IS IT HEALTHY OR UNHEALTHY?

THE IMPACT OF CONFLICTING HEALTH-RELATED INFORMATION ON ATTENTIONAL RESOURCES

By

PATRICK V. BARNWELL

A thesis submitted to the

School of Graduate Studies

Rutgers, The State University of New Jersey

In partial fulfillment of the requirements

For the degree of

Master of Science

Graduate Program in Psychology

Written under the direction of

Richard J. Contrada

And approved by

New Brunswick, New Jersey

October 2020

ABSTRACT OF THE THESIS

Is it healthy or unhealthy?

The impact of conflicting health-related information on attentional resources

By PATRICK V. BARNWELL

Thesis Director:

Dr. Richard J. Contrada

Although exposure to conflicting health-related information has been described as a growing problem worldwide (Carpenter et al., 2016), limited research has been conducted investigating the cognitive impact of such information. In a review conducted by Fan (2014), it was suggested that individuals exert greater cognitive effort when attending to conflicting information compared to congruent information. Therefore, individuals may employ strategies that are less cognitively burdensome after encountering conflicting information as a result of the limited availability of cognitive resources (Carpenter et al., 2016; Metzger & Flanagin, 2013). Although these strategies assist in the management of resources, they can greatly narrow the scope and/or depth of information processing, which may result in a degradation of performance. This reduction in functioning may have important implications for the ways in which individuals are capable of attending to health-related information, attaining related knowledge, and making important health decisions (Carpenter et al., 2016). Therefore, the main purpose of the study presented in this thesis was to test the relationship between conflicting health-related information exposure and attentional mechanisms, indexed by the Attentional Network Test (ANT, Fan et al., 2002). We proposed three main hypotheses: 1) exposure to conflicting health-related information (CHRI) would increase response errors during the ANT compared to participants assigned to the no conflicting health-related information (N-CHRI) condition, 2) exposure to CHRI would decrease the efficiency of each of the ANT systems (i.e., alerting, orienting, and execute control) compared to the N-CHRI condition, and 3) exposure to CHRI would increase self-reported workload, indexed by the NASA Task Load Index (NASA-TLX, Hart & Staveland, 1988), after completion of the ANT. Data from 184 online participants were analyzed to investigate these hypotheses. The participants were randomly assigned to read an article containing either congruent or conflicting health-related information. Subsequently, they completed the ANT and NASA-TLX. Participants in the CHRI condition produced more errors and slower reaction times on the ANT, and reported higher levels of workload. Consistent with prior research (Nagler et al. 2019; Nagler, 2014), CHRI participants also reported greater feelings of nutritional confusion and backlash directed at nutritional recommendations and research after being exposed to the conflicting information. The results from these analyses suggest that exposure to conflicted-health related information has the potential to impact attentional mechanisms responsible for accurate and prompt responding to incoming information. While further investigation is certainly needed to better understand this relationship and the potential associated consequences, the findings presented in this thesis can serve as a valuable starting point.

Table of Contents

List of Tables

List of Figures

Introduction

Exposure to conflicting health-related information has been described as a growing problem worldwide (Carpenter et al., 2016). In general, conflicting health-related information can be conceptualized as “two or more health-related propositions [statements or assertions about a health-related issue] that are logically inconsistent with one another” (Carpenter et al., 2016, p. 1175). Often these health-related conflicts involve some form of messaging that entails differing points of view (e.g., whole grains offering health benefits versus having no added health value) about a specific behavior or set of behaviors (e.g., food consumption/diet) which may result in a particular health outcome(s) (e.g., heart health, risk of diabetes or stroke; Nagler & LoRusso, 2017).

As a result of being presented with conflicting information, individuals are often forced to make decisions as to which recommendations to follow, or potentially, may decide to forgo making any decision at all (i.e., “decision paralysis”; Parnell, 2012). This decision making process is further complicated by the fact that individuals may encounter conflicting health-related information from numerous sources, ranging from written materials and brochures to various forms of digital content (e.g., vlogs/blogs, social media, television broadcasts; Mashiach, Seidman, & Seidman, 2002). Content accessible via the Internet, in particular, has been shown to present an abundance of conflicting information on a variety of health-related topics (e.g., screening guidelines and vaccinations; Mashiach, Seidman, & Seidman, 2002). The ability to readily access this chaotic messaging via countless platforms (e.g., social and mass media) has greatly increased its visibility (Nagler, Fowler, & Gollust, 2015). Additionally, the growing interest in the implementation of shared health-care related decision-making in clinical settings has amplified the exposure of both patients and practitioners to conflicting health-related information (Frosch et al., 2011). The confusion that may arise from this conflicting information can cause difficulties in both making important clinical decisions, as well as providing the most appropriate recommendations (Yoon et al., 2017). As a result of this onslaught of health-related information, individuals have become increasingly expected to be able to constantly attend to various outlets and forms of messaging, thoroughly evaluate the information, and decide what to believe and how to react most appropriately (Carpenter et al., 2016). These expectations have added an additional layer of complexity to a landscape that, for many, was already arduous to navigate.

Outcomes Related to Conflicting Information Exposure

As exposure to conflicting information continues to inundate individuals' daily lives, there is a growing body of research that suggests exposure to these types of information has an effect on a wide range of outcomes (Lee, Nagler, & Wang, 2018). Nan and Daily (2015) examined the effects of conflicting online information (accessed via blogs) about the human papillomavirus (HPV) vaccine on perceived vaccine efficacy and safety. Overall, they found that exposure to these conflicting views reduced certain individuals' perceptions of the vaccine's efficacy (Nan & Daily, 2015). Similarly, Chang (2013) found that men exposed to conflicting information about health benefits related to certain foods/supplements (e.g., tofu and vitamin B6) increased their negative attitudes towards the advocated health issues, and decreased intentions to comply with the advocated behaviors. These individuals were also less likely to advise others to adopt the advocated behaviors (Chang, 2013). Thus, the impact of exposure to conflicting information may be pervasive, in that it has the ability not only to influence those initially exposed, but also individuals that interact with the exposed via information transfer. In a subsequent study, Chang (2015) found that exposure to conflicting health information lowered individuals' overall perceptions of news credibility, their willingness to adopt advocated behaviors, and their attitudes toward health research in general. These findings suggests that exposure to conflicting information may be potent enough to conjure levels of negative feelings and beliefs about nutrition recommendations (i.e., "backlash"; Nagler, 2014), which may result in adverse health behavior changes.

Research conducted by Dixon and Clark (2012) found that participants who were assigned randomly to read a news article that presented conflicting information about the link between vaccines and autism reported greater uncertainty about the vaccine-autism link, and were more likely to believe that experts were divided on the health issue. Additional research conducted by Nagler (2014) demonstrated that exposure to conflicting information on the benefits and risks of consuming certain items (e.g., wine/alcohol, fish, and coffee consumption) was associated with confusion about which foods offer the most nutritional value, and the belief that scientists frequently change their opinions. As a result, participants doubted nutritional recommendation more broadly, including health behaviors about which information was much less conflicting (e.g., exercise and vegetable consumption; Nagler, 2014).

Cognitive Impacts of Conflicting Information Exposure

While prior research suggests that exposure to conflicting information can alter outcomes related to self-reported perceptions and intentions, the cognitive impact of such information has not been rigorously investigated. In a thorough review of mechanisms related to cognitive control, Fan (2014) suggested that individuals exert greater cognitive effort when attending to conflicting information compared to congruent information (often demonstrated by prolonged reaction times and increased error rates). Thus, simplified approaches toward encoding complex information that require less cognitive effort (e.g., heuristics or rules of thumb) may be subsequently adopted by an individual as a result of the limited availability of cognitive resources (Carpenter et al., 2016; Metzger & Flanagin, 2013; Yoon et al., 2017). Although these shortcuts assist in the management of resources and mitigate loss, they can greatly narrow the scope and/or depth with which information is being processed, which can potentially result in making decisions that are at odds with a targeted outcome. For instance, an individual implementing a shortcut may choose to focus all of their available resources on a single information provider, while simultaneously excluding other potentially informative sources (e.g., focusing on a personal testimonial, instead of consulting a doctor; Carpenter et al., 2016). Individuals may also decide to attend solely to information that is easy to evaluate while disregarding important, but more complex information in an attempt to manage resources with greater efficiency (Carpenter et al., 2016). Moreover, Keselman et al. (2008) suggested that when lay individuals search for complex (and thus, resource intensive) health-related information in order to develop a better understanding of the topic, they frequently attempt to find sources of information that confirm their prior thoughts, and tend to interpret the available information in ways that are most consistent with their own beliefs (i.e., confirmation bias). This is in accordance with information theory, which suggests that individuals are more likely to search for information through a peripheral route which strengthens both cognitive bias and individuals' preference for information they already trust (Yoon et al., 2017). Although these mental strategies work to lessen the cognitive burden of coping with complex or ambiguous information, they operate at the cost of introducing increased bias. These increases in bias have the potential to limit the gathering and/or interpretations of potentially relevant information, and in turn, may result in errors in judgement (Hibbard, Slovic, & Jewett, 1997; Payne, Bettman, & Johnson, 1993; Yoon et al., 2017). In the context of health-related decision making, judgement errors due to cognitive depletion can have dire consequences, such as choosing to not partake in potentially lifesaving cancer screenings or avoiding vaccinations at the cost of possibly developing life-threatening diseases (Nagler, Yzer, & Rothman, 2019). Accordingly, a goal of this master's thesis was to better understand how cognitive depletion resulting from conflicting information exposure may impact subsequent attentional processes that are necessary to accurately process and respond to new information.

Overall, the mechanisms through which conflicting health information affects individuals' subsequent ability to attend to new information are not well understood. However, attending to health relevant information is critical to the development of pro-health behaviors, especially those that rely on greater health literacy (HHS, 2000). The U.S. Department of Health and Human Services (2000) defines health literacy as the "degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions." Low health literacy is associated with poorer health-related knowledge and comprehension (DeWalt, 2004), as well as increased hospitalizations and emergency care, and decreased mammography screenings and influenza immunizations (Berkman & Donahue, 2011).

Furthermore, lower health literacy has been associated with a poorer ability to take medications as prescribed and interpret medication labels and health messages (Berkman & Donahue, 2011).

In addition to the development of health literacy, it is a broad assumption of all theories of health behavior and health behavior change that individuals possess the ability to attend to and comprehend health-related information. This assumption is embedded in the psychoeducational components of many interventions, as well as in the Health Belief Model, the Theory of Reasoned Action/Planned Behavior, and the Information-Motivation-Behavioral Skills Model (Brewer & Rimer, 2008; Fisher & Fisher, 1992). Since the ability to attend to new information is a cornerstone, albeit frequently overlooked, on which our current understanding of health behavior and health behavior change rests, it is imperative that it be more thoroughly investigated.

The Current Thesis

The aim of this thesis is to fill a critical gap in our understanding of how exposure to conflicting health-related information influences subsequent attentional processes, a topic that is of particular importance as a result of the ever-growing prevalence of conflicting information across numerous easily accessible media sources. Prior research has focused primarily on self-report measures related to perceptions and intentions (e.g., perceptions related to efficacy of vaccinations, Mashiach, Seidman, & Seidman, 2002; and intentions related to engaging in exercise, Nagler, 2014), but to our knowledge has not investigated task based measurements of attention and behavior in this domain. While self-report measures certainly provide valuable insights into an individual's evaluation of the constructs of interest, measurements obtained from cognitive tasks have the additional benefit of being less susceptible to the response biases (e.g., social desirability, acquiescence, halo effects) that have been demonstrated to affect self-report measures, and as a result may more accurately capture the behavioral changes and underlying processes that occur as a consequence of the exposure to conflicting information. Thus, this proposal will utilize both task based and self-report measurements in an attempt to further clarify the impact of conflicting health-related information exposure on attentional processes.

