experimental Social Psychology, 48, 538-542

Hofstede, G. (2001). Culture's consequences: comparing values, behaviors, institutions, and organizations across nations. Thousand Oaks, CA: Sage.

Jennings, M.K., & Zeitner, V. (2003). Internet use and civic engagement. Public Opinion Quarterly, 67(3), 311-334

Larrain, M.E., Zegers, B., & Trapp, A. (2007). Do adolescents compromise their identity when chatting on the internet? International Journal of Applied Psychoanalytic Studies, 4, 91-108

Lee, K., Cameron, C.A., Xu, F., Fu, G., Board, J. (1997). Chinese and Canadian children's evaluations of lying and truth telling: Similarities and differences in the context of pro- and anti-social behaviors. Child Development, 68(5), 924-934.

Lee, K., Xu, F., Fu, G., Cameron, C. A., & Chen, S. (2001). Taiwan and Mainland Chinese and Canadian children's categorization and evaluation of lie- and truth-telling: A modesty effect. British Journal of Developmental Psychology, 19, 525–542.

Oyserman, D., Coon, H., & Kemmelmeier, M. 2002. Rethinking individualism and collectivism: Evaluation of theoretical assumptions and meta-analyses. Psychological Bulletin, 128(1), 3-72.

Rutland, A. (1999). The development of national prejudice, in-group favouritism and self-stereotypes in British children. British Journal of Social Psychology, 38, 55-70.

Willard, N. (1997). Moral development in the information age. Clearinghouse on Early Education and Parenting, 222, 215-222.

Table 1. Means and standards deviations of Chinese and Canadian participants judgment scores by age and cultures in lie-telling scenarios, where the minimum score is -3 (very, very bad), and the maximum score is 3 (very, very good).

	Age Group					
	8 year olds		12 year olds		16 year olds	
Scenario and Culture	*M*	*SD*	*M*	*SD*	*M*	*SD*
Lie for Country						
China	-1.33	1.81	-1.93	1.17	-0.13*	1.63
Canada	-1.50	1.57	-1.43	1.19	-1.10	1.62
Lie for School						
China	-1.17	1.82	-1.67	1.24	-1.00	1.34
Canada	-1.43	1.81	-1.50	1.04	-1.23	1.38
Lie for Class						
China	-1.33	1.84	-2.23	1.84	-0.67	1.56
Canada	-1.73	1.62	-1.50*	1.01	-1.03	1.40
Lie for Self						
China	-1.67*	1.47	-2.20	0.92	-2.47	0.78
Canada	-2.30	0.79	-2.03	0.82	-1.87**	0.73

In each scenario, the comparisons of the means in each age group between the two cultures: †.05 < p < .06, *p < .05, **p < .01, ***p < .001

Table 2. Means and standards deviations of Chinese and Canadian participants judgment scores by age and cultures in truth-telling scenarios, where the minimum score is -3 (very, very bad), and the maximum score is 3 (very, very good).

	Age Group					
	8 year olds		12 year olds		16 year olds	
Scenario and Culture	*M*	*SD*	*M*	*SD*	*M*	*SD*
Truth against Country						
China	2.07	1.31	1.93	1.01	0.40	1.75
Canada	2.23	1.36	1.90	1.18	1.67*	1.68
Truth against School						
China	1.97	1.22	1.93	1.05	1.17	1.79
Canada	2.10	1.49	2.03	1.12	2.13	1.11
Truth against Class						
China	1.60	1.67	1.93	1.20	1.53	1.46
Canada	1.50	1.81	1.87	1.01	1.87	1.38
Truth against Self						
China	2.27	1.05	2.13	1.54	2.73	0.45
Canada	2.60	0.72	2.50	0.82	2.57	0.73

In each scenario, the comparisons of the means in each age group between the two cultures: †.05 < p < .06, *p < .05, **p < .01, ***p < .001

Appendix of Scenario Examples

Lie for country

Matthew loves soccer. One day, he went to watch an international soccer tournament. He was excited because a national team made up of high school students from across Canada was competing against a national high school team from Australia. During the tournament, Matthew realized that player number two from the Canadian team wasn't really a high school student, but a college student and should not have been on the Canadian team. The Canadian team won the first-place medal. Later, the coach from the Australian team walked up to Matthew and said, "Player number two from the Canadian team was great! Is he really in high school?" Matthew thought to himself:

If I say he's a high school student, I will have to lie; but the Canadian team will be able to keep the medal, but

If I say he's not a high school student, I will not have to lie; but the Canadian team will lose the medal.

Matthew thought about it for a moment, and answered, "Yes, he's a high school student."

Truth against country

Joshua loves basketball. One day, he went to watch an international basketball tournament. He was excited because a national team made up of high school students from across Canada was competing against a national high school team from Australia. During the tournament, Joshua realized that player number two from the Canadian team wasn't really a high school student, but a college student and should not have been on the Canadian team. The Canadian team won the first-place medal. Later, the coach from the Australian team walked up to Joshua and said, "Player number two from the Canadian team was great! Is he really in high school?" Joshua thought to himself:

If I say he's a high school student, I will have to lie; but the Canadian team will be able to keep the medal, but

If I say he's not a high school student, I will not have to lie; but the Canadian team will lose the medal.

Joshua thought about it for a moment, and answered, "No, he's not really a high school student."

Lie for school

Samantha loves science. One day, she went to watch a competitive science fair between her school and another school. During the competition, Samantha realized that Amy, who was one of the smartest kids on her school's team, wasn't really from her school and should not have been on her school's team. Samantha's school won the first-place medal. Later, a teacher from the other school walked up to Samantha and said, "Amy from your school was great! Does she really go to your school?" Samantha thought to herself:

If I say she goes to my school, I will have to lie; but my school will be able to keep the medal, but

If I say she doesn't go to my school, I will not have to lie; but my school will lose the medal.

Samantha thought about it for a moment, and answered, "Yes, she goes to my school."

Truth against school

Sarah loves math. One day, she went to watch a math competition between her school and another school. During the competition, Sarah realized that Anna, who was one of the smartest kids on her

school's team, wasn't really from her school and should not have been on her school's team. Sarah's school won the first-place medal. Later, a teacher from the other school walked up to Sarah and said, "Anna from your school was great! Does she really go to your school?" Sarah thought to herself:
If I say she goes to my school, I will have to lie; but my school will be able to keep the medal, but
If I say she doesn't go to my school, I will not have to lie; but my school will lose the medal.
Sarah thought about it for a moment, and answered, "No, she doesn't go to my school."

Lie for class

Nicholas loves spelling. One day, he went to watch a spelling bee between a team from his class and a team from another class. During the competition, Nicholas realized that Jeff, who was one of the best spellers on his class's team, had actually transferred to a different class a while ago. Since Jeff was not in Nicholas's class anymore, he should not have been on his class's team. Nicholas's class won the first-place medal. Later, the teacher from the other class walked up to Nicholas and said, "Jeff from your class's team was great! Is he really in your class?" Nicholas thought to himself:
If I say he's in my class, I will have to lie; but my class will be able to keep the medal, but
If I say he's not in my class, I will not have to lie; but my class will lose the medal.
Nicholas thought about it for a moment, and answered, "Yes, he's in my class."

Truth against class

Jacob loves singing. One day, he went to watch a singing competition between a choir from his class and a choir from another class. During the competition, Jacob realized that Patrick, who was one of the best singers in his class's choir, had actually transferred to a different class a while ago. Since Patrick was not in Jacob's class anymore, he should not have been in his class's choir. Jacob's class won the first-place medal. Later, the teacher from the other class walked up to Jacob and said, "Patrick from your class's choir was great! Is he really in your class?" Jacob thought to himself:
If I say he's in my class, I will have to lie; but my class will be able to keep the medal, but
If I say he's not in my class, I will not have to lie; but my class will lose the medal.
Jacob thought about it for a moment, and answered, "No, he's not in my class."

Lie for self

Amanda was playing with a ball inside her classroom and she accidentally broke a window. Her teacher asked her, "Do you know who broke the window?" Amanda thought to herself:
If I say I don't know, I will have to lie; but then I will not get in trouble, but
If I admit to breaking the window, I will not have to lie; but I will get in trouble.
Amanda thought about it for a moment, and answered, "No, I don't know who broke it."

Truth against self

Jennifer was playing with the school's newest computer and she accidentally damaged it. Her teacher asked her, "Do you know who broke the computer?" Jennifer thought to herself:
If I say I don't know, I will have to lie; but then I will not get in trouble, but
If I admit to damaging the computer, I will not have to lie; but I will get in trouble.
Jennifer thought about it for a moment, and answered, "Yes, I broke the computer."

What is Constructive Feedback? Comparing Praise and Objective Feedback in Learning Outcomes

Kendra Wong[1]
[1]Department of Psychology, University of British Columbia

Edited by: Bri Glazier, Department of Psychology, University of British Columbia. Received for review February 15th, 2013, and accepted April 2nd, 2013.

Abstract

Feedback has important social and developmental consequences in many areas, such as education and counseling, and different types of feedback can elicit different learning outcomes. Previous research yields inconclusive evidence on whether praise feedback or objective feedback yields better learning outcomes. This paper proposes a study to compare process praise, a type of feedback that directs attention to strategies or effort used to complete a task; person praise, or praise that directs attention to ability; objective process/self-regulation feedback, a type of behavioural feedback that focuses on strategies to improve on the task; and factual feedback. This study will be a between-groups design, where children ages 9 to 11 years old will be asked to imagine themselves as the protagonist in several scenarios depicting everyday situations in which the protagonist either succeeds or fails at a task. Children will be given a specific type of feedback after a successful scenario. Children will then be asked to imagine a failure scenario, and will be assessed on learning outcome, measured by their perceived performance, affect, and persistence. Based on previous research, it is predicted that children in the person praise condition will have less positive learning outcomes than those in the process praise condition. Compared to process praise, objective process/self-regulation feedback will likely be just as effective or more effective at eliciting positive learning outcomes, including confidence in success. This proposed study will demonstrate that, despite the perceived value of praise, other types of feedback may also induce positive learning outcomes.