For the current proposal, the basic theoretical model demonstrating the path from health communication exposure to changes in attentional capacity is presented in Figure 1. This model begins with an individual encountering a health communication. Once the individual has encountered the health communication, they may evaluate the information for internal consistency. If the information contained in the communication is determined to be congruent (i.e., the assertions presented in the messaging are consistent with one another; Carpenter et al., 2016), no additional cognitive processing is required beyond that of which is necessary to comprehend the communication, if the individual is motivated to do so. Thus, the individual's attentional capacity remains consistent or is at least not significantly diminished. However, if the individual interprets the information as conflicting, additional resources will be deployed in order to process the inconsistency. The execution of these additional resources results in a lessening of subsequent attentional capacity.

Using this model, the current thesis sought to develop and implement a novel study design that integrated both self-report and task based measurements in order to more fully elucidate the impact that exposure to conflicting health information may have on an individual's ability to attend to subsequent information. Specifically, participants were assigned randomly to a condition in which they were either asked to cognitively process congruent (i.e., consistent health-related propositions) or conflicting (i.e., health-related propositions that are inconsistent with one another) health-related information (Carpenter et al., 2016). Next, participants underwent an Attention Network Test (ANT; Fan et al., 2002). The ANT is a comprehensive behavioral index of attention that combines a cued reaction time task (Posner, 1980), and a flanker task (Eriksen & Eriksen, 1974) in order to evaluate the performance of the attention system across three types of processing: alerting, orienting, and executive control (Posner & Petersen, 1990). These systems are responsible for attaining and preserving a state of high sensitivity to incoming stimuli (alerting), orienting to information from sensory input (orienting), and resolving various forms of conflict (executive control; Posner, 2008). Prior research has found that performance on this test is decreased after the completion of tasks that deplete resources necessary for attention (Garrison, Finley, & Schmeichel, 2019), as well as after emotional stimulus exposure (Zhang, Zhou, & Zou, 2015). Following the ANT, participants completed a battery of self-report measures capturing workload (i.e., NASA Task Load Index [NASA-TLX]; Hart & Staveland, 1988), nutritional confusion (Nagler, 2014), and nutritional backlash (Nagler, 2014; Patterson et al., 2001) in order to more fully investigate the relationship between these domains, and the impact of conflicting information on attention (these measures will be elaborated upon in the Methods section).

Overall, we hypothesized that exposure to conflicting health-related information (CHRI) would significantly increase response errors during the ANT compared to that seen in participants assigned to the no conflicting health-related information (N-CHRI) condition. A Student's *t*-test was conducted in order to test this hypothesis. We also hypothesized that exposure to CHRI would decrease the efficiency of each of the ANT systems (i.e., alerting, orienting, and execute control) compared to the N-CHRI condition. A Hotelling's Two-Sample T^2 was conducted in order to test if the group means for all of the ANT systems differed. Additionally, a Student's *t*-test for each of the systems was conducted to test between groups effects for each of the ANT systems individually. Lastly, we hypothesized that exposure to CHRI would increase self-reported workload (indexed by the NASA-TLX raw score) after completion of the ANT. Similar to the prior hypotheses, we conducted a Student's *t*-test to test this hypothesis.

I. Methods

Overview

It is our hypothesis that passive exposure (i.e., being presented with information, but not having to actively utilize it) to CHRI has the potential to deplete cognitive resources, leading to decreased performance (increased errors/decreased network efficiency) on the Attention Network Test (ANT, Fan et al., 2002). We proposed that these lapses in accuracy and changes in attentional efficiency occur as a direct result of the additional cognitive resources required to process the prior conflicting information. Therefore, the ANT was used in this thesis as a proxy for one's ability to subsequently attend to new information, and respond in a timely and appropriate manner after conflicting information exposure. The battery of assessments that followed the ANT were included to measure constructs that may be broadly related to information processing and affective responses to conflicting information. In the section that follows, the measures and procedure will be more fully outlined to provide a concise, yet comprehensive overview of the study's methodology.

Participant Recruitment

Participants were recruited via Amazon Mechanical Turk (MTurk; https://www.mturk.com/). MTurk is an online platform run by Amazon.com, Inc. (https://www.amazon.com), in which "workers" (i.e., participants) can complete web-based tasks posted on the MTurk website for monetary compensation. These posts are frequently referred to as human intelligence tasks, or HITs, and can involve a variety of tasks ranging from completing surveys and user experience based activities to translating text into a specific language. Since its inception, MTurk has increasingly been utilized as a subject pool for social science research, as it has the ability to provide a more demographically diverse sample of U.S. adults than typical undergraduate subject pools (Buhrmester, Kwang, & Gosling, 2011), and yields data of comparable or better quality (Paoliacci & Chandler, 2014). Additionally, MTurk samples tend to more accurately represent the demographics of the national population than samples collection from undergraduate subject pools (Chandler & Shapiro, 2016). On average, MTurk workers' median age of 33 years (Paolacci, Chandler, & Ipeirotis, 2010) is closer to that of the national population than the ungraduated population options (median age of national population: 38.2 years; CIA, 2016). Furthermore, MTurk workers' income distribution maps onto that of the U.S. population more closely than student populations (Paolacci, Chandler, & Ipeirotis, 2010). Thus, MTurk lends itself well to studies, such as the one presented in this thesis, that benefit from a fairly demographically diverse sample of U.S. adults who can complete tasks administered via the Internet. Inclusion criteria for this study were: 1) over the age of 18, 2) ability to read and speak English fluently, 3) currently residing in the US, and 4) at least a 95% approval rating for performance on MTurk. Exclusion criteria for this study were: 1) inability to provide informed consent, and 2) severe visual impairments.

Based on a statistical power analysis (please see Figure 2) conducted for sample size estimation using an alpha = .05, power = 0.80, and an effect size = 0.4, an approximate *N* = 200 (i.e., 100 in each group) was needed for the between groups comparisons (‘pwr’ R package; Champely, 2018). In order to account for potential attrition and outlier rates, the sample size for this study was increased by approximately 20%. In total, 234 adult participants were recruited. It should be noted, that due to the limited research exploring the topic of conflicting information and its impact on attention, the selected effect size is not based on prior literature. Rather, the small effect size of 0.4 was based on the consideration that both the stimulus exposure and level of conflict contained in the stimulus are minimal, and thus, a small, but meaningful effect size was expected.

Measures

Health-Related Information Stimuli (Appendix B)

The health-related stimuli implemented in this study were adapted from Jung, Walsh-Childers, and Kim’s (2016) study investigating factors that may influence the perceived credibility of online sources that provide diet and nutritional information. These stimuli were originally developed to focus on whole grain consumption, as a result of reports suggesting a general trend toward increases in whole grain intake (American Dietetic Association [ADA], 2008), as well as a growing body of research exploring the health benefits related these grains (e.g., McIntosh et al., 2003). Thus, it was believed that this topic may be relevant to a broad range of individuals, but it would not be confounded by the strong emotional responses that may be elicited by other, potentially traumatic health-related topics (e.g., cancer screenings). While the purpose of Jung et al.'s (2016) study was to compare how perceived expertise (high versus low) of the information source, combine with the accuracy of the information provided (high versus low) may influence perceived credibility, the focus of the present study was only to investigate the impact on attention of providing information that is conflicting. Therefore, the stimuli were stripped of the expertise component, and were made to be similar in length, with the same number of actors (two professors), and appropriate in reading difficultly for the targeted population. Additionally, instead of manipulating accuracy of information, the conflicting information stimulus used in this study explicitly presented positions on the topic of whole grain intake that contradict each other.

Attentional Network Test (ANT)

The Attentional Network Test (ANT, Fan et al., 2002) is a comprehensive behavioral index of attention that merges a cued reaction time task (Posner, Synder & Davidson, 1980) and a flanker task (Eriksen & Eriksen, 1974) in order to evaluate the functioning of the attention system across three types of processing: alerting, orienting, and executive control (Posner & Petersen, 1990). Each trial of the ANT consisted of five events. The events began with a fixation period set to a random variable duration (400-1600 msec). This was followed by a warning cue that was presented for 100 msec, and then a fixation period for 400 msec. After this, the target and flankers were presented until a response was recorded, or the 1700 msec threshold was reached. Subsequently, the target and flankers disappeared, and a post fixation period for a variable duration (i.e., 3500 msec minus duration of the first fixation minus reaction time) was presented. Following this period, the next trial began. In total, there were 3 blocks containing 96 trial sequences, with each trial sequence lasting for exactly 4000 msec (see Figure 3 for a graphical representation).

To measure the changes in latency due to the alerting effect, two warning conditions were utilized: no-cue, and double-cue. During the no-cue trials, participants viewed only a fixation cross for 100 msec. For the double-cue trials, two warning cues appeared above and below the fixation cross. To derive the alerting effect score the mean reaction time for the correct double-cue trials was subtracted from the mean reaction time from the correct no-cue trials (Fan et al., 2002). The rationale for this design is that the appearance of the double-cue alerted the participant to the onset of the impending target, and since the warning was not present in the no-cue condition the reaction time difference provides a measure of alerting efficiency (McConnell & Shore, 2011).

In order to measure the changes in latency due to the orienting effect, the center-cue and spatial-cues were implemented. During the center-cue trials, participants were shown an asterisk at the location of the fixation cross for 100 msec. For the spatial trials, a warning cue appeared above or below the fixation cross. The warning cue always appeared in the correct location of the target, and thus, was always valid. To derive the orienting effect score the mean reaction time for the correct spatial-cue trials was subtracted from the mean reaction time for the correct center-cue trials (Fan et al., 2002). For these trials the spatial cue notified the participant as to the exact location of the stimulus. Thus, when the participant encountered the spatial cue, they were able to orient their attention to the location of the target prior to its appearance (McConnell & Shore, 2011). This resulted in a reaction time difference between the central and spatial cue conditions, which provided an index of orientation efficiency.

Lastly, to measure the changes in latency due to the executive control effect, the cue conditions across all trials were utilized. To derive the executive control effect score the mean reaction time for the correct congruent flanker trials were subtracted from the mean reaction time from the correct incongruent flanker trials (Fan et al., 2002). For the incongruent targets in these trials participants processed the conflicting information provided simultaneously by the target and flanker arrows. Conversely, during the congruent target displays, the flanker and target arrows provided participants with identical information, therefore, no conflict resolution was required. Thus, the reaction time difference between the congruent and incongruent arrow stimuli provided a measure of executive control efficiency.

The error rates during the ANT were computed by dividing the summed response errors across all trials by total trial count. This proportion served as an index of response accuracy (i.e., one's ability to respond appropriately). Lastly, average reaction times (RTs) were computed by dividing the summed RTs across all correct trials divided by the total number of trials. This numeric served as an index of average latency to respond (i.e., one's ability to respond promptly). This test has been applied in a wide range of investigations such as developmental (e.g., Rueda et al., 2004), clinical (e.g., Togo et al., 2015), psychiatric (e.g., Backes et al., 2011), neuroimaging (e.g., Xiao et al., 2016), and genetic studies (e.g., Fosella et al., 2002). The split-half reliability for the networks in this task is satisfactory, with a range between 0.588-0.684 (Wang et al., 2015).

Therefore, it was expected that this task would provide a valid and reliable index of attentional networks.