Keywords: *Feedback, Praise, Motivation, Self Perception, Childhood (birth-12 yrs), School Age (6-12 yrs)*

Feedback has important social and developmental consequences in many areas, such as education and counselling, and different types of feedback can elicit different learning outcomes (Hattie & Timperley, 2007; Kamins & Dweck, 1999; Kluger & DeNisi, 1996; Reese et al., 2009; Vander & Chugh, 2012). More than 80% of

Corresponding Author:
Kendra Wong
E-mail: kendralwong@gmail.com

parents report that using praise not only gives children confidence in themselves, but is also necessary for children to feel good about themselves (Dweck, 2002). However, past research in the field of educational psychology has shown conflicting evidence of the impact of different types of feedback. In an extensive review, Hattie and Timperley (2007) argued that praise is detrimental because it leads to self-handicapping and learned helplessness, and that feedback should place more focus on strategies of improvement rather than commenting on topics that are irrelevant to the task. However, this review did not take into account the type of praise and, indeed, other research has shown that specific types of praise return positive results (e.g. Dweck, 1999; Kamins & Dweck, 1999). Individuals who receive *process praise*, which focuses on strategies or effort, tend to outperform, be more persistent, be more confident about completing future tasks, and react more adaptively to setbacks, compared to individuals who receive *person praise*, which focuses on the individual (Kamins & Dweck, 1999; Skipper & Douglas, 2012). Although past research has indicated that process praise leads to better learning outcomes than person praise, there has been little research comparing process praise with other types of feedback, such as objective, non-evaluative feedback. Interestingly, Skipper and Douglas (2012) found that when schoolchildren and university students were confronted with setbacks, students who received objective feedback in the form of a test score did not react significantly differently from students who received process praise, while students who received person praise reacted most negatively. Thus, it is possible that objective feedback is as effective as process praise.

This paper will propose a study to compare process praise with a type of objective feedback, *objective process/self-regulation feedback*, in which the individual is provided information on strategies to better complete the task. If it is true that process praise and objective feedback lead to similarly positive learning outcomes, there are important implications for teaching and parenting methods. Reviews have identified the use of positive reinforcement as the primary practice in most behavioural interventions in educational settings (Kazdin, 1982; Martens, Witt, Daly, & Vollmer, 1999). If process praise and objective feedback produce similar effects, perhaps teachers should concentrate more on objective feedback in order to provide useful information rather than purely evaluative feedback that will not help individuals better perform the task in the future. This paper will also focus on the impact of objective process/self-regulation feedback on the individuals' perception of performance, affect, and persistence when faced with a setback, rather than individuals' performance as an outcome measure.

First, this paper will explain the feedback interventions theory (FIT), which asserts that behavioural feedback will result in behavioural change, whereas feedback directed at the individual is irrelevant and distracting. FIT takes into account many types of feedback, including praise, and makes predictions regarding the effectiveness of the different types of feedback. Then, the impact of naive theories of intelligence will be discussed, including how these theories affect individuals' reactions to success and failure. These naive theories of intelligence explain the positive learning outcomes due to process praise, and the negative learning outcomes due to person praise. Finally, there will be a comparison between process praise, person

praise, objective process/self-regulation feedback, and factual feedback (the control condition).

FIT states that individuals evaluate themselves based on how well they perceive their current task strategy is working and based on their confidence in succeeding (Kluger & DeNisi, 1996). When individuals receive behavioural feedback, they are cued to attend to their own behaviour and correct themselves appropriately, resulting in behavioural change (Kluger & DeNisi, 1996). According to FIT, there are four main types of feedback: (1) *task feedback,* which is directed at the correctness of the task (for example, "You need to re-organize your essay structure so it is more coherent"), (2) *self-regulation feedback*, which focuses on evaluating the self or one's work to improve ("Look back at your essay and see if you followed the structure that we went over in class"), (3) *process feedback*, which is directed at the individuals' strategies ("Make sure that your introduction has all the main points of your essay"), and (4) *self feedback*, which includes evaluative comments on the individual or the work ("Your introductory paragraph is well done") (Kluger & DeNisi, 1996). FIT considers process and self-regulation feedback to be most effective at improving performance because both process and self-regulation feedback allow individuals to evaluate different strategies and eliminate incorrect hypotheses (Hattie & Timperley, 2007; Kluger & DeNisi, 1996). Self feedback, which includes praise and criticism, is considered the least effective because it may be distracting and does not provide relevant information for completing future tasks (Hattie & Timperley, 2007; Kluger & DeNisi, 1996). Thus, FIT claims that individuals attempt a task by using different strategies, and if each new strategy does not get them closer to them closer to their goal, they can use behavioural feedback to change their behaviours appropriately (Kluger & DeNisi, 1996). If use of this new strategy brings individuals closer to their goal, individuals are more likely to persist in completing the task and are more likely to seek challenges (Kluger & DeNisi, 1996).

However, it may not be necessary for behavioural feedback to be *used*; it is possible that the mere *presence* of behavioural feedback elicits more confidence and persistence. That is, it may be the case that behavioural feedback elicits confidence, in addition to providing individuals with information to improve their strategies, resulting in better learning outcomes. Confidence may mediate the relationship between behavioural feedback and positive learning outcomes, although there has been little research studying the impact of behavioural feedback on confidence. In a review, Hattie and Timperley (2007) argue that process and self-regulation feedback, can help change participants' motivational orientation by improving their confidence in completing the task. Research on the relationship between feedback type and motivational orientation tends to focus on how motivational orientation may explain why individuals react differently to various types of feedback (e.g. Butler, 1987; Mueller & Dweck, 1998).

As previously mentioned, FIT asserts that individuals evaluate themselves based on their confidence in their own success, and this self evaluation, in addition to how well they perceive their strategies are currently working, determines whether they persist or seek more challenges. When faced with challenges, an individual's confidence in success is related to that individual's naïve theories of intelligence (Dweck, 1999; Hong, Chiu, Dweck, Lin, & Wan, 1999). *Entity*

theorists view intelligence as a personal characteristic that stays fixed and stable over time, despite the experiences people have. Entity theorists tend to have a *learned helplessness orientation* in response to setbacks and challenges, because they may feel that their abilities reflect upon their intelligence, which they feel cannot be improved, and thus give up easily. Those with a learned helplessness orientation feel pressured to produce future good performance, and thus avoid challenges that may result in poor performance (Hong et al., 1999; Mueller & Dweck, 1998). In contrast, *incremental theorists* understand intelligence to be malleable and to develop through learning (Dweck, 1999). Incremental theorists tend to be *mastery-oriented*, believing that effort is necessary to complete a challenging task (Dweck, 1999). Those that display a mastery-oriented response have high expectations and persistence, and tend to outperform those with a helpless response.

Individuals' helpless or mastery orientation can be influenced by the type of feedback and, in particular, the type of praise they receive (Dweck, 1999; Kamins & Dweck, 1999). Receiving person praise, such as "You're really smart!" may induce an entity theory of intelligence, since this praise may lead individuals to relate their ability to their intelligence, as in a learned helplessness orientation (Dweck, 1999). Receiving process praise, for example "You worked really hard on this!" may induce a more incremental theory of intelligence because process praise emphasizes the individual's efforts in relation to completing the task, rather than stable qualities (Dweck, 1999). After completing a task successfully, those who receive process praise and person praise are equally confident in their abilities to perform well in the future (Dweck, 1999; Kamins & Dweck, 1999) and self-report similarly on levels of persistence in a future task (Skipper & Douglas, 2012). However, upon encountering a failure, person-praised individuals are more likely than process-praised individuals to adopt a helpless orientation (Mueller & Dweck, 1998), responding more negatively in terms of evaluation of their own performance, affect, and persistence. Furthermore, person-praised individuals were more likely to believe that their failure in this task was a reflection of their own traits and abilities (Dweck, 1999; Kamins & Dweck, 1999). Thus, different types of praise lead to different orientations, which in turn lead to different learning outcomes. In addition, it is possible that different types of feedback lead to different learning outcomes directly. According to the FIT model, objective feedback produces better learning outcomes than any type of praise. However, previous research suggests that behavioural feedback and process praise lead to similarly positive orientations and theories of intelligence (Skipper & Douglas, 2012).

This proposed study will attempt to reconcile conflicting evidence of the impact of different types of feedback on individuals' perception of their own performance, affect, and persistence. Whereas some research has shown that praise is an effective form of feedback to encourage success and motivate achievement (Dweck, 1999; Kamins & Dweck, 1999), other research has found that feedback was most effective when given objectively (Hattie & Timperley, 2007; Kluger & DeNisi, 1996), without grades or praise (Lipnevich & Smith, 2009). The study will compare objective process/self-regulation feedback with process praise to determine if the two types of feedback elicit similarly positive perceptions of performance, affect, and persistence. Furthermore, this study will

also address the understudied topic of whether it is necessary for behavioural feedback to be *used* to elicit better outcomes, or if the mere *presence* of behavioural feedback elicits positive outcomes as well.

Method

This study will be a between-groups study design, using similar methods as Skipper and Douglas (2012). Participants will be school children aged 9–11, since the same age range of participants was used by Skipper and Douglas (2012) and by several other studies that explore the influence of feedback (e.g. Mueller & Dweck, 1998). The participants will be randomly assigned into one of four conditions: the process praise condition, the person praise condition, the objective process/self-regulation feedback condition (hereafter called the objective feedback condition), and the control condition. The dependent measures will be perceived performance, affect, and persistence.

Measures and Procedure

Participants will complete a questionnaire in which there will be five scenarios described. These scenarios ask the participants to imagine themselves as the protagonist in an everyday life situation, such as a child performing a math test:

> One day you were given some very difficult problems in [math]. You had never done them before but you […] wanted to show Mrs. Billington [your teacher] that you had listened carefully to her and that you could do the problems well. You worked very hard on the problems, taking your time and thinking very carefully so as not to make any mistakes. When you got your work back, you saw that you got all 5 out of 5 correct. Mrs. Billington says to you, "[feedback]". (Skipper & Douglas, 2012)

The participants in the process praise condition will receive feedback commenting on the effort from the protagonist: "You worked really hard at this." Participants in the person praise condition will receive feedback regarding a personal characteristic of the protagonist: "You're really good at this." Participants in the objective feedback condition will receive objective process feedback, a combination of process feedback and self-regulation feedback, which will ask the protagonist to find an improved strategy by evaluating his or her own work: "You know a better way of doing the first question. Try doing it that way." Participants in the control condition will receive factual feedback that does not involve any of the four types of feedback as described by FIT: "You got 5 out of 5 correct."

The first three scenarios will be successes, where the protagonist receives "5 out of 5 correct", and the remaining two scenarios will be failures, where the scenario will read, "You saw that you only got 3 out of 5 correct". Two failure scenarios are used because one failure may be discounted as unlucky (Dweck, 1999). The order of the scenarios presented on the questionnaire will be counterbalanced.

Dependent measures. After each success or failure, the participant will be asked, on a five-point scale, (1) how well they think they did on the test (perceived performance), (2) how their performance on the test made them feel (affect), and (3) whether they would like to take another test (persistence) (Skipper & Douglas, 2012). Participants will then be debriefed.

Expected Results and Discussion

This proposed study will be conducted to determine if objective feedback and process praise elicit similarly positive perceptions of individuals' performance, more positive affect, and more persistence. This study will also determine if the mere presence of objective feedback, a type of behavioural feedback, can change participants' motivational orientations to elicit better learning outcomes. Following each scenario depicting success and failure, children will receive objective feedback, person praise, process praise, or factual feedback, as well as measurements of perceptions of their performance, affect, and persistence.

Comparing Person Praise with Other Feedback

Previous research using similar materials and study design found that following each of the first three successful tasks, children in all conditions had equal levels of perceived performance, affect, and persistence (Skipper & Douglas, 2012). This is because participants had not yet encountered setbacks that would induce different types of coping strategies (Mueller & Dweck, 1998). Participants who receive person praise were more likely to have an entity theory of intelligence, and were more negatively impacted by failure than participants in the process-praise condition because they are dependent on success to maintain their self-worth (Mueller & Dweck, 1998). In response to failures, person praise participants tend to adopt a learned helplessness orientation, with poorer perceived performance, more negative affect, and less persistence than those in the process praise and control conditions (Hattie & Timperley, 2007; Mueller & Dweck, 1998; Skipper & Douglas, 2012). In contrast, participants in the process praise condition had more positive perceptions of their own score, more positive affect, and were more likely to adopt a mastery orientation, and thus attributed their success to their effort and reported more persistence than those in the person praise condition (Hattie & Timperley, 2007; Mueller & Dweck, 1998; Skipper & Douglas, 2012). Thus, in this proposed study it is likely that, following successes, participants in each condition will have equal levels of perceived performance, affect, and persistence. Following failures, participants in the person praise condition will adopt poorer learning outcomes than those who have received other types of feedback.

Comparing Process Praise and the Control Condition

Participants in the process praise condition may or may not have better learning outcomes than the control condition. The types control conditions vary greatly across different studies. Mueller and Dweck (1998) provided their control group with praise that was neither process praise nor person praise ("That's a really high score"), and found that children in the control group showed less positive achievement motivation than children in the process praise group. However, Skipper and Douglas (2012) provided their control group with feedback in the form of a test score and found that participants in the control condition reacted similarly to failure as those in the process praise condition. Skipper and Douglas (2012) argue that objective feedback, such as one's score on a test is sufficient to encourage positive learning outcomes, and that process praise may not necessarily produce more positive outcomes than objective feedback.

To complicate matters further, Lipnevich and Smith (2009) found that provision of grades on an essay draft was detrimental to college students' final essay grade, suggesting that provision of a score on a test does not encourage more positive learning outcomes. Since there is little evidence comparing process praise with provision of test scores, there are several possible outcomes: participants in the process praise condition will adopt more positive learning outcomes than those in the control condition, participants in the process praise condition will adopt less positive learning outcomes than those in the control condition, or participants in the process praise condition will adopt equally positive learning outcomes as those in the control condition.

Comparing Process Praise and Objective Feedback Praise

There has been little research comparing process praise and objective feedback praise. Because Skipper and Douglas (2012) found that participants provided with seemingly objective feedback had positive learning outcomes similar to those who were provided with process praise, it is expected that participants in this study who receive objective feedback will have similar or more positive learning outcomes as those in the process praise condition. In this study, the objective feedback contains a combination of process feedback and self-regulation feedback, which meta-analyses concluded to be the most effective forms of feedback (Hattie & Timperley, 2007; Kluger & DeNisi, 1996).

The Use of and the Mere Presence of Behavioural Feedback

According to FIT, individuals are constantly evaluating their progress on a task to find new strategies to bring them closer to their goals, and if these strategies do not bring them closer to their goal, they either persist or give up (Kluger & DeNisi, 1996). In an attempt to find more successful strategies, individuals use behavioural feedback by adjusting their own behaviour, and then once again evaluating their progress on a task. Since participants in this study will not be using the behavioural feedback to improve their strategies, the results of this study will determine if *using* the behavioural feedback is necessary to improve learning outcomes, or if just the mere *presence* of behavioural feedback can improve learning outcomes. There is some evidence in the literature that process and self-regulation feedback not only help improve behaviour, but can also help improve their task confidence (Earley, Northcraft, Lee, & Lituchy, 1990; Hattie and Timperley, 2007). In other words, the effects of behavioural feedback may be mediated by confidence in success, which is strongly related to self-efficacy and motivational orientation. If it is true that the effects of behavioural feedback are mediated by confidence in success, then the mere presence of behavioural feedback may be sufficient to improve learning outcomes. In this case, participants in the objective feedback condition should have more positive learning outcomes than the factual feedback (control) condition.

Conclusion

This paper proposes a study to compare different types of feedback to determine if objective feedback and process praise elicit similarly positive self-perceived performance, affect, and persistence. Person praise cues individuals to think of their performance on tasks as a reflection of their ability, causing them to have less positive learning outcomes than those who receive

process praise, especially in response to failure. Previous research has shown that objective feedback and process praise can lead to similar learning outcomes (Skipper & Douglas, 2012), and this could be because some types of objective feedback elicit confidence in success (Hattie & Timperley, 2007). In other words, process/self-regulation feedback, a type of objective feedback that provides strategies on how to improve, may be just as effective or more effective at improving learning outcomes as process praise. If this objective feedback is as effective as or more effective than process praise, it can be concluded that the influence of behavioural feedback is mediated by individuals' confidence in success.

This study will demonstrate that, despite the perceived value of praise, other types of feedback may also induce positive learning outcomes. Future studies, reviews, and meta-analyses should distinguish between different types of praise. Failure to take into account different types of praise has led past research and reviews to find contradictory evidence regarding the effectiveness of praise. In addition, future research may concentrate on studying the relationship between behavioural feedback, self-efficacy and motivational orientation. Such investigations will allow researchers to understand the sources of the effectiveness of behavioural feedback. Understanding different types of feedback has important implications for teaching and parenting practices, and researching their differing levels of effectiveness will prove valuable for improving children's learning outcomes.

References

Butler, R. (1987). Task-involving and ego-involving properties of evaluation: Effects of different feedback conditions on motivational perceptions, interest, and performance. *Journal of Educational Psychology*, *79*(4), 474-482. doi:10.1037/0022-0663.79.4.474

Dweck, C. S. (1999). Self-Theories: Their role in motivation, personality, and development. Philadelphia, PA: The Psychology Press.

Dweck, C. S. (2002). Messages that motivate: How praise molds students' beliefs, motivation, and performance (in surprising ways). In J. Aronson (Ed.), *Improving academic achievement: Impact of psychological factors on education* (pp. 37–60). San Diego: Academic Press.

Earley, P. C., Northcraft, G. B., Lee, C., & Lituchy, T. R. (1990). Impact of process and outcome feedback on the relation of goal setting to task performance. *Academy of Management Journal*, *33*(1), 87-105.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81-112. doi:10.3102/003465430298487

Hong, Y., Chiu, C., Dweck, C. S., Lin, D. M., & Wan, W. Implicit Theories, Attributions, and Coping: A Meaning System Approach. *Journal of Personality and Social Psychology, 77*(3), 588-599. doi: 10.1037/0022-3514.77.3.588

Kamins, M. L., & Dweck, C. S. (1999). Person versus process praise and criticism: Implications for contingent self-worth and coping. *Developmental Psychology*, *35*(3), 835-847. doi:10.1037/0012-1649.35.3.835

Kazdin, A. E. (1982). Applying behavioral principles in the schools. In C. R. Reynolds & T. B. Gutkin (Eds.), *Handbook of School Psychology* (pp. 501–529). New York: Wiley.

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin*, *119*(2), 254-284. doi:10.1037/0033-2909.119.2.254

Lipnevich, A. A., & Smith, J. K. (2009). Effects of differential feedback on students' examination performance. *Journal of Experimental Psychology: Applied*, *15*(4), 319-333. doi:10.1037/a0017841

Martens, B. K., Witt, J. C., Daly, E. J., & Vollmer, T. (1999). Behavior analysis: Theory and practice in educational settings. In C. R. Reynolds & T. B. Gutkin (Eds.), *Handbook of School*

Psychology (3rd ed., pp. 638–663) New York: Wiley.