NASA Task Load Index (NASA-TLX; Appendix 3)

The NASA Task Load Index (NASA-TLX; Hart & Staveland, 1988) is one of the most widely used self-report instruments to assess overall subjective workload. The underlying assumption of the instrument is that the combination of responses to its 6 items (e.g., "How mentally demanding was the task?") represent the overall workload experienced by the respondent (Hart, 2006). These six items were measured on a 21-point Likert scale. In order to compute a raw workload index, the numeric responses for the items were summed together, and then divided by six. A higher score represented a greater level of perceived workload experienced by the respondent. The NASA-TLX has been shown to be a valid and reliable measure of this construct, and has been cited in over 4,400 studies (Hart, 2006). Prior research exploring the reliability of the NASA-TLX found it to be highly correlated (> 0.90) with other measures of workload (e.g., Subjective Workload Assessment Technique and Workload Profile; Battiste & Bortolussi, 1988; Hill et al., 1992), thus suggesting that it possess strong convergent validity. Furthermore, repeated measures reliability has shown correlations of .77 (Battiste & Bortolussi, 1988).

Nutritional Confusion Scale (Appendix C)

The Nutritional Confusion Scale is a six item (e.g., "It is not always clear to me what foods are best for me to eat") self-report measure reported on a five-point Likert scale, ranging from "Strongly agree" (1) to "Strongly disagree" (5). This scale was developed by Nagler (2014) to explore individual differences in confusion arising from nutritional information and research (i.e., "perceived ambiguity about nutrition recommendations and research"; Nagler, 2014, p. 2). The scale score is derived by summing the six items together, so that a higher score represents greater confusion. Prior research exploring the psychometric properties of the scale suggested that it demonstrated adequate internal consistency (α = .77; Nagler, 2014). Furthermore, a principal components analysis provided evidence that the scale possesses the proposed unidimensional structure (Nagler, 2014).

Nutritional Backlash Scale (Appendix C)

The Nutritional Backlash Scale is a six item (e.g., "I am tired of hearing about what foods I should or should not eat") self-report measure reported on a five-point Likert scale, ranging from "Strongly agree" (1) to "Strongly disagree" (5). The scale was created to explore individual differences in backlash resulting from nutritional information recommendations and research exposure (i.e., "negative beliefs about nutrition recommendations and research"; Nagler, 2014, p. 2). This scale was adapted from Patterson et al.'s (2001) 11-item scale by Nagler (2014) in order to more precisely capture the properties of the construct of interest. In order to derive the scale score, the six items are summed together, so that a higher score represents greater backlash. Prior research exploring the psychometric properties of the scale suggested that it demonstrated adequate internal consistency (α = .71; Nagler, 2014). Additionally, a principal components analysis was conducted to investigate the dimensionality of the scale. The results from this analysis suggested that the scale possessed a unidimensional structure (Nagler, 2014).

Procedure

Data Collection

Participants were recruited via a posting on Amazon Mechanical Turk (MTurk). The posting stated that if the participant consented to participate in this study they would be asked to read a brief health-related article, complete a game, and respond to a series of questionnaires. After consenting to participate, the participant was assigned randomly to read either the congruent (N-CHRI condition) or conflicting health-related article (CHRI condition). Subsequently, participants were directed to the Inquisit Web platform (https://www.millisecond.com/) to complete the ANT (i.e., the "game"). Inquisit Web is a flexible online platform that utilizes a web browser plugin to precisely capture a wide range of psychological and cognitive assessments (for an overview of the reliability of Web-based testing interfaces please see Pinet et al., 2017).

Following the ANT, participants completed the NASA-TLX, and items related to general information contained in the article (used to evaluate if basic comprehension was achieved). After this, the nutritional confusion and nutritional backlash scales were administered randomly. Lastly, the participants completed the demographic items, viewed the debriefing statement, and received compensation upon submission of their work (please see Figure 4 for the study flowchart). Participants were compensated $2.50 for completing the 40 minute online study.

Participants

In total, 234 adult participants were recruited via a HIT posting on MTurk. Following the data treatment procedures outlined below, 184 participants remained (83 Male, 98 Female, 3 "Prefer Not to Respond", M_{age} = 42.66, age range = 22-76 years).

The sample consisted of 73% White, 10% African American, 7% Multiracial, 4% Asian, 3% Hispanic, 2% “Other”, and 1% Middle Eastern participants. All participants were over 18 years old, resided in the United States, possessed at least a 95% acceptance rate for their work on MTurk, reported no severe visual impairments, and reported being able to speak and read the English language fluently.

In accordance with recommendations for the detection and treatment of implausible values and probabilistic outliers, a series of techniques were implemented to improve the quality and distribution of the collected data (Kittur et al., 2008; DeSimone et al., 2015; Keith et al., 2017). First, five attention check items were embedded throughout the survey portion of the study that followed the ANT. These attention check items prompted the participant to select a predefined response (e.g., “Strongly Agree” on a Likert scale). Participants that failed to respond correctly to more than two of these items were excluded from analyses (please see Table 1 for frequencies).

Two items were then used to evaluate the participant’s basic comprehension of the article that served as the vehicle for the experimental manipulation. These asked the participant to select the primary topic of the article (i.e., “whole grains”), and whether the article displayed at the beginning of the study described a debate about a health topic. If the participant responded that the article was primarily about a topic other than whole grains, and/or if they responded that the article contained no debate in the CHRI condition (or that it contained conflict in the N-CHRI), the participant’s data were excluded from analyses.

Lastly, in order to identify outliers on the ANT, *z*-scores were computed for each participant, by condition, for the overall percent correct, as well as for the reaction times for each of the ANT effects (i.e., alerting, orienting, and executive control). Participants with a *z*-score greater than 2 or less than -2 for the overall percent correct, or greater than 3 or less than -3 for each of the effects reaction times, were excluded from analyses. These thresholds were selected based on careful evaluation of the overall distribution of values for each of these variables. The frequency and percent of occurrence for each of these techniques can also be found in Table 1.

II. Results

Differences in Attention Network Test Error Rates

Three primary hypotheses were proposed for this study in order to investigate the relationship between conflicting information exposure and attentional mechanisms. First, it was hypothesized that the group exposed to conflicting health-related information (CHRI) would have greater response error rates during the ANT compare to participants assigned to the no conflicting health related information condition (N-CHRI). In order to test this hypothesis, the proportion data were first subjected to an arcsine transformation (McDonald, 2014). This was a necessary step in order to make the data more closely conform to the assumptions of the statistical test (e.g., normality, homogeneity of variance, independence of means and variability), given the presence of negative skew in the raw data. The skew was as expected with a task of this nature when administered to neurotypical participants, since the majority of participants score in the upper percent range. Using the arcsine transformed data, a Student's *t*-test was conducted. Levene's test indicated unequal variances (F = 13.39, p = .000). Thus, the statistics reported here are calculated with equal variance not assumed (i.e., Welch's *t*-test). The results suggested that there was a meaningful difference in the overall correct response rate for the participants assigned to the CHRI condition (*M* = 95.27, *SD* = 6.28) compared to those assigned to the N-CHRI condition (*M* = 97.56, *SD* = 1.95); t (132) = 3.02, p = .003, d = .45[1]. Therefore, participants who were exposed to conflicting information appeared to make a greater number of errors on the ANT when compared to participants who encountered information lacking conflict (Figure 5). In addition to a greater number of errors, the CHRI group (*M* = 526.07, *SD* = 130.95) also demonstrated longer latencies to respond to the ANT stimuli during correct trials than did the N-CHRI group (*M* = 492.43, *SD* = 72.53); t (132) = -2.12, p = .04, d = -.32 (Figure 6).

Differences in Attentional Networks Efficiency

This study's second hypothesis proposed that exposure to CHRI would decrease the effectiveness of each of the three ANT systems compare to participants assigned to the N-CHRI. In order to test if the group means for all of the ANT systems were different, the data were subjected to a Hotelling's Two-Sample T^2. Results from this statistical analysis demonstrated no multivariate effect for the relationship between condition and the ANT systems, Hotelling's $T(3, 177) = .99$, $p = .40$, partial $\eta^2 = .02$. Similarly, univariate analyses exploring each of the relationships between condition and system demonstrated no effect for alerting $F(1, 180) = 2.22$, $p = .14$, partial $\eta^2 = .01$; orienting, $F(1, 180) = .60$, $p = .44$, partial $\eta^2 = .003$; or executive control, $F(1, 180) = .29$, $p = .59$, partial $\eta^2 = .002$ (Figure 7).

Differences in Self-Reported Workload

Lastly, it was hypothesized that exposure to CHRI would increase self-reported workload (indexed by the NASA-TLX raw score, which demonstrate an $\alpha = .69$ in this

---

[1] Means and standard deviations reported here are in untransformed units for ease of interpretation.

sample) after completion of the ANT. In order to test this hypothesis, the data were submitted to a Student's *t*-test. This univariate test revealed a meaningful difference in the self-reported workload for the participants assigned to the N-CHRI (M = 8.58, SD = 3.74) compared to participants assigned to the CHRI condition (M = 10.49, SD = 4.25); t (181) = -3.23, p = .001, d = -.47 (Figure 8). These results suggest that participants in the CHRI condition perceived a greater workload during the ANT when compared to those that encountered congruent information.

Differences in Self-Reported Nutritional Confusion and Backlash

In additional to the three hypotheses discussed above, two exploratory analyses were conducted. These analyses explored the relationship of conflicting information exposure to both nutritional confusion and nutritional information backlash. Nutritional confusion and nutritional information backlash were measured using the nutritional confusion and nutritional backlash scales developed by Nagler (2014). In the current study both scales reached acceptable reliability, α = 0.85 and α = 0.81, respectively. A Student's *t*-test was first conducted to investigate the relationship between condition and nutritional confusion. This analysis revealed differences in the self-reported nutritional confusion for the participants assigned to the N-CHRI (M = 12.17, SD = 4.72) compared to participants assigned to the CHRI (M = 14.66, SD = 4.85); t (132) = -2.49, p = .003, d = -.51 (Figure 9). These results suggest that after participants were exposed to conflicting health related information they experienced a greater sense of nutritional confusion compared to those in the congruent condition.

Lastly, a Student's *t*-test was conducted in order to investigate the relationship between condition and nutritional information backlash. This analysis revealed differences in self-reported nutritional information backlash for the participants assigned to the N-CHRI (*M* = 13.42, *SD* = 4.66) compared to those assigned to the CHRI (*M* = 15.29, *SD* = 4.68); *t* (132) = -2.32, *p* = .02, *d* = -.39 (Figure 10). Similar to the nutritional confusion findings, these results suggest that the participants exposed to conflicting information experienced greater feelings of backlash targeted broadly at nutritional information and research compared to those in the congruent condition. Both of these findings are consistent with findings presented in prior literature (e.g., Nagler, 2014; Clark et al., 2019).

III. Discussion

The aim of this thesis was to fill a critical gap that we believe exists in our current understanding of how exposure to conflicting health-related information influences subsequent attentional processes. In order to investigate this, we randomly assigned participants to read articles that contained either congruent (i.e., assertions that are consistent with one another; Carpenter et al., 2016) or conflicting (i.e., assertions that are inconsistent when presented together; Carpenter et al., 2016) information about the potential health benefits of whole grain consumption. Subsequently, the participants were administered an attention test that indexed three proposed attentional networks (i.e., alerting, orienting, and executive control). Following this test, responses to self-report instruments were recorded to capture individual differences in task workload, nutritional confusion, and nutritional backlash. Through implementing these methodologies, we sought to provide a foundational exploration of the impact of conflicting health-related information (CHRI) exposure on both attentional performance and associated self-report measures.