Mueller, C. M., & Dweck, C. S. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality And Social Psychology*, *75*(1), 33-52. doi:10.1037/0022-3514.75.1.33

Reese, R. J., Usher, E. L., Bowman, D. C., Norsworthy, L. A., Halstead, J. L., Rowlands, S. R., & Chisholm, R. R. (2009). Using client feedback in psychotherapy training: An analysis of its influence on supervision and counselor self-efficacy. *Training and Education in Professional Psychology, 3*(3), 157-168. doi:10.1037/a0015673

Skipper, Y., & Douglas, K. (2012). Is no praise good praise? Effects of positive feedback on children's and university students' responses to subsequent failures. *British Journal of Educational Psychology*, *82*(2), 327-339. doi:10.1111/j.2044x-8279.2011.02028.x

Vander Kloet, M., & Chugh, B. (2012). An interdisciplinary analysis of microteaching evaluation forms: How peer feedback forms shape what constitutes 'good teaching'. *Educational Research and Evaluation*, *18*(6), 597-612. doi:10.1080/13803611.2012.704171

Etiology and Expression of Savant Syndrome: Insight into the Inner Workings of the Human Brain

Elaine Chan[1]
[1]Department of Psychology, University of British Columbia

Edited by: Simon Ho, Department of Psychology, University of British Columbia. Received for review January 31st, 2013, and accepted April 11, 2013.

Abstract

Savant syndrome is a rare condition in which an individual expresses both extraordinary mental ability and disability. While its causes remain poorly understood, it has often been linked to autism due to their relatively high comorbidity rate. Like autism, there is some evidence of a genetic basis. Nurmi et al. (2003) found evidence of a linkage of savant skills to the 15q11-q13 chromosomal region. Furthermore, the genes involved in the development of savant syndrome may well have pleiotropic effects that influence neural structures and cognition. Individuals with savant syndrome have demonstrated differences in neuronal activity, brain structure and functioning compared to neurotypical individuals. Savants also show atypical cognitive processing styles. Two theories of cognition, weak central coherence and hyper-systemization (Baron-Cohen, Ashwin, Ashwin, Tavassoli, & Chakrabarti, 2009), are discussed. Despite research efforts, no single theory has yet been able to explain all cases of savant syndrome (Treffert, 2009). However, this review proposes that the basis of the syndrome lies in atypical functioning of the human brain at the neuronal, structural and cognitive levels. Uncovering the underlying neural mechanisms of savant syndrome may provide insight into the potential of the human brain and shed light on learning and memory, as well as be of clinical and therapeutic importance for autism.

Keywords*: savant syndrome, autism, brain structure, genetics, cognition*

Savant syndrome, or Savantism, has been of particular interest to researchers and lay people alike because of its juxtaposition between extraordinary mental ability and mental disability. Savant syndrome is a rare condition in which a person with mental impairment also exhibits abilities in a certain area that surpass the abilities of neurotypical people. The degree of underlying mental impairment varies between savants, as do the areas in which savants have been found to excel in.

Corresponding Author:
Elaine Chan
E-mail: elainechan30@gmail.com

Savantism has been most commonly demonstrated in the domains of: (a) music (e.g., ability to reproduce a complex sequence after just one exposure); (b) mathematics (e.g., fast arithmetic and prime number calculations); (c) calendar calculation (e.g., knowledge of the day of the week that a date from the past or future falls on); (d) art (e.g., recreating complex scenes with accurate perspective and details); (e) memory of facts; and (f) mechanical or spatial skills (Happé & Vital, 2009; Howlin, Goode, Hutton, & Rutter, 2009; Treffert, 2009). Less frequently documented savant abilities include 'pseudo-verbal' skills such as hyperlexia (precocious reading ability), unusual sensory discrimination, and perfect appreciation of passing time without the use of a time-keeping device (Rimland, 1978; Treffert, 2009).

It has been estimated that around 50 percent of savants have autistic spectrum disorder (ASD), while the remaining 50 percent suffer from other mental disorders or brain damage (Treffert, 2009). Studies have shown that approximately 10 to 30 percent of people diagnosed with ASD exhibit savant behaviour, compared with 0.06 to 0.1 percent of those with other forms of mental impairment (Hill, 1977; Howlin et al., 2009; Rimland, 1978; Saloviita, L. Ruusila, & U. Ruusila, 2000). Due to the relatively high prevalence of savant syndrome among individuals with ASD, the investigation into the etiology of this syndrome has often overlapped with that of autism, which has a strong genetic basis. For example, Bailey, Phillips, and Rutter (1996) estimated the heritability of autism to be at least 90 percent, based on a large number of family and twin studies. As a result, researchers have inferred that savant syndrome may also have a genetic basis (Ploeger, van der Maas, Raijmakers, & Galis, 2009).

In 2003, Nurmi et al. discovered support for a genetic basis to savant syndrome. In order to identify the specific gene variant that predisposes for risk of autism, researchers elected to use subsets of families of autistic individuals based on savant skills. They found that in the subset of families in which subjects had greater savant skills, the evidence for linkage to chromosome 15q11-q13 was increased more than threefold relative to the overall data set. Those families in which subjects had few or no savant skills showed no evidence of linkage. Nurmi et al. proposed that their findings could be explained by the presence of genes in the chromosome 15q11-q13 region that, when stimulated, contribute to predisposition towards a particular cognitive style or intellectual impairments and strengths.

Regardless of the specific gene variant, Ploeger et al. (2009) hypothesize that the genes involved in the development of savant syndrome have pleiotropic effects (affecting more than one phenotypic trait) that originate in the early organogenesis stage of embryological development. As support for their hypothesis, Ploeger et al. discuss common shared characteristics among savants such as the high frequency of brain anomalies, premature births, and the occurrence of congenital anomalies (e.g., extra digits) – all of which may result from pleiotropic disturbances during early organogenesis. It is reasonable to expect that genetics and their pleiotropic effects therefore influence neural characteristics and cognitive function.

It is these neural abnormalities, which are predisposed by genetics or a result of brain damage or disease, which may explain both the extraordinary abilities

and disabilities of savants. These atypical neural characteristics, from neuronal activity and brain structure to cognitive processing style, are presently discussed in this review. The basis of savant syndrome appears to lie in atypical neural and cognitive functioning. Uncovering the etiology of this phenomenon may not only be of therapeutic value, but also provide insight into how the brain functions and reveal the extremes of its potential.

Neuronal Activity

Researchers have discovered differences in perceptual processing between savants and neurotypical individuals at the neuronal level. In 2008, Kelleher and Bear proposed that aberrant synaptic protein synthesis in neurons plays a role in the expression of savant abilities in autistic individuals. In neurotypical people, effective memory consolidation and retention typically increase incrementally from repeated exposure to new information, but many savants have the capacity for remarkable retention after a single exposure (Kelleher & Bear, 2008). Kelleher and Bear suggest that this superior declarative memory, which is a common feature of savant abilities in autistic individuals, is a result of excessive protein synthesis. This promotes rapid and efficient synaptic capture and consolidation of hippocampal memory traces, regardless of their salience. However, they argue that this form of synaptic protein synthesis is also the cause for the more generalized impairment of cognitive function that is observed in savants (Kelleher & Bear, 2008).

Fabricius (2010) has also proposed a theory involving neurons that he has coined the Savant Hypothesis. He maintains that savants retain the entire signal representation of sensory input at higher-levels of cognition. This is in contrast to cognitively typical people who take in the entire signal but then "sparsify" it to a smaller subset of neurons that approximates the signal, which leaves individuals with only a compressed representation of the stimulus (Fabricius, 2010). Generally, this approximation of the stimulus in neurotypical individuals is sufficient for cognition and may be more efficient, therefore accelerating decision-making (Fabricius, 2010; Snyder, 2009). Fabricius' Savant Hypothesis helps to explain how savants have access to details that seem to elude neurotypical people, and is purported to be able to explain why artistic savants can recreate fine details in their respective works.

Brain Structure and Function

Given that neurons are the building blocks of the brain and that differences in processing are already observed at this neuronal level, it is not surprising that there are larger scale differences observed in the brain structures of savants and neurotypical individuals. In a case study of a multi-talented savant with ASD, Wallace, Happé, and Giedd (2009) observed that the superior parietal region of the savant's cortex was the only area thicker than that of a neurotypical control group, while areas such as the superior and medial prefrontal, medial temporal, and motor cortices were found to be thinner. Of note, the superior parietal lobe has been associated with calculation and artistic abilities, which were the two domains in which this particular savant exhibited special skill (Wallace et al., 2009). However, the question remains whether this is a result of 'nature or nurture', or in other words, cause or effect. These size differences could very well be the result of extensive practice in the specific areas in which the savant exhibited his skills, rather than innate differences

(Wallace et al., 2009). Savants often exhibit circumscribed interests within their skill area. When combined with the strength of detail-focused processing that is often found in individuals with autism, this results in over-learning and massive exposure that is likely reflected in atypical brain structure (Wallace et al., 2009).

The effects of brain injury and disease on neural structure and functioning can also lead to the emergence of savant skills. This acquired form of savant syndrome has usually been found to occur after damage involving the left anterior temporal lobe (Hughes, 2010). Hughes proposed that this type of injury inhibits what he referred to as "the tyranny of the left hemisphere", thereby allowing the typically non-dominant right hemisphere to reveal savant skills that may have been suppressed. Another possibility is that when the left hemisphere is damaged, the right hemisphere compensates by developing new skills, perhaps through the formation of novel connections and re-organization of neural networks (Treffert & Christensen, 2005). Interestingly, autism has also been associated with right-hemispheric bias (Herbert et al., 2005; Koshino et al., 2005). Dysfunction of the left anterior temporal lobe has been implicated in the occurrence of savant syndrome for both autistic savants and individuals who acquire the syndrome, such as in some patients with frontotemporal dementia (FTD) (Miller et al., 1998; Snyder, Bahramali, Hawker, & Mitchell, 2006; Young, Ridding, & Morrell, 2004). In FTD patients, savant-like abilities typically manifest as artistic and musical skill where none previously existed, and arise alongside other autistic-like symptoms such as preoccupation with visual details and loss of semantic memory (Miller et al., 1998).

Impairment of the left anterior temporal lobe has been induced in healthy individuals through the application of repetitive transcranial magnetic stimulation (rTMS) to the area (Snyder et al., 2006; Young et al., 2004). Snyder et al. (2006) found that immediately following rTMS, 10 out of 12 participants improved their ability to accurately guess the number of items that flashed on a computer screen, displaying savant-like numerosity. Furthermore, eight of these participants became worse at guessing as the effects of the magnetic pulses receded (Snyder et al., 2006). Young et al. (2004) also used rTMS to interrupt the function of the left frontotemporal region in 17 participants, and found that five displayed savant-type skills during the period of stimulation. These enhanced skills included declarative memory, drawing, mathematics, and calendar calculating. However, the amount of rTMS required to show savant-like abilities may vary between individuals, which is why improved performance was not observed in all 17 participants (Young et al., 2004). These findings demonstrate that neurotypical individuals have the neural capacity for savant-type skills, but are likely hindered by the dominant left hemisphere that serves normal cognitive functioning.

Cognitive Style

As alluded to in the previous section, atypical neural structures give rise to atypical cognitive functioning. The two most prominent theories regarding the cognitive styles of savants are presently discussed. Both theories attempt to explain the development of savant abilities as the way in which savants process sensory information.

Theory of Weak Central Coherence

The remarkable attention-to-detail that is observed in many autistic savants has been the focus of various studies suggesting that savant syndrome is the result of weak central coherence. This theory attributes the extraordinary abilities of savants to the enhancement of lower-level information processing mechanisms at the cost of higher-level processing, resulting in a local processing bias that benefits the development of savant skills (Neumann et al., 2010; Snyder & Mitchell, 1999). In other words, while neurotypical individuals tend to favour global processing (looking at the big picture) over local processing, the opposite is seen in autistic individuals, in both savants and non-savants (Snyder et al., 2006; Wallace et al., 2009). This lower-level sensory information is suggested to exist in all individuals but is not normally accessible (i.e., except by dysfunction or artificial means such as rTMS) (Snyder & Mitchell, 1999; Young et al., 2004).

Bias towards local processing allows individuals with autism to focus on details and individual parts of an object rather than on the object as a whole. For example, autistic individuals show relative strength on the block design subtest of the Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974), in which subjects are shown a design or model and, under time constraints, asked to replicate it using the blocks provided to them. In this task, ability to see a whole design in terms of its parts is advantageous. In addition, they often outperform controls on the embedded figures test (Witkin, Oltman, Raskin, & Karp, 1971), which requires participants to spot a simple shape within a more complex figure (Ring et al., 1999; Wallace et al., 2009). Individuals with autism are also less fooled than others by standard visual illusions (such as the Titchener Circles in which the presence of the surrounding circles affects an individual's ability to judge whether the two inner circles are the same size) and appear to perceive such figures in a less unified way (Happé, 1999). Snyder (2009) suggests that the degree to which autistic individuals possess this cognitive style of weak central coherence may help to explain the expression of savant skills in some, but not all, individuals with autism.

Pring and Hermelin (2002) demonstrated the relationship between weak central coherence and savant syndrome in a study comparing an autistic savant skilled in calendar calculation to two control participants (a departmental secretary and a professor of mathematics) on a set of unpracticed letter or number association tasks. Pring and Hermelin (2002) found that the savant was able to master the rules governing the relationships between the series of items, as well as recalibrate previous knowledge to solve new tasks more quickly than the controls. Additionally, when presented with new problems, the savant made no initial errors on any tasks, unlike the controls. The researchers concluded that weak central coherence may serve to enable savants to perceive and retain single pieces of information separately rather than as an integrated whole, and that this segmental strategy allowed for the fast reorganization and reconstruction of relationships between items of information (Pring & Hermelin, 2002). They elaborated further that practice effects in savants might allow task speeds to improve, but that practice alone could not explain their remarkable performance. Consequently, it may be the cognitive style of weak central coherence (characteristic of, yet not confined, to ASD) that is the common, predisposing factor to

development of savantism rather than autism itself (Happé & Vital, 2009).

In contrast to the aforementioned hypothesis of left frontotemporal inhibition leading to the display of savant abilities, local processing bias has been observed in patients with acquired right hemisphere damage (Heinze, Hinrichs, Scholz, Burchert, & Mangun, 1998; Robertson & Lamb, 1991). Furthermore, neuroimaging studies of autistic individuals have found reduced white matter volume in the right hemisphere (Waiter et al., 2005). However, a significant limitation of neuroimaging studies comparing healthy controls to individuals with ASD exists, as it is unclear whether these two groups share the same underlying cognitive style, raising the question of whether these two groups can truly be compared (Happé & Frith, 2006).

Hyper-Systemizing Theory

As an alternative to the theory of weak central coherence, Baron-Cohen, Ashwin, Ashwin, Tavassoli, and Chakrabarti (2009) have developed the hyper-systemizing theory to explain how the hyper-systemizing characteristics seen in the cognitive style of autistic individuals predisposes individuals to develop special talents. They argue that while both theories describe excellent attention to detail, the emphasis on only attention to detail in the weak central coherence theory does not explain the development of talent (Baron-Cohen et al., 2009). The hyper-systemizing theory outlines how superior attention to detail is directed towards developing law-based pattern recognition (for example, 'if p, then q' rules or input-operation-output reasoning) by noting structure and rules (Baron-Cohen et al., 2009). Baron-Cohen et al. suggest that this hyper-systemizing can aid in the explanation of savant talent in rule-based domains such as identification of prime numbers, calendrical calculation, art (laws of perspective), memory, music, and learning foreign languages. They also argue that the level of attention to detail in individuals with ASD is a consequence of the sensory hypersensitivity that these individuals also possess. This theory could potentially serve to explain the errorless performance and quick ability of the savant in grasping novel rules and relationships in a set of unpracticed letter or number association tasks (Pring & Hermelin, 2002).

Conclusion and Future Directions

It is apparent that the expression of savantism lies in atypical neural functioning and cognitive processing. In regards to differences at the neuronal level, excessive synaptic protein synthesis may cause the superior declarative memory that is commonly found in savants. Fabricius' (2010) Savant Hypothesis posits that savants maintain access to details by retaining the entire signal representation of sensory input at higher-levels of cognition rather than approximating it in the way that neurotypicals do. Differences in neural structure and activation, as compared to controls, have been reported in savants, including a thicker superior parietal region (Wallace et al., 2009) and an impaired left frontotemporal area (Hughes, 2010; Snyder et al., 2006). Savant abilities may also be a result of differences in cognitive style. The two main theories in this vein of research are the theory of weak central coherence, where local processing is favoured over global processing, and the hyper-systemizing theory, which attributes the talents of savants to their ability to develop law-based pattern recognition by noting structure and rules (Baron-Cohen et al., 2009). These neural and cognitive differences may give

rise to the extraordinary abilities of savants, but are also likely responsible for their more generalized cognitive deficits.

In spite of all the research efforts surrounding the savant syndrome phenomenon, the cognitive and neural mechanisms underlying savant skill development and expression remain inconclusive in that no one theory can yet explain all cases of savant syndrome (Wallace et al., 2009). Furthermore, controversies remain regarding whether differences in neural structures are the cause of savant skills or are an effect of over-practice and development. There have also been inconsistent findings and issues regarding the reliability of findings (e.g., Ma et al., 2005; Waiter et al., 2005). However, it is important to realize that more progress has been made in the past two decades towards better understanding and explaining savant syndrome than in the previous century (Treffert, 2009).

Considerable limitations to research on savant syndrome exist, such as a lack of standardized testing, heterogenous descriptions of the syndrome and constrained testability of savants (Bölte & Poustka, 2004). The most pressing limitation to this research however, is the low frequency of the syndrome in the population. This rarity makes savant syndrome particularly difficult to study, and researchers must resort to case studies or use small sample sizes in their work.

More research is needed in order to replicate and confirm findings. It would be useful to combine some of the many theories that have been proposed, as most are not mutually exclusive and may lend support for one another. Further research into the etiology of savantism will provide more insight into the complexities and mechanisms of cognitive processing, learning, and memory in the human brain. It may even be possible to utilize these findings to aid learning and memory in the majority of people. Neurotypical individuals have demonstrated the neural capacity for savant-like skills (Snyder et al., 2006; Young et al., 2004); it is plausible that there is untapped potential in the human brain. Finally, due to the relatively high prevalence of individuals with autism exhibiting savant syndrome, discovering conclusive results about the etiology of savant syndrome may be closely linked to uncovering the etiology of autism and ASD in general. If this link were to be found, it would have implications for the development of novel methods of treatment and understanding for individuals with ASD.

Declaration of Conflicting Interests

The author declared they have no conflicts of interests with respect to their authorship or the publication of this article.

References

Bailey, A., Phillips, W., & Rutter, M. (1996). Autism: towards an integration of clinical, genetic, neuropsychological, and neurobiological perspectives. Journal of Child Psychology and Psychiatry, 37(1), 89-126. doi:10.1111/j.1469-7610.1996.tb01381.x

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., & Chakrabarti, B. (2009). Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. Philosophical Transactions of the Royal Society B: Biological Sciences, 364, 1377-1383. doi:10.1098/rstb.2008.0337

Bölte, S., & Poustka, F. (2004). Comparing the intelligence profiles of savant and nonsavant individuals with autistic disorder. Intelligence, 32, 121-131. doi:10.1016/j.intell.2003.11.002

Fabricius, T. (2010). The savant hypothesis: is autism a signal-processing problem? Medical Hypotheses, 75, 257-265. doi:10.1016/j.mehy.2010.02.034

Happé, F. (1999). Autism: cognitive deficit or cognitive style? Trends in Cognitive Sciences,

3(6), 216-222. doi:10.1016/S1364-6613(99)01318-2

Happé, F., & Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. Journal of Autism and Developmental Disorders, 36(1), 5-25. doi:10.1007/s10803-005-0039-0

Happé, F., & Vital, P. (2009). What aspects of autism predispose to talent? Philosophical Transactions of the Royal Society B: Biological Sciences, 364, 1369-1375. doi:10.1098/rstb.2008.0332

Heinze, H. J., Hinrichs, H., Scholz, M., Burchert, W., & Mangun, G. R. (1998). Neural mechanisms of global and local processing: A combined PET and ERP study. Journal of Cognitive Neuroscience, 10, 485-498. doi:10.1162/089892998562898