Consistent with what was proposed in our first hypothesis, it appears that individuals exposed to CHRI demonstrated differences in their ability to consistently identify the target stimulus. Specifically, individuals assigned to the CHRI condition made more errors than those in the N-CHRI group at an aggregate level. Moreover, those exposed to conflicting information demonstrated greater average latencies (e.g., a slowing) to respond. Thus, it seems plausible that attentional mechanisms required for greater performance during the ANT were degraded by the resource intensive evaluation necessary to process the conflict present in the article. This finding is somewhat consistent with prior ego depletion literature where manipulations that require participants to actively engage in a task (e.g., the Stroop or a writing task) can increase error rates or decrease the speed in which these individuals respond on a subsequent performance task (Garrison, Finley, & Schmeichel, 2019). An interesting distinction in the work presented in this thesis is that the manipulation used was, in our opinion, quite minimal. Thus, it appears that a similar pattern of degradation in attentional resources can occur even when presented with a manipulation that does not require the participant to engage in a task that demands active participation.

Contrary to our second hypothesis, the results from this study suggested that there was no multivariate effect for the relationship between condition and the ANT systems. This finding is in line with Garrison et al. (2019) who also found no multivariate effect for the ANT networks after participants completed a controlled writing task which was proposed to deplete resources necessary for attentional performance. Overall, this result may suggest that while there is a general deficit in accuracy and processing speed at an aggregate level for the CHRI participants, the changes in RT that are present as a result of cues that assist with processing (e.g., a spatial cue versus a center cue during the spatial trials) or limit interference (as is the case during the congruent executive control trials) during each of the networks is proportionally similar in each group. Since this thesis contained only neurotypical participants, it seems reasonable to assume that the general operation of the attentional networks was comparable among participants, especially when aggregated. Thus, the changes in performance that occurred as a function of being provided information that assisted with processing (or lessened interference) induced a similar effect in both groups, albeit with different RT starting points.

Lastly, consistent with our third hypothesis, individuals in the CHRI condition reported a greater level of workload during the ANT. In general, this finding seems to suggest that individuals exposed to conflicting information found it necessary to exert greater effort in order to accomplish their level of performance during the ANT. As Fan (2014) noted, greater cognitive effort is exerted when attending to conflicting information compared to congruent information. Thus, it may have been necessary for the CHRI participants to initiate this greater effort on the ANT due to the prior cognitive impact caused by the conflict presented in the manipulation. Even with the exertion of this greater effort, the CHRI group was unable to perform at a comparable level to the N-CHRI group from an overall error and speed perspective. This may suggest that while the CHRI group attempted to put forth greater effort, the amount of resource available or effort leveraged was not enough to overcome the effect of the manipulation.

In addition to these findings, results from two exploratory analyses investigating nutritional confusion and backlash towards nutritional recommendations and research suggested that brief exposure to conflicting health related information has the potential to increase self-reported feelings of both confusion and backlash. These results echo the findings from Nagler et al. (2019), who found that self-reported backlash and confusion increase as the level of exposure to conflicting information (in their study, related to mammograms) was manipulated. Therefore, in addition to the cognitive difficulty involved in reasoning the propositions present in the conflict, it may be the case that affective responses to the conflict also lessen resources available to attentional mechanisms.

While not the focus of this thesis, we would be remiss if we did not point out that motivation most certainly plays an important role in how deeply information is processed, and thus, how much resource is allocated. Prior research has suggested that motivational states can greatly influence how much cognitive effort individuals are willing to exert, and subsequently, which strategies they employ in order to complete the task at hand (Ferdinand & Czernochowski, 2018). Depending on the motivational state, the strategies chosen may not focus on optimizing task performance, but rather, may strike a compromise between effort invested and performance (Ferdinand & Czernochowski, 2018). Therefore, an individual that is currently in a low motivational state may choose to sacrifice performance in favor of conserving effort. In the context of conflicting information exposure, individuals viewing the information would need to possess enough motivation to exert the effort to read and evaluate the information in order to actually detect the conflict. In situations where individuals do not possess this minimal amount of motivation, the premise of the information would not be captured (and thus, the conflict would go unnoticed). It may also be the case, that in certain instances an individual possess enough initial motivation to evaluate the conflicting health-related information, but subsequently decides the effort required to continue on to something new is not worth the further exertion of resources. This decision may be made due to the complexity contained in the initial information, which required greater effort to evaluate, and as a result the ratio of effort to performance reached an unacceptable threshold. Thus, a lessening of effort would serve as a strategy directed at reinstating a more desirable ratio at the cost of a potential decrease in performance.

Limitations

Although we believe this study provides preliminary evidence that supports the possibility that brief exposure to conflicting health-related information can reduce resources necessary for accuracy and speed on an attentional test, as well as increased self-reported levels of nutritional confusion and backlash (which replicates prior findings in the literature), it possesses several limitations that will be outlined in this section. First, while it was expected that there would be loss of data due to the nature of the study (i.e., asking participants to read an article that may not be of interest to them, and then having them complete a task that can be fatiguing), the amount of loss is notable (approximately 21%), however it was distributed approximately equally in each group (26 N-CHRI and 24 CHRI participants were flagged as probabilistic outliers). While we do not believe this introduced a bias that would systematically alter the results of one group over another, we are unable to definitively confirm this. Thus, the results contained in this thesis should be interpreted with this limitation in mind.

Another limitation of this study is the somewhat narrow investigation of factors involved in changes in attentional resources. Since this thesis was developed to serve as a foundational work that could be built upon, the measures included were kept to a minimum in order to focus on the main relationship of interest (i.e., conflicting information and its impact on attentional performance). However, in doing so, other potentially meaningful factors such as motivation and affect were not explored. Given that this study provides preliminary evidence supporting the broad concept we set forth to test, it seems reasonable that a next step would be to attempt to parse out ancillary factors that may be able to provide additional insight into the complex relationship that exists between conflicting information exposure and attentional mechanisms.

Lastly, since this study took place in an online environment, using measures that served as indices of constructs, it is difficult to accurately estimate the extent to which these findings are able to be generalized to real-life settings (i.e., external validity). While this level of understanding is not a requisite for experimental research, in the case of determining how conflicting information exposure may negatively alter an individual's ability to optimally function in their daily life, it would certainly be desirable. Thus, studies in real-life environments where participants are likely to encounter conflicting information (e.g., clinical settings) would help to better illuminate the potential "real" consequences of conflicting information exposure. Furthermore, the design of this study was such that the CHRI participants immediately completed the attention task after exposure to the conflicting health-related information. Thus, further exploration would be needed to determine if exposure to conflicting information has any enduring effects on attention or other related domains.

Implications

Overall, the results from this study suggest that exposure to conflicting health-related information may subsequently reduce an individual's ability to closely attend and accurately respond to incoming information. This reduction in ability may have important implications for the ways in which individuals are capable of seeking and attending to health-related information, attaining related knowledge, and ultimately, making important health decisions (Carpenter et al., 2016). For example, if an individual has less cognitive resources available due to the impact of conflicting information exposure, and is therefore unable to attend to new information efficiently, they may be forced to rely on the information previously obtained when making crucial decisions or delay the decision completely until additional cognitive resources become available. Both, making under informed or delayed health-related decisions have the potential to result in undesirable outcomes, especially when compared to a more prompt and well-informed decision-making approach. Thus, it seems that special care should be taken in clinical settings to ensure that the messaging provided (both in the environment, and by providers and staff) is consistent so that patients are able to concentrate all of their available resources on the information and decisions at hand. While this certainly would not limit the amount of exposure the patient experiences outside of this setting, it may create an environment that is conducive to optimal resource management while discussing important health-related issues and concerns.

Additionally, based on the study reported in this thesis, as well as prior work by Nagler et al. (2019; Nagler, 2014), it appears conflicting information exposure also has the potential to increase feelings of confusion and backlash directed at recommendations and research. Taken in conjunction with the lessening of attentional ability, these feelings may also contribute to suboptimal decision-making. For example, individuals that are experiencing greater confusion related to an important health issue in which an informed decision must be made will likely have a difficult time coming to a resolution, all the while spending precious cognitive resources (which in turn may lessen the amount of resources that can be made available to the decision-making process). Moreover, feelings of backlash may motivate an individual to not even explore information related to a health concern ("What do they know anyway"), and/or completely doubt any information they encounter regardless of the value it may provide. Thus, the interaction between conflicting health-related information exposure, confusion, and backlash may play a significant role in the ways in which individuals are capable of attending to and evaluating information, as well as their general willingness to seek it out.

Conclusion

The study presented in this thesis sought to explore the impact of conflicting health-related information exposure on attentional mechanisms. The results from this study suggest that individuals exposed to conflicting health-related information experienced a reduction in attentional resources that are necessary for accurate and prompt responding, when compared to individuals exposed to congruent information. Additionally, as prior research by Nagler et al. (2019; Nagler, 2014) has suggested, conflicting health-related information exposure appears to increase both feelings of confusion and backlash directed towards scientific recommendations and research. One of the main contributions of this work is that it provides preliminary evidence that even brief exposure to conflicting information about a fairly benign topic (i.e., whole grains) has the potential to impact attentional mechanisms indexed by a performance measure. While further exploration is surely needed to better understand this relationship, components of which are briefly discussed in the limitations section, we feel the findings presented in this thesis act as a strong foundation on which future research can build upon when conceptualizing a broad range of studies related to information/media exposure, clinical recommendations/encounters, attentional processes, and health decision-making.

References

American Dietetic Association. (2008). Nutrition and You: Trends 2008. Report and Results. Retrieved from http://www.eatrightpro.org/~/media/eatrightpro%20files/media/trends%20and%20reviews/nutrition%20and%20you/trends_2008_presentation.ashx

Backes, V., Kellermann, T., Voss, B., Krämer, J., Depner, C., Schneider, F., & Habel, U. (2011). Neural correlates of the attention network test in schizophrenia. *European Archives of Psychiatry and Clinical Neuroscience*, *261*(S2), 155–160. https://doi.org/10.1007/s00406-011-0264-9

Berkman, N. D., & Donahue, K. (2011). Low Health Literacy and Health Outcomes: An Updated Systematic Review. *Annals of Internal Medicine,155*(2), 97-116. https://doi.org/10.1059/0003-4819-155-2-201107190-00005

Brewer, N. T., & Rimer, B. K. (2008). Perspectives on health behavior theories that focus on individuals. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), Health behavior and health education: Theory, research, and practice (pp. 149-165). San Francisco, CA, US: Jossey-Bass.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A New Source of Inexpensive, Yet High-Quality, Data? *Perspectives on Psychological Science*, *6*(1), 3–5. https://doi.org/10.1177/1745691610393980

Carpenter, D. M., Elstad, E. A., Blalock, S. J., & DeVellis, R. F. (2014). Conflicting Medication Information: Prevalence, Sources, and Relationship to Medication Adherence. *Journal of Health Communication*, *19*(1), 67–81. https://doi.org/10.1080/10810730.2013.798380

Carpenter, D. M., Geryk, L. L., Chen, A. T., Nagler, R. H., Dieckmann, N. F., & Han, P. K. J. (2016). Conflicting health information: a critical research need. *Health Expectations: An International Journal of Public Participation in Health Care and Health Policy*, *19*(6), 1173–1182. https://doi.org/10.1111/hex.12438

Central Intelligence Agency. (2016). United States. In The world factbook. Retrieved from https://www.cia.gov/library/publications/the-world-factbook/geos/us.html

Champely, S. (2018). pwr: Basic Functions for Power Analysis. R package version 1.2-2. https://CRAN.R-project.org/package=pwr

Chandler, J., & Shapiro, D. (2016). Conducting Clinical Research Using Crowdsourced Convenience Samples. *Annual Review of Clinical Psychology*, *12*(1), 53–81. https://doi.org/10.1146/annurev-clinpsy-021815-093623

Chang, C. (2013). Men's and Women's Responses to Two-Sided Health News Coverage: A Moderated Mediation Model. *Journal of Health Communication*, *18*(11), 1326–1344. https://doi.org/10.1080/10810730.2013.778363

Chang, C. (2015). Motivated Processing: How People Perceive News Covering Novel or Contradictory Health Research Findings. *Science Communication*, *37*(5), 602–634. https://doi.org/10.1177/1075547015597914

Clark, D., Nagler, R. H., & Niederdeppe, J. (2019). Confusion and nutritional backlash from news media exposure to contradictory information about carbohydrates and dietary fats. *Public Health Nutrition*, *22*(18), 3336–3348. https://doi.org/10.1017/S1368980019002866

DeSimone, J. A., Harms, P. D., & DeSimone, A. J. (2015). Best practice recommendations for data screening: DATA SCREENING. *Journal of Organizational Behavior*, *36*(2), 171–181. https://doi.org/10.1002/job.1962

DeWalt, D. A., Berkman, N. D., Sheridan, S., Lohr, K. N., & Pignone, M. P. (2004). Literacy and health outcomes: A systematic review of the literature. *Journal of General Internal Medicine*, *19*(12), 1228–1239. https://doi.org/10.1111/j.1525-1497.2004.40153.x

Dixon, G. N., & Clarke, C. E. (2013). Heightening Uncertainty Around Certain Science: Media Coverage, False Balance, and the Autism-Vaccine Controversy. *Science Communication*, *35*(3), 358–382. https://doi.org/10.1177/1075547012458290

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics*, *16*(1), 143–149. https://doi.org/10.3758/BF03203267

Fan, J. (2014). An information theory account of cognitive control. *Frontiers in Human Neuroscience*, *8*. https://doi.org/10.3389/fnhum.2014.00680

Fan, J., McCandliss, B. D., Sommer, T., Raz, A., & Posner, M. I. (2002). Testing the Efficiency and Independence of Attentional Networks. *Journal of Cognitive Neuroscience*, *14*(3), 340–347. https://doi.org/10.1162/089892902317361886

Ferdinand, N. K., & Czernochowski, D. (2018). Motivational Influences on Performance Monitoring and Cognitive Control Across the Adult Lifespan. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.01018

Fisher, J. D., & Fisher, W. A. (1992). Changing AIDS-risk behavior. *Psychological Bulletin*, *111*(3), 455–474. https://doi.org/10.1037/0033-2909.111.3.455

Frosch, D. L., Moulton, B. W., Wexler, R. M., Holmes-Rovner, M., Volk, R. J., & Levin, C. A. (2011). Shared decision making in the United States: policy and implementation activity on multiple fronts. *Zeitschrift Für Evidenz, Fortbildung Und Qualität Im Gesundheitswesen*, *105*(4), 305–312. https://doi.org/10.1016/j.zefq.2011.04.004

Garrison, K. E., Finley, A. J., & Schmeichel, B. J. (2019). Ego Depletion Reduces Attention Control: Evidence From Two High-Powered Preregistered Experiments. *Personality and Social Psychology Bulletin*, *45*(5), 728–739. https://doi.org/10.1177/0146167218796473

Hart, S. G. (2006). Nasa-Task Load Index (NASA-TLX); 20 Years Later. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *50*(9), 904–908. https://doi.org/10.1177/154193120605000909

Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. In Advances in Psychology (Vol. 52, pp. 139–183). https://doi.org/10.1016/S0166-4115(08)62386-9

HHS (U.S. Department of Health and Human Services). (2000). *Healthy People 2010: Understanding and Improving Health.* Washington, DC: U.S. Department of Health and Human Services. Retrieved from https://www.cdc.gov/nchs/healthy_people/hp2010.htm

Hibbard, J. H., Slovic, P., & Jewett, J. J. (1997). Informing Consumer Decisions in Health Care: Implications from Decision-Making Research. *The Milbank Quarterly*, *75*(3), 395–414. https://doi.org/10.1111/1468-0009.00061

Inquisit 5 [Computer software]. (2016). Retrieved from https://www.millisecond.com

Jung, E. H., Walsh-Childers, K., & Kim, H.-S. (2016). Factors influencing the perceived credibility of diet-nutrition information web sites. *Computers in Human Behavior*, *58*, 37–47. https://doi.org/10.1016/j.chb.2015.11.044

Keith, M. G., Tay, L., & Harms, P. D. (2017). Systems Perspective of Amazon Mechanical Turk for Organizational Research: Review and Recommendations. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.01359

Keselman, A., Browne, A. C., & Kaufman, D. R. (2008). Consumer health information seeking as hypothesis testing. *Journal of the American Medical Informatics Association: JAMIA*, *15*(4), 484–495. https://doi.org/10.1197/jamia.M2449

Kittur, A., Chi, E. H., & Suh, B. (2008). Crowdsourcing user studies with Mechanical Turk. *Proceeding of the Twenty-Sixth Annual CHI Conference on Human Factors in Computing Systems - CHI '08*, 453. https://doi.org/10.1145/1357054.1357127

Lee, C., Nagler, R. H., & Wang, N. (2018). Source-specific Exposure to Contradictory Nutrition Information: Documenting Prevalence and Effects on Adverse Cognitive and Behavioral Outcomes. *Health Communication*, *33*(4), 453–461. https://doi.org/10.1080/10410236.2016.1278495

McConnell, M. M., & Shore, D. I. (2011). Mixing measures: Testing an assumption of the attention network test. *Attention, Perception, & Psychophysics*, *73*(4), 1096–1107. https://doi.org/10.3758/s13414-010-0085-3

McDonald, J.H. (2014). *Handbook of biological statistics* (3rd ed.). Balitmore, Maryland: Sparky House Publishing.

McIntosh, G. H., Noakes, M., Royle, P. J., & Foster, P. R. (2003). Whole-grain rye and wheat foods and markers of bowel health in overweight middle-aged men. *The American Journal of Clinical Nutrition*, *77*(4), 967–974. https://doi.org/10.1093/ajcn/77.4.967

Mashiach, R., Seidman, G. I., & Seidman, D. S. (2002). Use of mifepristone as an example of conflicting and misleading medical information on the internet. *BJOG: An International Journal of Obstetrics and Gynaecology*, *109*(4), 437–442. https://doi.org/10.1111/j.1471-0528.2002.t01-1-01124.x

Metzger, M. J., & Flanagin, A. J. (2013). Credibility and trust of information in online environments: The use of cognitive heuristics. *Journal of Pragmatics*, *59*, 210–220. https://doi.org/10.1016/j.pragma.2013.07.012

Nagler, R. H. (2014). Adverse outcomes associated with media exposure to contradictory nutrition messages. *Journal of Health Communication*, *19*(1), 24–40. https://doi.org/10.1080/10810730.2013.798384

Nagler, R. H., Fowler, E. F., & Gollust, S. E. (2015). Covering Controversy: What Are the Implications for Women's Health? *Women's Health Issues: Official Publication of the Jacobs Institute of Women's Health*, *25*(4), 318–321. https://doi.org/10.1016/j.whi.2015.04.011

Nagler, R. H., & LoRusso, S. M. (2017). Conflicting Information and Message Competition in Health and Risk Messaging. In R. H. Nagler & S. M. LoRusso, Oxford Research Encyclopedia of Communication. https://doi.org/10.1093/acrefore/9780190228613.013.292

Nagler, R. H., Yzer, M. C., & Rothman, A. J. (2019). Effects of Media Exposure to Conflicting Information About Mammography: Results From a Population-based Survey Experiment. *Annals of Behavioral Medicine*, *53*(10), 896–908. https://doi.org/10.1093/abm/kay098

Nan, X., & Daily, K. (2015). Biased Assimilation and Need for Closure: Examining the Effects of Mixed Blogs on Vaccine-Related Beliefs. *Journal of Health Communication*, *20*(4), 462–471. https://doi.org/10.1080/10810730.2014.989343

Paolacci, G., Chandler, J., & Ipeirotis, P. G. (2010). Running experiments on Amazon Mechanical Turk. *Judgment and Decision Making*, *5*, 411–419. https://doi.org/10.1177/0963721414531598

Parnell, G. S. (Ed.). (2012). *Handbook of decision analysis* [Electronic resource]. Hoboken, NJ: Wiley.

Patterson, R. E., Satia, J. A., Kristal, A. R., Neuhouser, M. L., & Drewnowski, A. (2001). Is There a Consumer Backlash Against the Diet and Health Message? *Journal of the American Dietetic Association*, *101*(1), 37–41. https://doi.org/10.1016/S0002-8223(01)00010-4

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1993). *The adaptive decision maker*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139173933

Pinet, S., Zielinski, C., Mathôt, S., Dufau, S., Alario, F.-X., & Longcamp, M. (2017). Measuring sequences of keystrokes with jsPsych: Reliability of response times and interkeystroke intervals. *Behavior Research Methods*, *49*(3), 1163–1176. https://doi.org/10.3758/s13428-016-0776-3

Posner, M. I. (1980). Orienting of attention: Then and now. *The Quarterly Journal of Experimental Psychology*, *32*(1), 3–25. https://doi.org/10.1080/17470218.2014.937446

Posner, M. I. (2008). Measuring Alertness. *Annals of the New York Academy of Sciences*, *1129*(1), 193–199. https://doi.org/10.1196/annals.1417.011

Posner, M. I., & Petersen, S. E. (1990). The Attention System of the Human Brain. *Annual Review of Neuroscience*, *13*(1), 25–42. https://doi.org/10.1146/annurev.ne.13.030190.000325

R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/

Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., & Posner, M. I. (2004). Development of attentional networks in childhood. *Neuropsychologia*, *42*(8), 1029–1040. https://doi.org/10.1016/j.neuropsychologia.2003.12.012

Togo, F., Lange, G., Natelson, B. H., & Quigley, K. S. (2015). Attention network test: Assessment of cognitive function in chronic fatigue syndrome. *Journal of Neuropsychology*, *9*(1), 1–9. https://doi.org/10.1111/jnp.12030

Xiao, M., Ge, H., Khundrakpam, B. S., Xu, J., Bezgin, G., Leng, Y., Zhao, L., Tang, Y., Ge, X., Jeon, S., Xu, W., Evans, A. C., & Liu, S. (2016). Attention Performance Measured by Attention Network Test Is Correlated with Global and Regional Efficiency of Structural Brain Networks. *Frontiers in Behavioral Neuroscience, 10*. https://doi.org/10.3389/fnbeh.2016.00194

Yoon, H., Sohn, M., Choi, M., & Jung, M. (2017). Conflicting Online Health Information and Rational Decision Making: Implication for Cancer Survivors. *The Health Care Manager*, *36*(2), 184–191. https://doi.org/10.1097/HCM.0000000000000159

Zhang, H., Zhou, R., & Zou, J. (2015). Modulation of executive attention by threat stimulus in test-anxious students. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.01486

Appendix A

Tables

Table 1.

Outlier Distribution

Outlier Type	Outlier Frequency	Outlier Percent
Attention Check	8	3.4 %
Comprehension	30	12.8 %
+/-3 SD Percent Correct	13	5.6 %
+/-2 SD Alerting Effect	3	1.3 %
+/-2 SD Orienting Effect	3	1.3 %
+/-2 SD Executive Control Effect	5	2.1 %

Note. The outlier frequency and percent represent total number for each criterion. However, it was possible for participants to be counted across criteria for exceeding multiple thresholds.

Table 2.

Correlations between Study Variables

	ANT Percent Correct (Arcsine)	ANT Overall RT	ANT Alerting	ANT Orienting	ANT Executive Control	NASA-TLX	Nutritional Confusion	Nutritional Backlash
ANT Percent Correct (Arcsine)	-							
ANT Overall RT	-0.075	-						
ANT Alerting	-0.026	-0.145	-					
ANT Orienting	0.139	-0.033	0.030	-				
ANT Executive Control	-0.101	0.149*	-0.147*	0.198**	-			
NASA-TLX	-0.420**	0.155*	-0.143	-0.208**	-0.062	-		
Nutritional Confusion	-0.198*	0.199*	-0.035	-0.045	0.065	0.330**	-	
Nutritional Backlash	-0.026	0.101	-0.012	-0.012	-0.019	0.217**	0.641**	-

Note. *$p \leq 0.05$, **$p \leq 0.01$.

Figures

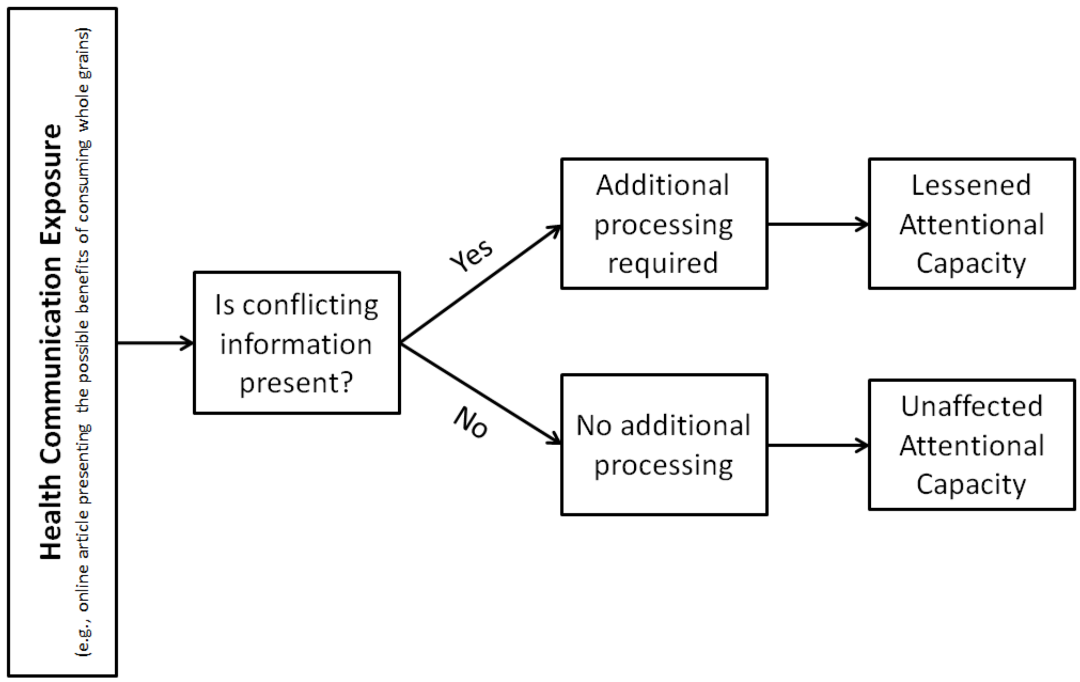

Figure 1. Theoretical model describing the path from health communication exposure to attentional capacity

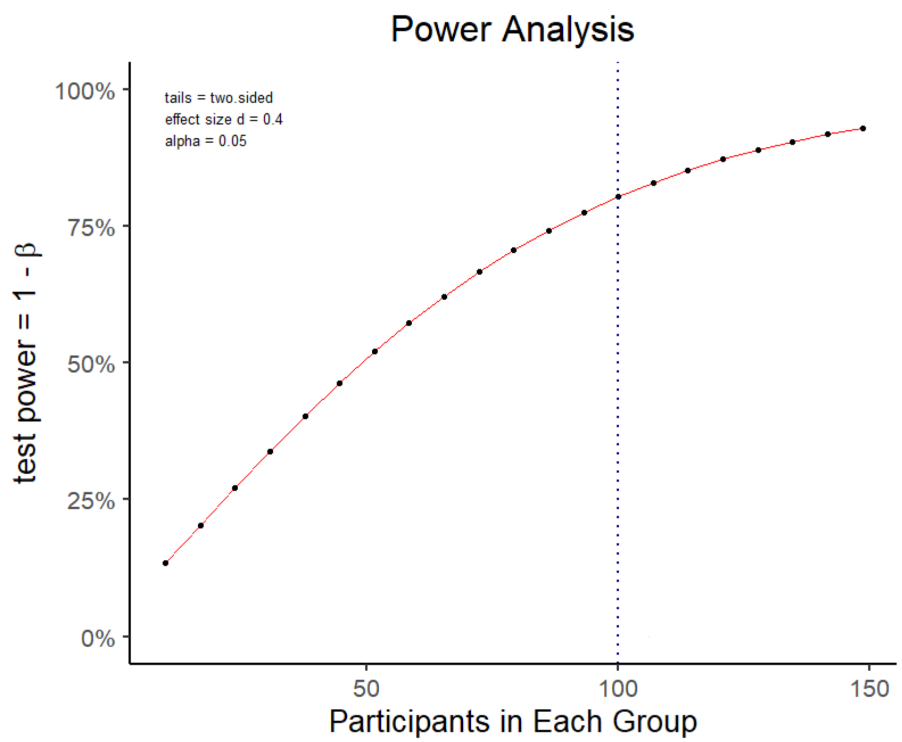

Figure 2. Power analysis results for between groups comparisons

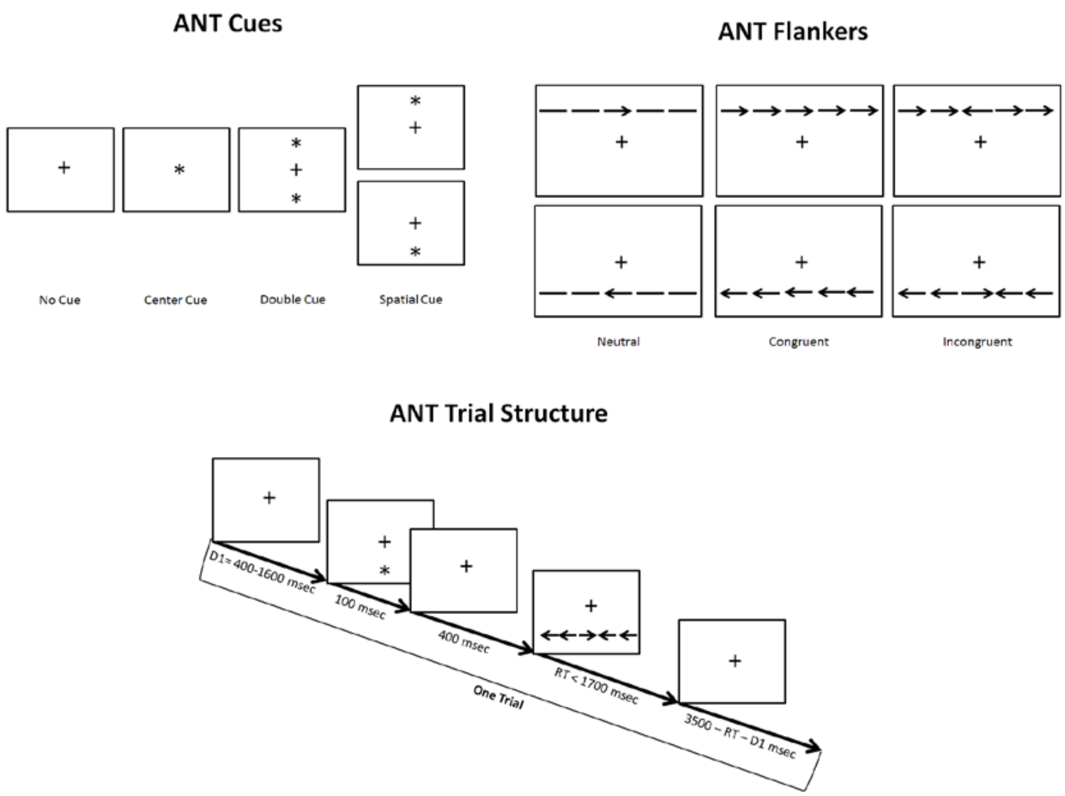

Figure 3. ANT Components and Trial Structure (Figure adapted from Fan et al., 2002)

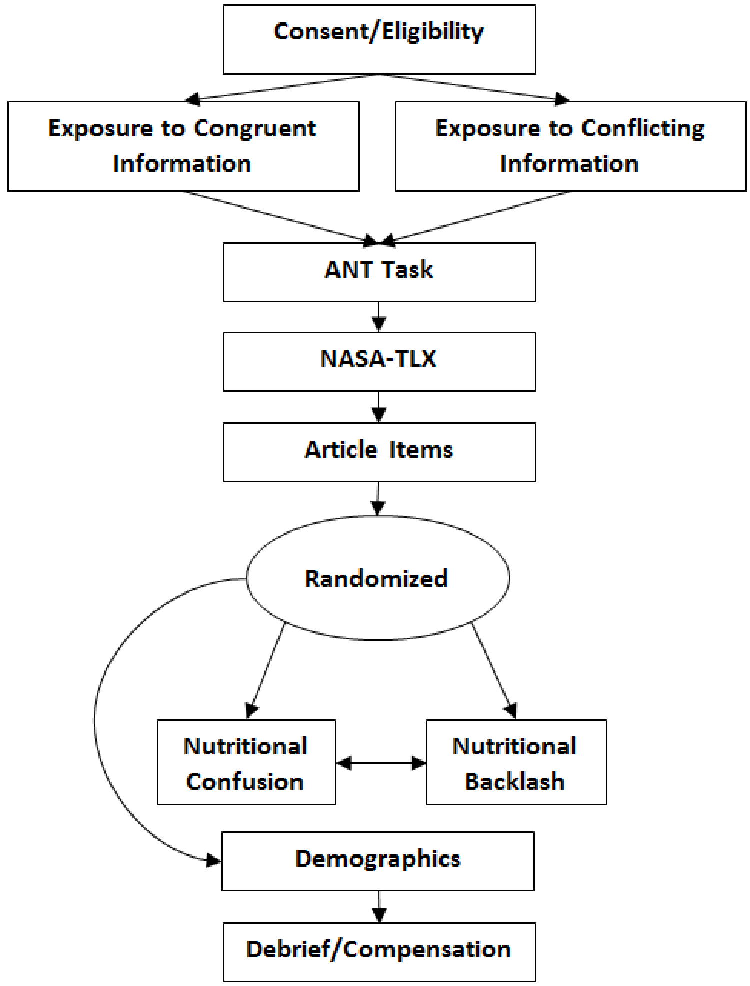

Figure 4. Study design flowchart

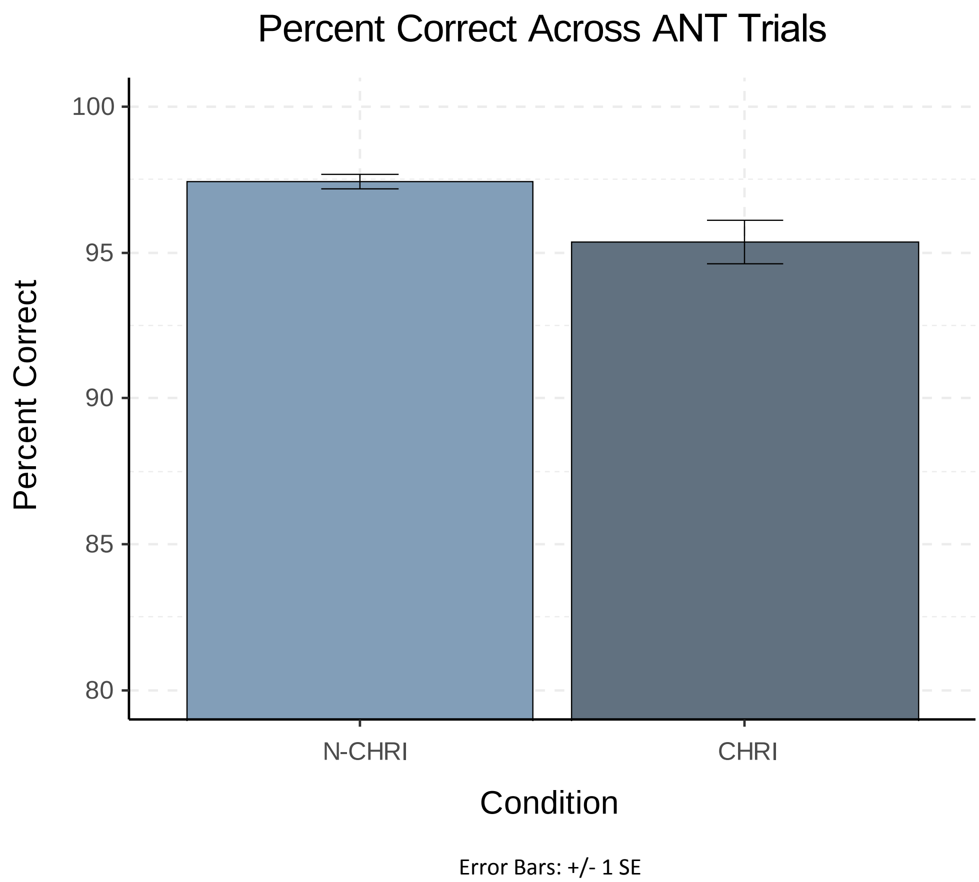

Figure 5. Mean percent of correct trials on the ANT for each condition in untransformed units

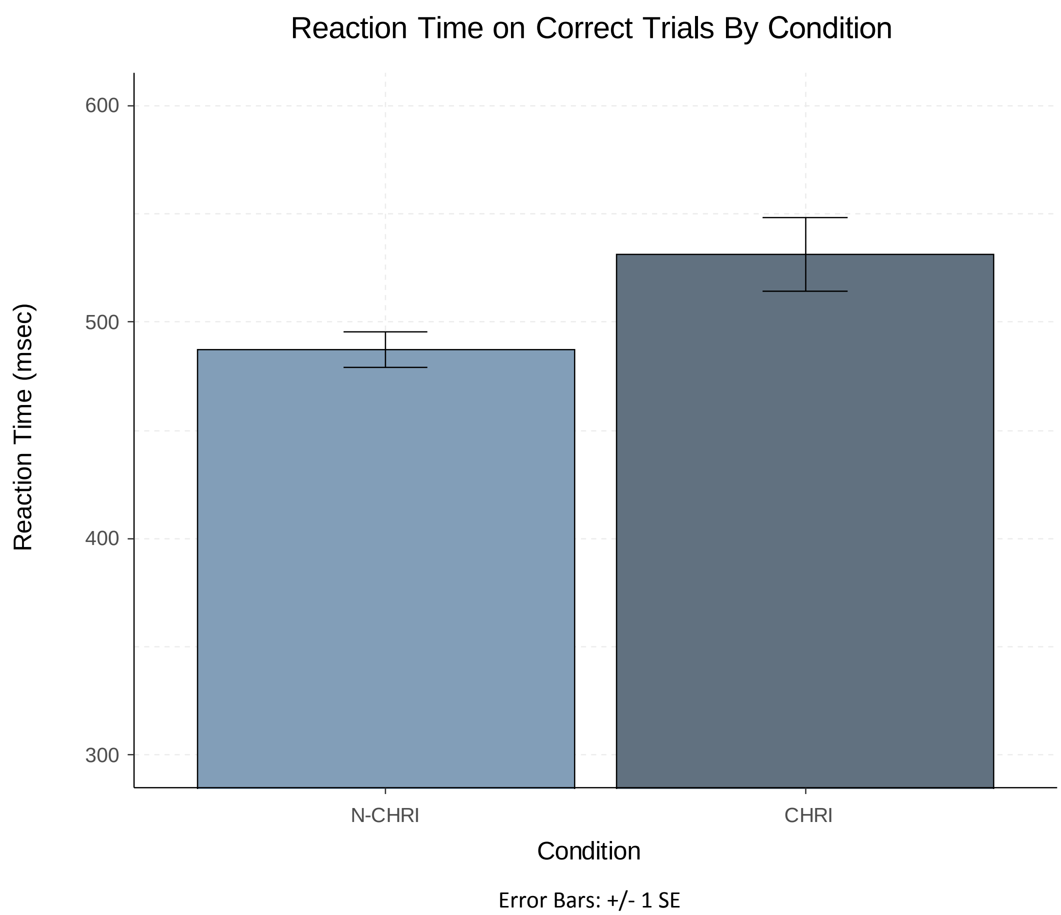

Figure 6. Mean reaction time of correct trials on the ANT for each condition

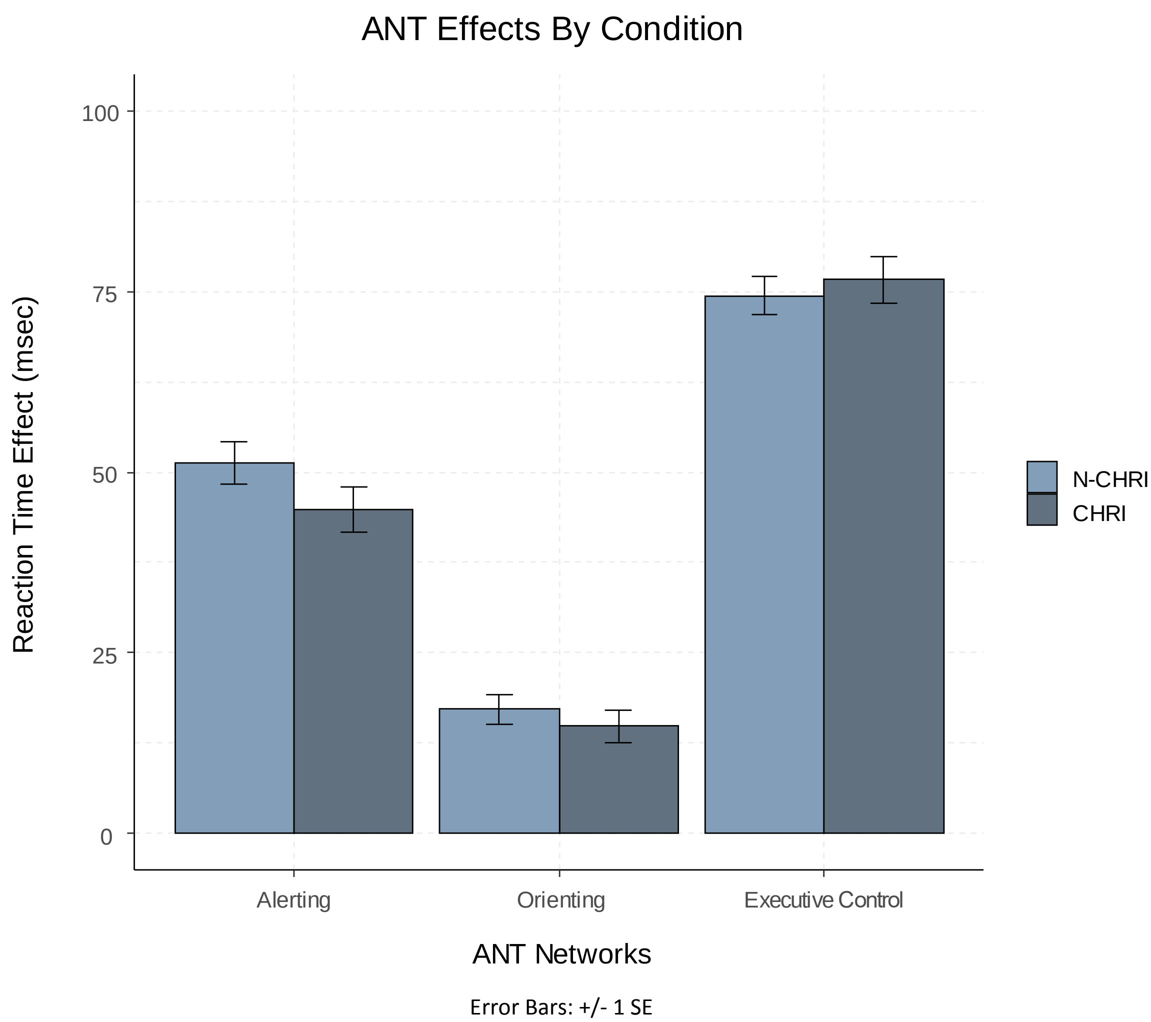

Figure 7. Mean effects for each of the three ANT networks for each condition

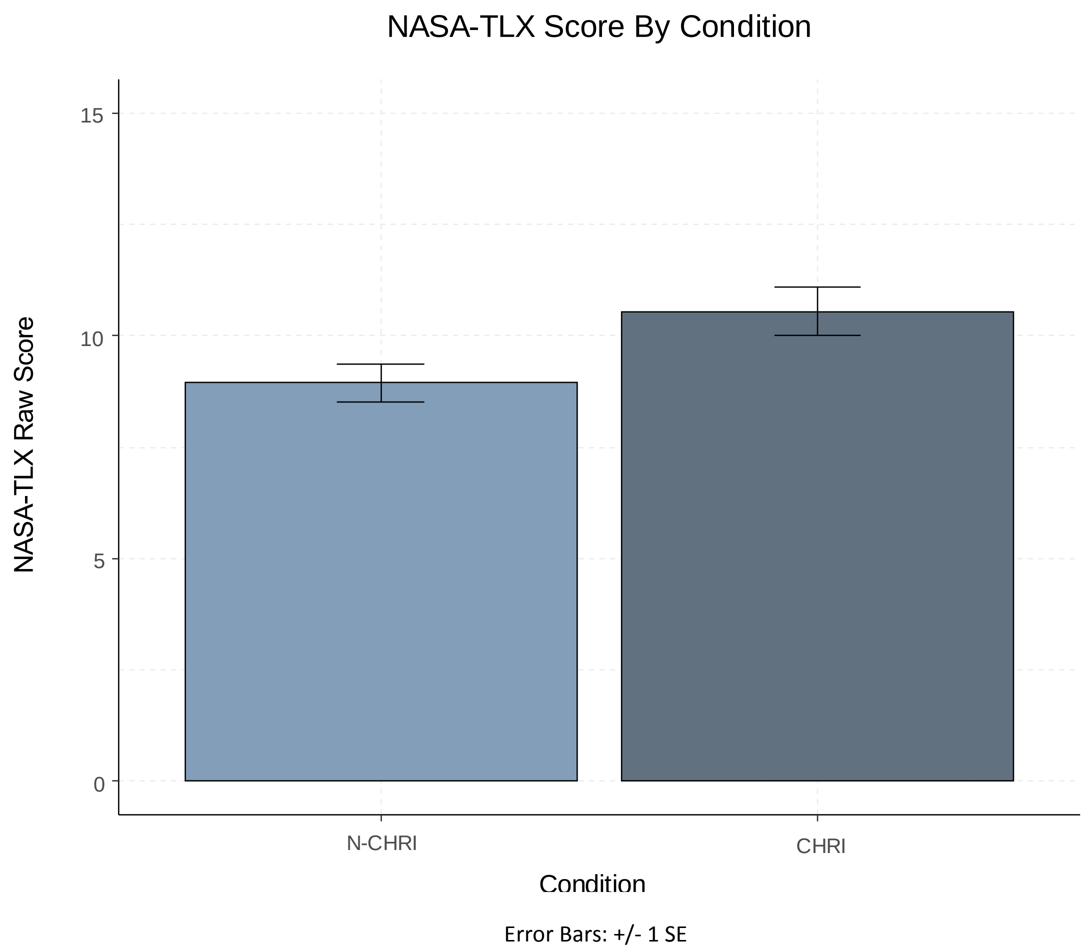

Figure 8. Mean NASA-TLX raw score for each condition

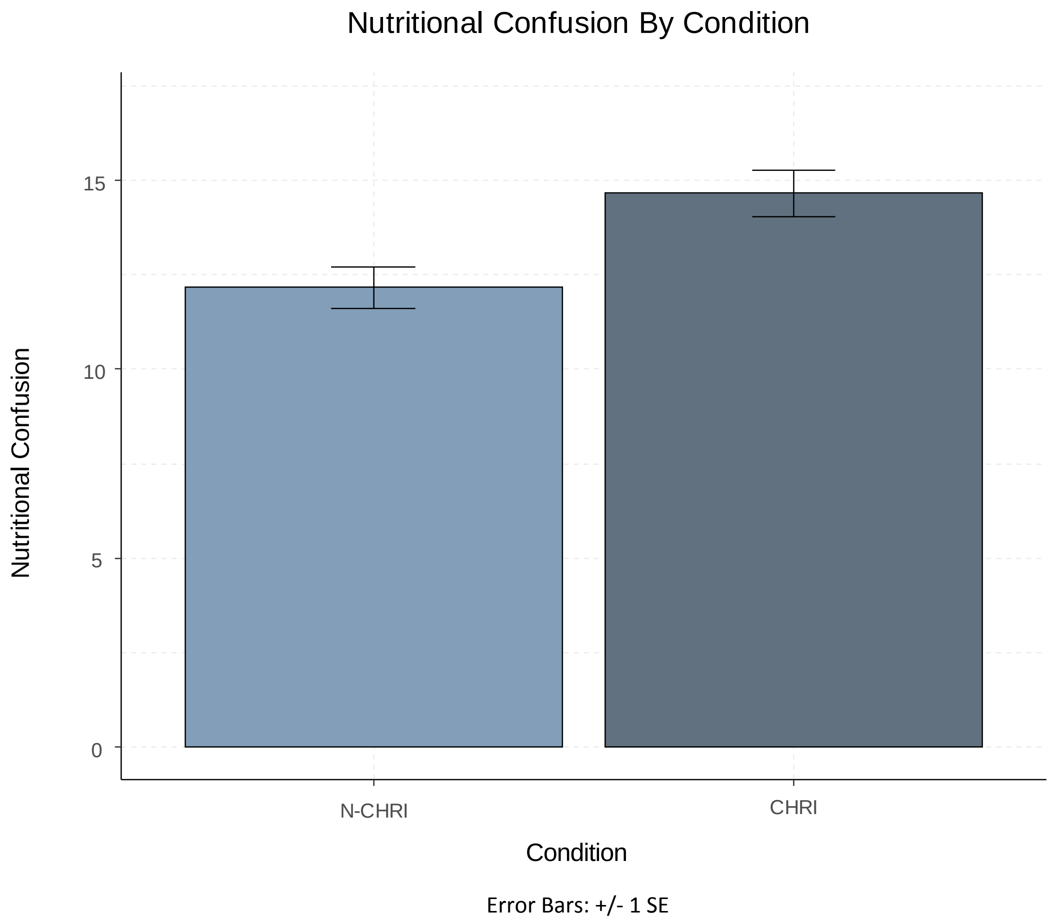

Figure 9. Mean nutritional confusion score for each condition

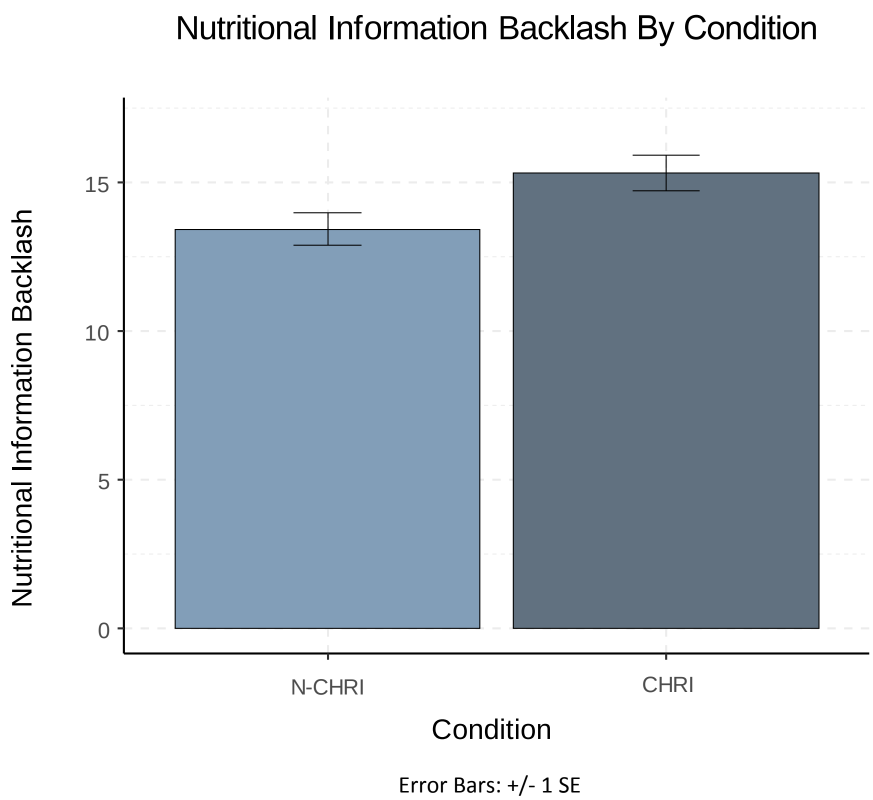

Figure 10. Mean nutritional information backlash score for each condition

Appendix B

Congruent Information Stimulus (Adapted from Jung et al., 2016)

Please read the following article very carefully.

You will be asked questions about this article later in the session.

Whole Grains = Whole Health

Lona Sandon, an assistant professor of clinical nutrition at UT Southwestern Medical Center, says it's important to keep whole grains in your diet.

'Research shows that whole grains are good for your heart, lower risk of diabetes, and stroke, and may help prevent certain cancers,' she says. 'They also help in managing weight.'

Additionally, Rebecca Strickler, an assistant professor of clinical nutrition at the UW Madison Medical School, says whole grains are full of nutrients including fiber, folate and niacin, vital B vitamins, and magnesium. These nutrients make whole grain foods significantly healthier than non-whole-grain foods. 'The phytochemicals found in whole grains have been shown to have health promoting and disease prevention benefits,' she adds.

Experts recommend that adults aim for three servings, or 48 grams, of whole grains a day. Be sure to look for the words 'Made with whole grain' and '100 percent whole grain' on the packages.

Conflicting Information Stimulus (Adapted from Jung et al., 2016)

Please read the following article very carefully.

You will be asked questions about this article later in the session.

Whole Grains = Whole Health?

Lona Sandon, an assistant professor of clinical nutrition at the UT Southwestern Medical Center, says it's important to keep whole grains in your diet.

'Research shows that whole grains are good for your heart, lower risk of diabetes, and stroke, and may help prevent certain cancers,' she says. 'They also help in managing weight.'

However, Rebecca Strickler, an assistant professor of clinical nutrition at the UW Madison Medical School, says whole grain foods are not significantly different from non-whole-grain foods in terms of their nutrient levels, including fiber, folate and niacin, vital B vitamins, and magnesium. 'Researchers do not know yet whether the phytochemicals found in whole grains have health promoting and disease prevention benefits,' she adds.

Among experts, there is still an ongoing debate as to the potential health benefits of whole grains, and what the appropriate serving amount would be for adults if any benefits exist.

Appendix C

Measures

NASA Task Load Index (Hart & Staveland, 1988)

Below are a series of questions that relate to the task you just completed. Please select a mark on the scales below to indicate your response to each question as it relates only to the immediately prior task.

1. How mentally demanding was the task?
   Very Low Very High

2. How physically demanding was the task?
   Very Low Very High

3. How hurried or rushed was the pace of the task?
   Very Low Very High

4. How successful were you in accomplishing what you were asked to do?
   Perfect Failure

5. How hard did you have to work to accomplish your level of performance?
   Very Low Very High

6. How insecure, discouraged, irritated stressed, and annoyed were you?
   Very Low Very High

Nutritional Confusion (Nagler, 2014)

1. It is not always clear to me what foods are best for me to eat

   Strongly Disagree Strongly Agree

   1 2 3 4 5

2. I find nutrition recommendations to be confusing

   Strongly Disagree Strongly Agree

   1 2 3 4 5

3. Nutrition research findings make sense to me (Reverse Scored)

   Strongly Disagree Strongly Agree

   1 2 3 4 5

4. I know what I should be eating to stay healthy (Reverse Scored)

   Strongly Disagree Strongly Agree

   1 2 3 4 5

5. I find nutrition research studies hard to follow

   Strongly Disagree Strongly Agree

   1 2 3 4 5

6. I understand scientists' recommendations about what foods I should eat (Reverse Scored)

   Strongly Disagree Strongly Agree

   1 2 3 4 5

Nutritional Backlash (Nagler, 2014; Patterson et al., 2001)

1. I am tired of hearing about what foods I should or should not eat
   Strongly Disagree Strongly Agree
   1 2 3 4 5

2. Scientific research provides good guidance about the best foods to eat (Reverse Scored)
   Strongly Disagree Strongly Agree
   1 2 3 4 5

3. The evidence about healthy food choices is growing (Reverse Scored)
   Strongly Disagree Strongly Agree
   1 2 3 4 5

4. Dietary recommendations should be taken with a grain of salt
   Strongly Disagree Strongly Agree
   1 2 3 4 5

5. Scientists really don't know what foods are good for you
   Strongly Disagree Strongly Agree
   1 2 3 4 5

6. I pay attention to new research on food and nutrition (Reverse Scored)
   Strongly Disagree Strongly Agree
   1 2 3 4 5

Demographic Items

1. How old are you? _______________
2. What is your date of birth (MM/DD/YYYY): _______________
3. What is your gender?
    - o Male
    - o Female
    - o Prefer not to respond
    - o Other (Please Specify): _______________

4. Which category best describes you (select all that apply)?
    - o African American or Black
    - o Asian American or Asian (e.g., Japanese, Chinese, Korean)
    - o South Asian American or South Asian (e.g., Indian, Pakistani, Afghani, Bangladeshi)
    - o Southeast Asian American or Southeast Asian (e.g., Cambodian, Laotian, Vietnamese)
    - o Middle Eastern or North African (e.g., Lebanese, Iranian, Egyptian)
    - o Native Hawaiian, Pacific Island American, or Pacific Islander
    - o Hispanic, Latino, or Spanish origin
    - o Native American, American Indian, or Alaskan Native
    - o White
    - o Other: _______________