Herbert, M. R., Ziegler, D. A., Deutsch, C. K., O'Brien, L. M., Kennedy, D. N., Filipek, P. A., Bakardjiev, A. I., Hodgson, J., Takeoka, M., Makris, N., & Caviness, V. S. (2005). Brain asymmetries in autism and developmental language disorder: a nested whole-brain analysis. Brain, 128(1), 213-226. doi:10.1093/brain/awh330

Hill, A.L. (1977). Idiot savants: rate of incidence. Perceptual & Motor Skills, 44(1), 161-162.doi:10.2466/pms.1977.44.1.161

Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2009). Savant skills in autism: psychometric approaches and parental reports. Philosophical Transactions of the Royal Society B: Biological Sciences, 364, 1359-1367. doi:10.1098/rstb.2008.0328

Hughes, J.R. (2010). A review of savant syndrome and its possible relationship to epilepsy. Epilepsy & Behavior, 17, 147-152. doi:10.1016/j.yebeh.2009.12.014

Kelleher, R.J., & Bear, M.F. (2008). The autistic neuron: troubled translation? Cell, 135, 401-406. doi:10.1016/j.cell.2008.10.017

Koshino, H., Carpenter, P. A., Minshew, N. J., Cherkassky, V. L., Keller, T. A., & Just, M. A. (2005). Functional connectivity in an fMRI working memory task in high-functioning autism. Neuroimage, 24(3), 810-821. doi:10.1016/j.neuroimage.2004.09.028

Ma, D.Q., Jaworski, J., Menold, M.M., Donnelly, S., Abramson, R.K., Wright, H.H., . . . Cuccaro, M.L. (2005). Ordered-subset analysis of savant skills in autism for 15q11-q13. American Journal of Medical Genetics Part B (Neuropsychiatric Genetics), 135B, 38-41. doi:10.1002/ajmg.b.30166

Miller, B. L., Cummings, J., Mishkin, F., Boone, K., Prince, F., Ponton, M., & Cotman, C. (1998). Emergence of artistic talent in frontotemporal dementia. Neurology, 51(4), 978-982. doi:10.1212/WNL.51.4.978

Neumann, N., Dubischar-Krivec, A.M., Braun, C., Löw, A., Poustka, F., Bölte, S., & Birbaumer, N. (2010). The mind of the mnemonists: an MEG and neuropsychological study of autistic memory savants. Behavioural Brain Research, 215, 114-121. doi:10.1016/j.bbr.2010.07.008

Nurmi, E.L., Dowd, M., Tadevosyan-Leyfer, O., Haines, J.L., Folstein, S.E., & Sutcliffe, J.S. (2003). Exploratory subsetting of autism families based on savant skills improves evidence of genetic linkage to 15q11-q13. Journal of the American Academy of Child and Adolescent Psychiatry, 42(7), 856-863. doi:10.1097/01.CHI.0000046868.56865.0F

Ploeger, A., van der Maas, H.L.J., Raijmakers, M.E.J., & Galis, F. (2009). Why did the savant syndrome not spread in the population? A psychiatric example of a developmental constraint. Psychiatry Research, 166, 85-90. doi:10.1016/j.psychres.2007.11.010

Pring, L., & Hermelin, B. (2002). Numbers and letters: exploring an autistic savant's unpractised ability. Neurocase, 8, 330-337. doi:10.1076/neur.8.3.330.16193

Rimland, B. (1978). Savant capabilities of autistic children and their cognitive implications. In G. Serban (Ed.), Cognitive defects in the development of mental illness (pp. 43–65). New York, NY: Bruner-Mazel.

Ring, H.A., Baron-Cohen, S., Wheelwright, S., Williams, S.C.R., Brammer, M., Andrew, C., & Bullmore, E.T. (1999). Cerebral correlates of preserved cognitive skills in autism: a functional MRI study of embedded figures task performance. Brain, 122, 1305-1315. doi:10.1093/brain/122.7.1305

Robertson, L. C., & Lamb, M. R. (1991). Neuropsychological contribution to theories of part/whole organization. Cognitive Psychology, 23, 299-330. doi:10.1016/0010-0285(91)90012-D

Saloviita, T., Ruusila, L., & Ruusila, U. (2000). Incidence of savant syndrome in Finland. Perceptual and Motor Skills, 91, 120-122. doi:10.2466/pms.2000.91.1.120

Snyder, A. (2009). Explaining and inducing savant skills: privileged access to lower level, less-processed information. Philosophical Transactions of the Royal Society B: Biological Sciences, 364, 1399-1405. doi:10.1098/rstb.2008.0290

Snyder, A., Bahramali, H., Hawker, T., & Mitchell, D.J. (2006). Savant-like numerosity skills revealed in normal people by magnetic pulses. Perception, 35, 837-845. doi:10.1068/p5539

Snyder, A. W., & Mitchell, D. J. (1999). Is integer arithmetic fundamental to mental processing?: the mind's secret arithmetic. Proceedings of the Royal Society B: Biological Sciences, 266(1419), 587-592. doi:10.1098/rspb.1999.0676

Treffert, D.A. (2009). The savant syndrome: an extraordinary condition. A synopsis: past, present, future. Philosophical Transactions of the Royal Society B: Biological Sciences, 364, 1351-1357. doi:10.1098/rstb.2008.0326

Treffert, D. A. & Christensen, D. D. (2005). Inside the mind of a savant. Scientific American, 293(6), 108-113. doi:10.1038/scientificamerican1205-108

Waiter, G. D., Williams, J. H., Murray, A. D., Gilchrist, A., Perrett, D. I., & Whiten, A. (2005). Structural white matter deficits in high-functioning individuals with autistic spectrum disorder: A voxel-based investigation. Neuroimage, 24, 455-461. doi:10.1016/j.neuroimage.2004.08.049

Wallace, G.L., Happé, F., & Giedd, J.N. (2009). A case study of a multiply talented savant with an autism spectrum disorder: neuropsychological functioning and brain morphometry. Philosophical Transactions of the Royal Society B: Biological Sciences, 364, 1425-1432. doi:10.1098/rstb.2008.0330.

Wechsler, D. (1974). Manual for the Wechsler Intelligence Scale for Children-Revised. San Antonio, TX: The Psychological Corporation.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. A. (1971). A manual for the embedded figures test. Palo Alto, CA: Consulting Psychologists Press.

Young, R.L., Ridding, M.C., & Morrell, T.L. (2004). Switching skills on by turning off part of the brain. Neurocase, 10(3), 215-222. doi:10.1080/13554790490495140

Hembrooke, H. & Gay, G. (2003). The laptop and the lecture: The effects of multitasking in learning environments. *Journal of Computing in Higher Education, 15,* 46-64.

Kastner, S. & Ungerleider, L.G. (2000). Mechanisms of visual attention in the human cortex. *Annual Review of Neuroscience, 23,* 315-341.

Ren, D., Zhou, H., & Fu, X. (2009). A deeper look at gender difference in multitasking: Gender-specific mechanism of cognitive control. *2009 Fifth International Conference on Natural Computation*, 13-17.

Smallwood, J., O'Connor, R.C., Sudbery, M.V., & Obonsawin, M. (2007). Mind-wandering and dysphoria. *Cognition and Emotion, 21,* 816–842.

Insulin Resistance Impairs Functional Motor Recovery Following Ischemic Stroke

Jennifer K. Ferris[1]
[1]Department of Psychology, University of British Columbia

Edited by: Simon Ho, Department of Psychology, University of British Columbia. Received for review January 31st, 2013, and accepted April 8th, 2013.

Abstract

Ischemic stroke is a major contributor to death and disability in Canada. Type-2 diabetes is a significant risk factor for stroke, and diabetics have poorer functional recovery following stroke than non-diabetics. Recent evidence suggests that insulin resistance, a hallmark of type-2 diabetes, is responsible for the poorer recovery outcomes observed in diabetic stroke patients. This review summarizes current research on the impact of insulin resistance on mechanisms of neuroplasticity and recovery from stroke. Specifically, this review critically assesses evidence for (i) the effects of Central Nervous System (CNS) insulin signaling on NMDA receptor recruitment and long-term potentiation (LTP), (ii) the impact of LTP on plasticity in the motor cortex, and (iii) the impact of insulin resistance on these processes. This review proposes a mechanism by which insulin resistance impacts functional recovery after stroke in diabetic patients. The implications of these findings for current treatment paradigms of type-2 diabetes are considered, with suggestions for improved care.

Keywords: *Stroke, diabetes, neuroplasticity, long-term potentiation, insulin*

Stroke is the third leading cause of death and disability in Canada (Statistics Canada, 2009) and post-stroke care is a major burden on our healthcare system, representing a total cost of $2.5 billion a year (Mittmann et al., 2012). Stroke is not only devastating at the societal level, but it can seriously impact a patient's quality of life, with high rates of disability and institutionalization (Petrea et al., 2009). It is therefore imperitive to identify factors that can impact recovery from stroke to improve current rehabilitative paradigms - type-2 diabetes is one of these factors.

We have long known that type-2 diabetes is a risk factor for stroke; diabetics are four times more likely to suffer an ischemic stroke than non-diabetics (National Stroke Association, 2012). Importantly, diabetics also have worse outcomes after experiencing a stroke, with higher rates of mortality and disability (Kissela & Air, 2006),

Corresponding Author:
Jennifer Ferris
E-mail: jenniferkferris@gmail.com

independent of other risk factors (Wei et al., 2010). However, the mechanistic links between diabetes and increased rates of disability are not yet fully understood. This review will present research examining the impact of insulin resistance, a hall-mark of type-2 diabetes, on neuroplasticticity, and how this may impact functional recovery from stroke. Specifically, the current paper reviews four empirical articles to demonstrate that insulin resistance impairs insulin-mediated NMDA recruitment and long term potentiation (LTP), which hinders the cortical plasticity necessary for functional motor recovery following stroke. This paper will address literature on ischemic stroke (characterized by a blockage of blood flow to brain tissue), rather than hemorrhagic stroke (characterized by a bleed of blood onto brain tissue), thus the term "stroke" will be used only to refer to ischemic stroke.

Diabetes and Insulin Resistance

Insulin is a hormone responsible for maintaining glucose homeostasis in the body. Insulin is released by the pancreas in response to elevated blood glucose, and binds to the insulin receptor. Insulin receptor binding initiates a cascade of intracellular events, which results in glucose uptake by cells in the body. Cells use glucose as an energy source, and certain cells in the body (such as the skeletal muscles) are unable to uptake glucose from the bloodstream without the actions of insulin and the insulin receptor. Thus, insulin secretion and insulin receptor signaling are fundamental regulators of metabolic processes in the body.

Type-2 diabetes is an acquired metabolic disorder of middle age. Type-2 diabetes is characterized by two abnormal conditions of insulin signaling: (i) insulin secretion is reduced due to a loss of insulin-producing cells in the pancreas and (ii) insulin receptors become unable to respond to insulin binding, a condition known as insulin resistance (for review see: Kahn, 2003). Diet and lifestyle have an important contribution to the etiology of type-2 diabetes. The precise dietary composition that causes insulin resistance remains controversial, however, there is strong evidence to support a role of frequent consumption of highly refined carbohydrates in the induction of insulin resistance (for review see: Isharwal, Misra, Wasir, & Nigam, 2009). Consumption of highly refined carbohydrates causes large spikes in blood glucose levels. To manage this elevated blood glucose, the pancreas must release high levels of insulin. Prolonged consumption of refined carbohydrates leads to chronically elevated blood insulin levels, or hyperinsulinemia. A consequence of hyperinsulinemia, is insulin resistance; insulin receptors become progressively less responsive to insulin molecules in the bloodstream (Samuel & Shulman, 2012).

Insulin resistance has serious negative consequences for diabetic patients including reduced glucose uptake in the skeletal muscles, reduced glycogen storage in the liver, and the accumulation of lipids in the muscle and liver. While exercise rapidly increases insulin receptor sensitivity (Borghouts & Keizer, 2000), insulin resistance typically manifests in overweight and sedentary populations. Obesity and disrupted metabolic processes can lead to a vicious cycle of physical inactivity and increasing insulin resistance in diabetic patients. Importantly, a greater severity of insulin resistance is associated with increased risk of stroke, independent of other components of type-2 diabetes, such as hyperglycemia, obesity, or hypertension

(Bravata et al., 2005).

Insulin in the Central Nervous System

Insulin molecules freely cross the blood-brain barrier (Woods, Seeley, Baskin, & Schwartz, 2003). Insulin receptors exist in the brain, but insulin signaling in the brain is functionally distinct from insulin signaling in the periphery. The CNS insulin receptor is structurally different from insulin receptors in the periphery (Park, 2001), and is not uniformly distributed throughout the brain, with highest concentrations in the hypothalamus, hippocampus and cerebral cortex (Werther et al., 1987). Furthermore, neurons are not reliant on insulin receptor activation for glucose uptake (Belfiore et al., 2009; Reagan, 2010). Taken together, this suggests that the primary role of insulin in the brain is not the regulation of glucose homeostasis; rather it appears that insulin in the CNS has a wide variety of roles. Insulin binding to neural insulin receptors induces a signaling cascade that is far more complex than that of peripheral insulin receptors. Central insulin signaling has been implicated in many roles that are relevant to stroke recovery including cell survival, neurogenesis and mediating inflammatory processes (Nelson et al., 2008). For the purposes of this review we will focus discussion on (i) the effects of insulin resistance in the brain, (ii) the role of central insulin signaling in mechanisms of neuroplasticity, specifically its effects on long-term potentiation (LTP) and (iii) the implications of impaired neuroplasticity due to insulin resistance on functional motor recovery following stroke.

Insulin Resistance in the Brain

As previously stated, insulin in the brain is not primarily involved in the regulation of glucose homeostasis, and insulin receptors are structurally distinct than those in the periphery. Therefore, it is possible that dietary-induced insulin resistance affects CNS insulin receptors differently than peripheral insulin receptors. To address this question, Mielke and colleagues (2005) conducted a study examining the effects of a high fructose diet on neural insulin signaling in hamsters. Hamsters were fed either a high-fructose or a standard (control) diet for six weeks. The authors then assessed the ability of the hamster's hippocampal and cortical tissue to respond to insulin by giving hippocampal and cortical tissue samples a brief exposure to exogenous insulin and measuring insulin receptor response. The authors found that fructose-fed hamsters demonstrate significantly less insulin receptor activation in response to exogenous insulin. They also found that fructose-fed hamsters had significantly lower amounts of Insulin Receptor Substrate-1 (IRS1), a protein that is activated by the insulin receptor. However, there were no differences between groups in the total amount of insulin receptors present. These findings suggest that a high-fructose diet causes insulin receptors to become resistant to insulin binding, but these effects are not due to a decrease in the number of insulin receptors present.

The authors did not mention whether the high-fructose and control diets were calorically equivalent, so there is the possibility that the hamsters fed the more palatable high-fructose diet were also consuming a greater amount of total calories relative to hamsters on standard chow. A high caloric load could artificially inflate the differences between groups. However, overconsumption of calories coupled with high sugar intake is characteristic of human diabetes-inducing diet patterns, so even if these results overestimate the contribution of sugar consumption to central insulin-

resistance, the high-fructose diet employed in this study is still an appropriate model of type-2 diabetes. This study is highly suggestive that CNS insulin receptors become insulin resistant in response to a diet high in simple sugars, just as peripheral insulin receptors do. Furthermore, insulin resistance in CNS neurons impairs the ability of the insulin receptor to activate its downstream signaling pathways. We will now turn to evidence examining what the downstream effects of insulin receptor signaling are, as they relate to mechanisms of neuroplasticity.

Insulin Signaling and Neuroplasticity

Long-term potentiation (LTP) is a basic mechanism of plasticity in the nervous system. LTP is the process by which synchronous firing between neurons causes strengthening of their connections, such that presynaptic neurons become more efficient at eliciting responses from postsynaptic neurons. LTP is widely accepted to be a molecular basis of experience-dependent change in the nervous system, as repeated bouts of electrical activity cause amplified connections between commonly activated pathways. The induction of LTP relies on glutamate signaling, specifically, excitatory glutamate released by a presynaptic neuron binds to NMDA receptors on the postsynaptic neuron, and NMDA receptor activation causes LTP induction (for review, see: Miyamoto, 2006).

Insulin receptor signaling has an effect on NMDA receptor activation, and therefore on LTP, as demonstrated by Christie and colleagues (1999). Hippocampal cell cultures were incubated with treatments of either insulin or an inert control in artificial cerebrospinal fluid for 20 or 60 minutes. After these incubation periods, the amount of NMDA receptor protein was measured and compared between insulin treated hippocampal tissue and control. The authors found that after 20 minutes of exposure to insulin there was an increased amount of total activated NMDA receptor subunits in the hippocampal cultures, however at 60 minutes of exposure there was no difference in activated NMDA receptor units in the insulin treated tissue relative to controls. The authors did not speculate as to the cause of this decrease in NMDA receptor activation after 60 minutes of insulin exposure, however, in light of the more recent findings of Christie et al. (2005) we can hypothesize that this was due to the CNS neurons becoming insulin resistant and therefore unable to induce NMDA receptor recruitment.

These findings suggest that activation of the insulin receptor causes an increase in the recruitment and activation of NMDA units to the synaptic junction. A change in the total amount and availability of NMDA receptors regulates the amount of LTP induction in the brain; therefore these findings are highly suggestive that insulin acts as a regulator of neuronal plasticity in the healthy brain. Conversely, as insulin resistance disrupts brain insulin signaling, type-2 diabetes would have a negative impact on neuroplasticity.

Neuroplasticity and recovery from stroke

LTP has been best studied in hippocampal tissue; LTP is proposed to be a molecular basis for learning and memory processes in the hippocampus. Less is known about the role of LTP-mediated neuroplasticity in cortical motor domains. Use-dependent plasticity is the dynamic reorganization of motor cortex in response to well-practiced movement patterns. A classic example of use-dependent plasticity is that the motor cortex of violinists has much larger

representations of the hand used for the complex movements of fingering the strings of the violin than of the hand used to hold the bow (Schwenkreis et al., 2007). After ischemic stroke, established neural connections in motor regions may be damaged, impairing movement. In order to compensate for the loss of established neural connections, new patterns of cortical activation must be established and these new connections are formed by engaging in movement during rehabilitation (Nudo et al., 1997). Use-dependent plasticity is therefore considered a fundamental mechanism underlying recovery of function after stroke. To understand the molecular mechanisms behind use-dependent plasticity, Büteffisch and colleagues (2000) investigated the role of LTP on use-dependent plasticity in the motor cortex of healthy adults.

Büteffisch and colleagues (2000) examined whether administering a pharmacological blockade of NMDA receptors would impair use-dependent cortical plasticity in healthy adults. Participants were administered dextromethorphan (DM) a drug that blocks NMDA receptors, or a placebo drug. Participants were then given a Transcranial Magnetic Stimulation (TMS) based motor training protocol. TMS is a technique that allows for the precise, non-invasive, stimulation of cortical neurons via electromagnetic currents. It is guided by MRI scans, allowing for a high degree of accuracy in the focal stimulation of cortex. After DM or placebo administration, the TMS system was used to locate the precise region of motor cortex that caused the participant's right thumb to contract and twitch downwards. Once this region was localized and recorded participants were instructed to repeatedly move their thumb upwards for 30 minutes. After the 30 minutes had elapsed, the researcher would again stimulate the same region of motor cortex that had initially caused the thumb to twitch downwards. In subjects given the placebo drug, this same cortical region would now cause the thumb to twitch *upwards* in the direction they had been voluntarily practicing, demonstrating use-dependent reorganization of the motor cortex in response to repeated movements. However, in subjects given DM, their thumb would continue to twitch *downwards*, indicating than use-dependent reorganization of the motor cortex had not occurred after NMDA receptors were blocked.

This study demonstrates that NMDA-mediated LTP is essential for use-dependent motor cortex reorganization in the healthy brain. While this study does not elucidate the plastic changes required for motor rehabilitation following a stroke, it does provide convincing evidence for a basic mechanism underlying use-dependent cortical plasticity.

Finally, we will consider a study looking at LTP in cortical tissue following stroke. Hagemann et al. (1998) conducted a study to examine the effects of stroke on LTP in the cortical tissue around the area of ischemic damage. They induced an ischemic lesion in the cortex of adult rats. The authors then collected tissue from the area of cortex directly surrounding the ischemic lesion and from the contralateral region of cortex in the other, uninjured, hemisphere. They then applied rapid electrical stimulation to cortical tissue to induce LTP, and measured cell response to this stimulation with electrophysiological recordings. The authors report that there was greater amplitude of LTP in tissue directly surrounding the cortical lesion than in uninjured tissue. This suggests that after a stroke LTP is potentiated in tissue surrounding the damaged site,

perhaps to facilitate cortical reorganization and functional recovery in the surviving tissue surrounding an ischemic cortical lesion.

Taken together these studies demonstrate that LTP is essential for use-dependent cortical plasticity in the healthy brain, and this LTP is amplified in the injured brain, perhaps as a compensatory mechanism to promote functional recovery following ischemic stroke.

Conclusions

To summarize the findings from the studies discussed here: (i) a diet high in refined carbohydrates induces insulin resistance in the brain, which impairs downstream insulin receptor signaling, (ii) insulin receptor signaling is important for NMDA receptor recruitment and is therefore a regulator of LTP, (iii) LTP is important for use-dependent reorganization of the motor cortex in healthy brains, and (iv) LTP is potentiated in surviving tissue after a stroke, suggesting the importance of LTP-mediated cortical plasticity in stroke recovery.

The converging evidence from these studies provides a mechanistic explanation for why stroke patients with type-2 diabetes have poorer recovery outcomes than non-diabetic stroke patients: insulin resistance caused by diabetes impairs LTP in the CNS. This could cause a reduction in LTP potentiation in the critical post-stroke window and reduced use-dependent plasticity. This means that diabetics will be less able to establish new compensatory cortical motor pathways to develop functional recovery after a stroke. Therefore, type-2 diabetics are at an intrinsic disadvantage in their ability to induce neuroplastic change to mediate their recovery after a stroke.

Connecting insulin signaling to recovery from stroke is a very new area of research. As such, this review is limited in its analysis by the evidence available on the topic. These conclusions are based on logical conjecture from available evidence, but the proposed mechanisms here have yet to be directly tested in diabetic stroke patients. Future research should directly assess LTP in the diabetic human brain to see if there are alterations in use-dependent plasticity before a stroke is ever experienced. Research is also required to assess the impact of LTP on long-term stroke recovery, and whether this is impacted by type-2 diabetes.

A broader implication of this review is that the current treatment paradigms for management of diabetes are inadequate. The current model of type-2 diabetes care is focused almost entirely on blood sugar management, with little-to-no attempts to address insulin resistance. However, there is evidence to suggest that a low glycemic-index diet (Boden et al., 2005; Yamanouchi et al., 1995), regular exercise (Houmard et al., 2004), and supplementation with the antioxidant alpha-lipoic acid (Jacob et al., 1999) can improve insulin receptor sensitivity in type-2 diabetics. If insulin resistance can be reduced, or even reversed, then this may have important implications for post-stroke recovery. Interventional studies are required to see if an insulin-sensitizing protocol implemented soon after a stroke is experienced can improve long-term recovery outcomes in diabetics. The evidence reviewed in this paper is highly suggestive that such a treatment avenue could have therapeutic promise.

If insulin resistance impairs mechanisms of neuroplasticity then unless we directly address improving insulin sensitivity, type-2 diabetics will always be disadvantaged in

their ability to recover from ischemic stroke and will continue to experience greater levels of disability than non-diabetic stroke victims. An appreciation for the role of metabolic processes in brain health has been growing steadily over the past 10 years. We must harness this growing body of knowledge to develop better interventional and rehabilitative strategies and improve recovery after trauma to the brain.

Declaration of Conflicting Interests

The author declared they have no conflicts of interests with respect to their authorship or the publication of this article.

References

Abel, E. D., O'Shea, K. M., & Ramasamy, R. (2012). Insulin resistance: metabolic mechanisms and consequences in the heart. *Arteriosclerosis, Thrombosis, and Vascular Biology*, *32*(9), 2068–76. doi:10.1161/ATVBAHA.111.241984

Belfiore, A., Frasca, F., Pandini, G., Sciacca, L., & Vigneri, R. (2009). Insulin receptor isoforms and insulin receptor/insulin-like growth factor receptor hybrids in physiology and disease. *Endocrine Reviews*, *30*(6), 586–623. doi:10.1210/er.2008-0047

Boden, G., Sargrad, K., & Homko, C. (2005). Effect of a low-carbohydrate diet on appetite, blood glucose levels , and insulin resistance in obese patients with type-2 diabetes. *Annals of Internal Medicine. 142*(6), 403–412. doi: 10.7326/0003-4819

Borghouts, L. B., & Keizer, H. a. (2000). Exercise and insulin sensitivity: a review. *International Journal of Sports Medicine*, *21*(1), 1–12. doi:10.1055/s-2000-8847

Bravata, D. M., Wells, C. K., Kernan, W. N., Concato, J., Brass, L. M., & Gulanski, B. I. (2005). Association between impaired insulin sensitivity and stroke. *Neuroepidemiology*, *25*(2), 69–74. doi:10.1159/000086286

Houmard, J. a, Tanner, C. J., Slentz, C. a, Duscha, B. D., McCartney, J. S., & Kraus, W. E. (2004). Effect of the volume and intensity of exercise training on insulin sensitivity. *Journal of Applied Physiology*, *96*(1), 101–6. doi:10.1152/japplphysiol.00707.2003

Isharwal, S., Misra, A., Wasir, J. S., & Nigam, P. (2009). Diet & insulin resistance: a review & Asian Indian perspective. *The Indian Journal of Medical Research*, *129*(5), 485–99.

Kahn, S. E. (2003). The relative contributions of insulin resistance and beta-cell dysfunction to the pathophysiology of Type 2 diabetes. *Diabetologia*, *46*(1), 3–19. doi:10.1007/s00125-002-1009-0

Kissela, B., & Air, E. (2006). Diabetes: impact on stroke risk and poststroke recovery. *Seminars in Neurology*, *26*(1), 100–7. doi:10.1055/s-2006-933313

Mittmann, N., Seung, S. J., Hill, M. D., Phillips, S. J., Hachinski, V., Coté, R., Buck, B. H., et al. (2012). Impact of disability status on ischemic stroke costs in Canada in the first year. *The Canadian Journal of Neurological Sciences*, *39*(6), 793–800.

Miyamoto, E. (2006). Molecular Mechanism of Neuronal Plasticity : Induction and Maintenance of Long-Term Potentiation in the Hippocampus. *Journal of Pharmacological Sciences*, *442*, 433–442. doi:10.1254/jphs.

Nelson, T. J., Sun, M.-K., Hongpaisan, J., & Alkon, D. L. (2008). Insulin, PKC signaling pathways and synaptic remodeling during memory storage and neuronal repair. *European Journal of Pharmacology*, *585*(1), 76–87. doi:10.1016/j.ejphar.2008.01.051

Nudo, R. J., Plautz, E. J., & Milliken, G. W. (1997). Adaptive plasticity in primate motor cortex as a consequence of behavioral experience and neuronal injury. *Seminars in Neuroscience*, *9*(1-2), 13–23. doi:10.1006/smns.1997.0102

Park, C. R. (2001). Cognitive effects of insulin in the central nervous system. *Neuroscience and Biobehavioral Reviews*, *25*(4), 311–23. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11445137

Petrea, R. E., Beiser, A. S., Seshadri, S., Kelly-Hayes, M., Kase, C. S., & Wolf, P. a. (2009). Gender differences in stroke incidence and poststroke disability in the Framingham heart study. *Stroke*, *40*(4), 1032–7. doi:10.1161/STROKEAHA.108.542894

Reagan, L. P. (2010). Insulin-Mediated Neuroplasticity in the Central Nervous System. In S. Craft & Y. Christen, Eds., *Diabetes, insulin and Alzheimer's disease.* (43–56) Heidelberg: Springer Press. doi:10.1007/978-3-642-04300-0

Samuel, V. T., & Shulman, G. I. (2012). Mechanisms for insulin resistance: common threads and missing links. *Cell*, *148*(5), 852–71. doi:10.1016/j.cell.2012.02.017

Schwenkreis, P., El Tom, S., Ragert, P., Pleger, B., Tegenthoff, M., & Dinse, H. R. (2007). Assessment of sensorimotor cortical representation asymmetries and motor skills in violin players. *The European Journal of Neuroscience*, *26*(11), 3291–302. doi:10.1111/j.1460-9568.2007.05894.x

Wei, J. W., Heeley, E. L., Wang, J.-G., Huang, Y., Wong, L. K. S., Li, Z., Heritier, S., et al. (2010). Comparison of recovery patterns and prognostic indicators for ischemic and hemorrhagic stroke in China: the ChinaQUEST (QUality Evaluation of Stroke Care and Treatment) Registry study. *Stroke*, *41*(9), 1877–83. doi:10.1161/STROKEAHA.110.586909

Woods, S. C., Seeley, R. J., Baskin, D. G., & Schwartz, M. W. (2003). Insulin and the blood-brain barrier. *Current Pharmaceutical Design*, *9*(10), 795–800. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12678878

Yamanouchi, K., Shinozaki, T., Chikada, K., NIshikawa, T., Ito, K., Shimuzi, S., Ozawa, N., et al. (1995). Daily walking combined with diet therapy is a useful means for obese NIDDM patients not only to reduce body weight but also to improve insulin sensitivity. *Diabetes Care*, *18*(6), 775–778.

UBC Ψ UJP

University of British Columbia's
Undergraduate Journal of Psychology

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA