5-2021

Attribute Framing Effect as a Function of Selective Auditory Frequency Amplification

Nicole Marie DeSimone
Montclair State University

Abstract

A set of cognitive biases that have been associated with functional asymmetry of the brain's hemispheres are framing effects. The attribute framing effect is when valenced descriptive messages – "frames" – influence judgements towards the topic of the message consistent with the valence of the frame. Evidence suggests that information processing in the right hemisphere contributes to framing effects. Double Filtering by Frequency (DFF) theory asserts that the hemispheres are biased to process sensory information based upon relative frequencies, with the right hemisphere dominantly responding to stimuli containing relatively lower frequencies. Previous work links differential processing by the right hemisphere, through exposure to relatively lower frequency stimuli, as a method of strengthening framing effects. Specifically, a method in which the lower range of audio frequencies in the voice of a spoken message are selectively amplified relative to the higher frequencies, has been shown to increase the effect of attribute framing. The present study aimed to extend this research on the attribute framing effect through the usage of selective auditory frequency amplification (SAFA). Utilizing a task-irrelevant mode of presenting the auditory stimulus, it was hypothesized that music containing a selectively amplified relatively lower range of frequencies would activate the right hemisphere relative to the left. Because the right hemisphere may be more responsive to effects of framing, presentation of relatively lower frequencies was expected to enhance the framing effect via right hemisphere activation. The current work does not find support for the usage of task-irrelevant SAFA to increase the effect of attribute framing. Potential reasons for the findings are discussed.

Keywords: framing effect, attribute framing, cerebral lateralization, decision making

MONTCLAIR STATE UNIVERSITY

Attribute Framing Effect as a Function of Selective Auditory Frequency Amplification

by

Nicole Marie DeSimone

A Master's Thesis Submitted to the Faculty of

Montclair State University

In Partial Fulfillment of the Requirements

For the Degree of

Master of Arts

May 2021

College of Humanities and Social Sciences

Department of Psychology

Thesis Committee:

[redacted]

Ruth E. Propper, Ph.D
Thesis Sponsor

[redacted]

Joshua Sandry, Ph.D

[redacted]

John Paul Wilson, Ph.D

Attribute Framing Effect as a Function of Selective Auditory Frequency Amplification

A THESIS

Submitted in partial fulfillment of the requirements

For the degree of Master of Arts

by

Nicole Marie DeSimone

Montclair State University

Montclair, NJ

2021

Acknowledgements

Throughout the process of completing this project, I received an overwhelming amount of support and assistance that must be acknowledged. I especially owe the completion of this project to my committee chair and research mentor, Dr. Propper – none of this would have been possible without her great deal of help. She has made science persist even throughout a global pandemic – this has taught me a great deal about what it takes to be successful in my career. Secondly, I would like to extend my thanks to my committee members, Dr. Sandry and Dr. Wilson. I appreciate the time and effort it has taken in helping me put my thesis together. I would also like to thank Sophia Lall and Melissa Villafana for their efforts in data collection and helping put together the materials for this work.

I wish to give an endless amount of gratitude to my parents for their support throughout my educational journey. My being a first-generation student and academic has been a learning curve for *all* of us and I would not be here if it were not for them. Additionally, I would like to thank my boyfriend, Ariel, for being my biggest support system throughout the past two years.

Lastly, I dedicate this work to my cousin Elena Vitale. Your memory and honor are in everything that I do.

Contents

Attribute Framing Effect as a Function of Selective Auditory Frequency Amplification

Framing Effects

The framing effect is a psychological phenomenon underlying decision making, in which the wording used in a message impacts the way people feel about the subject. Context and choice of words used – the "frame" – leads people to conceptualize the subject in a particular way (McCormick & Seta, 2012). First described by Tversky & Kahneman (1981), the effect was presented through the idea of a "decision-frame" in which people based their decisions upon subtle differences in language usage that are unconsciously perceived. Perceived potential outcomes of decisions are thus based upon the impression given about the choices by the wording of the options. An option that is described in a positive manner will be preferable to a decision-maker because it evokes a positive association and seems more attractive (Krishnamurthy et al., 2001). A meta-analysis of over 200 studies of decision-making and framing found that the framing effect is a reliable psychological phenomenon across various research designs with small to moderate effect sizes (Kuhberger, 1998).

While most early studies of the framing effect focused on the context of risky decision making, it was later proposed that there are variations of the framing effect. Levin, Schneider, & Gaeth (1998) suggested three distinct types of framing – risky-choice, goal framing, and attribute framing. Risky choice framing involves options for a decision that vary in their level of potential risks. The classic example of risky choice framing, upon which subsequent research on the framing effect is built upon, is known as the "Asian disease problem" (Tversky & Kahneman, 1981). In this study, a situation was presented in which a new disease was expected to arise in the U.S. and kill 600 people – participants had to make a choice between two programs that were proposed to fight the illness. In the first condition ($N = 152$), the *risk averse* scenario, the described options were that Program A would save 200 people – not mentioning the 400 guaranteed deaths – while Program B expected only 1/3 of a chance of saving all 600 people, with a 2/3 chance of saving none of them. 72% of participants chose Program A – avoiding the risk of all of the people dying was more attractive than the possibility of saving all of them. In the second group ($N = 155$), the *risk-taking* condition, Program C would lead to 400 people dying while Program D had a 1/3 chance of no one dying, with a 2/3 chance that all 600 would die. 78% of participants chose Program D –when framed this way, the 1/3 chance of no deaths is more attractive than a guarantee of 400 deaths. As illustrated by the study, people are more likely to be more averse to risk when the presented options are framed in terms of *gains*, such as lives saved, rather than *losses*, such as lives lost.

The second type of framing effect is goal framing, which presents target behaviors for which people must state their willingness to participate, with the frame focusing on the potential consequences of either performing or not performing the action. For example, this effect has been demonstrated in the context of choosing health behaviors. In work (Detweiler et al., 1999) on goal framing's effect on intended sunscreen usage utilized four types of messaging describing outcomes of using sunscreen: benefits gained, benefits not gained, negative consequences not gained, and negative consequences gained. This line of research found that the most effective messaging in promoting sunscreen usage were the two that emphasized gaining. In the goal framing effect, people are more likely to perform a behavior when they a message highlights what they might gain from doing so, rather than what they would potentially lose.

The final type of framing effect, attribute framing, consists of a specifically worded message, describing a certain characteristic of a subject for which one must display preference. The description highlights either positive or negative attributes of the subject and tends to generate associations towards it – positively described attributes evoke a higher preference towards the subject while negative attributes arouse negative associations towards it. The attribute framing effect has been demonstrated in consumer research – when a meat product is advertised as being “75% lean,” customers react more favorably towards the product than a product advertised as “25% fat” regardless of the fact that both of these products have the exact same percentage of fat (Levin & Gaeth, 1988). People tend to be more attracted to the option when it is perceived as being described more positively rather than negatively. Because of the potentially persuasive nature of the attribute framing effect, it may have applicative value and thus, researchers have explored methods to potentially enhance this effect. In designing their investigations, researchers have utilized cerebral lateralization to their advantage.

Cerebral Lateralization

Cerebral lateralization refers to the fact that the two hemispheres of the brain are asymmetrically specialized for different functions (Sperry, 1974;1982). Certain lateralized cognitive processes, such as hemispheric differences in information processing, are potentially linked to framing effects.

An aspect of the processing of information that is potentially linked to framing effects is belief-updating. It has been hypothesized that the right hemisphere is associated with the ability to integrate newly learned information into one’s belief system (Ramachandran, 1995). This hypothesis was supported by findings from patients with anosognosia. Some people with anosognosia have incurred damage to their right parietal lobe, causing paralysis of their body on the left side, but are unable to acknowledge or accept their condition. This neurological phenomenon is believed to arise due, in part, to a deficit in right hemispheric processes. This was demonstrated through a study of three sets of experiments where four individuals with anosognosia answered questions that were designed to elucidate unconscious knowledge of their physical deficits. When explicitly reminded of their paralysis, patients began to continue to deny reality or make rationalizations for their inability to use both hands such as, “I have never been very ambidextrous." This may be because the right hemisphere acts as an "anomaly detector," – when confronted with events or facts that contradict beliefs, processes of the right hemisphere, facilitate updating prior beliefs with new knowledge. Thus, Ramachandran (1995) suggested that individuals with damaged right hemispheres lack a component of information processing that does not allow them to fully process new information. When presented with the new information that their body cannot move the way it once had, they are unable to assimilate this knowledge due to the damaged right hemisphere's inability to update their prior belief about their body. Echoing these earlier findings, work done with paralyzed patients who similarly suffered from unilateral right hemisphere damage were also unable to update their belief that they could perform a behavior with their paralyzed limbs regardless of witnessing the fact that they were failing the task (Marcel et al., 2004).

These studies support the notion that the right hemisphere is important in shaping conscious knowledge through integration of new information. When one is presented with a valenced frame about a subject – one highlighting only either a positive or negative feature – this information either supports or updates existing beliefs via the "anomaly detector" of the right hemisphere (Ramachandran, 1995), which potentially impact the attitudes or judgements that one has towards the subject of the frame. This supports that framing effects may occur, partly, through belief-updating, as individuals update their belief about a subject based upon framed information with which they are presented.

Theories underlying the cognition involving decision-making may also help to explain how framing effects arise. The dual-process model of cognition theorizes that there are two separate systems of information processing that are involved in decision making – the first system involves automatic processing relying upon contextual and emotional cues while the second system involves logical deliberation (Mukherjee, 2010). Guo, Trueblood, & Diederich

(2017) provided evidence that framing effects occur under the first, automatic system of cognition by showing that framing is enhanced under the pressure of time, supporting that the effect likely relies on automatic decision making. Additionally, it has been found that framing effects still occur under distraction conditions, providing evidence that the effects arise from the automatic processing of information. Instead of deliberating about what options truly mean, the frame is used as a reference to quickly make a choice. It has been indicated that the right hemisphere is predominant in inferring meaning using context when processing language (Brownell et al., 1992; Beeman, 1993; Goel et al., 2007). The right hemisphere, thus, may be differentially involved in contributing to the effects of framing as it parses meaning and makes an automatic evaluation or decision based on the readily available information that has been given. This is a possible reason why the framing effect is seen when the right hemisphere is preferentially activated and not as prevalent the left hemisphere is more active (McElroy & Seta, 2003; 2004).

Handedness

A characteristic stemming from cerebral lateralization that has been associated with information processing is handedness. The hand that individuals use to complete everyday tasks, such as writing or opening a jar, may give insight to their brain's organization. Research has found that those who use a mixture of both hands rather than either predominantly right or left have an enhancement of right hemispheric cognition, which has been attributed to an increase in communication between the hemispheres allowing for an increased access to processes of the right hemisphere. Individuals who are more inconsistent with their hand usage have shown an increase in being persuaded into updating their beliefs, an aspect of information processing that is lateralized to the right hemisphere (Christman et al., 2008; Prichard, Propper, & Christman, 2013*)*.

Handedness has been specifically linked with framing effects. In the context of the classic Asian disease problem, those who use their hands inconsistently were found to be more susceptible to the effect of bias in making risky decisions when the options were framed as risk-taking rather than risk-averse (Stein, 2012). Additionally, Jasper, Woolf, & Christman (2014) found that inconsistently handed people were more likely to be affected by the frame of a health-related message.

Handedness differences in framing effects provide additional evidence that this cognitive bias may be lateralized to the right hemisphere. The association between mixed-handed individuals with increased access to right hemispheric cognition, as well as to an increase in framing effect, lends further support that the right hemisphere is biased to process information in such a way to contribute to the effects of framing.

Double Filtering by Frequency Theory & Hemispheric Activation

Cerebral lateralization has been theorized to apply to the processing of sensory information based upon relative frequencies (Sergent, 1982). Double Filtering by Frequency (DFF) theory proposes that at the first level of processing, task-relevant visuospatial and auditory information are filtered by both hemispheres. Subsequently, this information is then filtered again, asymmetrically, as the hemispheres have a predisposed sensitivity based on differences in frequency of the information. Within this framework, the right hemisphere is more sensitive towards processing relatively lower frequency sensory information while the left hemisphere is more inclined towards processing relatively high frequency information (Ivry & Lebby, 1993). Therefore, when either hemisphere is exposed to relatively higher or lower frequency information, that hemisphere and its related processes may become more active than the other.

This exposure to relative differences in frequency is a potential method of selectively activating either hemisphere to enhance processes that have been shown to be lateralized. The literature contains evidence that researchers have been able to activate either hemisphere relative to the other through presenting individuals with certain stimuli or behavioral tasks. This has allowed for the exploration of the relationships between the hemispheres and cognitive functions. For example, it has been demonstrated through electroencephalography (EEG) that performing both simple arithmetic, as well as complex mathematical tasks (Hamid et al., 2011), differentially activates the left hemisphere due to the left hemisphere's differential involvement in solving such problems (Molina del Rio et al., 2019). This type of hemispheric activation-task performance relationship has been demonstrated on multiple domains, including episodic memory retrieval and economic decision-making. Researchers have found that unilateral hand clenching may activate the contralateral hemisphere and these associated processes and functions (Harle & Sanfey, 2016; Propper et al., 2013).

Selective Auditory Frequency Amplification & Framing Effects

As discussed, the right hemisphere of the brain has been linked to processes that potentially contribute to framing effects. Researchers have empirically investigated the relationship between the right hemisphere and framing effects through methods utilizing the tenets of DFF theory.

Gallagher & Dagenbach (2007) studied risky-decision framing, employing a method of auditory stimulation containing relative frequency differences. In this work, participants were verbally presented with the classic Asian disease problem (Tversky & Kahneman, 1981) to both ears through headphones. On the audio, there was a triple layering of tracks – the original track, a second track, and white noise. The second track differed based on condition – the audio presented to the *relatively lower frequency* group had a second track consisting only of the higher frequencies (above 2411 Hz) of the same voice speaking a list of random words while the audio track for the *relatively higher frequency* group consisted only of the lower frequencies of this voice (frequencies above 798 Hz were removed). This method of layering had the effect of creating a relatively higher or lower frequency of the central message compared to the second voice. The white noise served the purpose of acting as the first stage of information filtering. Under DFF theory, the white noise would act as not being relevant to the task and would be filtered out. Subsequently, during the second stage of filtering, the relatively lower frequency information would be directed to processing by the right hemisphere.

The result (Gallagher & Dagenbach, 2007) was that those in the *relatively higher frequency* group did not display the risky decision framing effect while those in the *relatively lower frequency* group showed this effect. The findings of this study provide evidence that, given the ideas proposed by DFF theory, the right hemisphere differentially contributes to the effect of framing because framing effects occurred when the right hemisphere was differentially activated through presentation with an amplification of relatively lower frequency audio.

The method that was used by Gallagher and Dagenbach (2007) can be referred to as selective auditory frequency amplification (SAFA). In SAFA, tracks of audio are layered to create an effect of amplifying the selected range of frequencies relative to the original track of audio. Following the DFF theory, right hemispheric processing is relatively activated when lower frequencies are amplified. Thus, when relatively lower frequencies are amplified through SAFA, right hemisphere activity is enhanced, thereby stimulating cognitive processes of the right hemisphere.

McCormick and Seta (2012) altered the methodology of the previous study (Gallagher & Dagenbach, 2007) to extend the findings to attribute framing. In the previous study, the audio that participants heard contained a layering of 2 tracks of voices embedded within white noise. McCormick and Seta (2012) instead heard one voice that had certain ranges amplified, which enhanced real-world applicability. Participants were presented with a spoken message – one group heard ground beef described as *85% lean* while the other group heard it described as *15% fat*. They were asked to indicate which item in a pair of associates, such as good tasting or bad tasting, they were most likely to associate with *85% lean* ground beef, the positive condition, or *15% fat* ground beef, which served as the negative condition. Preference responses were given on a 10-point Likert-type scale. Consistent with the attribute framing effect, the researchers hypothesized that the positively framed message describing ground beef as *85% lean* would evoke more positive associations towards the beef than the participants hearing the beef described as *15% fat*.

The audio of the message that participants heard (McCormick & Seta, 2012) was edited based on the SAFA method used by Gallagher and Dagenbach (2007). Two audio tracks were layered – the original track, which contained all frequencies of the voice speaking the message, and a second track which contained only either the lower range of frequencies, between 80 Hz and 2080 Hz, or the higher range of frequencies, between 2080 Hz and 4080 Hz. Consistent with the DFF theory, as well as with previous findings associating framing effects with the right hemisphere, it was hypothesized that selectively amplifying the lower range of frequencies, thus activating the right hemisphere, in the voice speaking the message would evoke stronger positive evaluations of the ground beef as compared to those that heard the selectively amplified higher range of frequencies. Overall, the researchers expected that participants hearing the positive frame, *85% lean ground beef* message, containing relative amplification of the lower frequencies would have the strongest positive preference towards the ground beef. The findings of the study supported the hypothesis because there was an interaction between framing of the message and the auditory manipulation. When lower frequencies were relatively amplified, purportedly activating the processing of the right hemisphere, the framing effect occurred -- those reading the more positive description rated the ground beef more positively and those reading the negative description rated the ground beef more negatively. When the higher range of frequencies were relatively amplified, there was no support for the framing effect with significant difference between those in the positive and negative conditions. This provided further supported for the usage of the SAFA method in enhancing framing effects.

Task-Irrelevant Stimulation & Attention

Under the DFF theory, the first level of the processing of information occurs when attention is directed to task-relevant information. Then, from there, information is biased to be processed differentially by the hemispheres based upon its relative frequency. However, this theory does not address processing of information that is not directly relevant. Does relative frequency of a task-irrelevant stimulus impact its processing in the same way as task-relevant stimuli?

Theories about attention state that when there is an increase in cognitive load, a person is more likely to be distracted by distractors (Lavie, 2010). This is because, due to the demands of cognition, there is a reduced ability to filter relevant from irrelevant information and maintain control of full attention towards the primary task. When the task itself is more cognitively demanding, the processing of the irrelevant stimulus is increased. However, under a lower cognitive load, the processing of the stimulus is decreased because there is a capacity for cognitive control to maintain attention towards the task (Lavie, 2005). Following the load theory associated with cognition, task-irrelevant stimuli are processed by the brain even during cognition of a separate task.

When a musical task-irrelevant was presented simultaneous to a task of reading comprehension, neural potentials as visualized by electroencephalogram (EEG), were higher when background music was present as compared to when it was not present (Du et al., 2020). This suggested that the background music was processed despite not being relevant to the primary reading task. Additionally, research has demonstrated that when attention was required in a visual tracking task, concurrent irrelevant auditory stimuli were processed. EEGs showed that there were spikes of peaks of neural potentials consistent with the processing of the sounds (Zhang et al., 2006). These finding supports that even across sensory modalities, stimuli are processed even when not relevant to the primary task. As such, it is supported that task-irrelevant auditory stimuli are processed despite conscious attention being directed to a primary cognitive task. Therefore, there is potential value in directly investigating whether the assumptions of DFF theory extend to task-irrelevant auditory stimuli.

The Current Study

The current study seeks to replicate and extend the findings of McCormick & Seta (2012) to a novel, task-irrelevant usage of the SAFA method to examine a potential route of strengthening the effects of attribute framing via differential hemispheric activation. If this method is supported by the current work, it would extend the idea of DFF theory to frequencies of task-irrelevant auditory information. This method of SAFA would also provide researchers an approach to differentially activating the hemispheres without requiring conscious, focused attention to a stimulus.

From the original study, modifications were made in the mode of presentation of the stimulus, making it irrelevant to the framing task. The original study used a speaker’s voice to present a framed message, with SAFA used on the audio. This served to differentially activate the hemispheres by submitting them to the auditory stimulus, which also contained the framing task. However, in the present study, hemispheric activation was indirectly promoted with instrumental music containing SAFA playing through speakers, rather than having a message spoken through headphones. Instead of listening to the attribute frame task being spoken, participants read the message while the music played in the background, centrally presented.

This music had a selected range of frequencies relatively amplified. Thus, the auditory stimulus was irrelevant to the actual task of rating the ground beef based on the descriptive message.

It was hypothesized that listening to music with relatively lower amplified frequencies would differentially activate the right hemisphere as compared to hearing either relatively higher selectively amplified frequencies or music with no amplified frequencies. Thus, participants in the *relatively lower SAFA* condition were expected to display a stronger attribute framing effect than those in the *relatively higher SAFA* condition as well as the control group. It was also predicted that participants reading the *85% lean* ground beef (positive) frame were expected to rate the ground beef more favorably than those reading the *15% fat* ground beef (negative) frame. Overall, it was predicted that there would be an interaction between SAFA and the attribute frame.

Method

Participants

A total of 60 participants (14 men, 46 women) between the ages of 18 and 42 (M= 20.56, *SD* = 3.64) participated in this study. Participants were randomly assigned to one of the six conditions. Data was collected from each of the participants individually in separate laboratory rooms. Recruitment of participants occurred via the SONA system, between September 2019 and March 2020, from a pool of undergraduate psychology students at Montclair State University. Data collection was intended to continue until May 2020; however, due to the global COVID-19 pandemic, this collection was prematurely terminated. Therefore, sample size did not reach the intended level for robust statistical power.

Inclusion criteria noted that only adults, aged 18 and up, with self-reported normal or corrected-to-normal hearing were able to participate in the study. Participants received class credit for their participation. In accordance with Montclair State University Institutional Review

Board, informed consent was obtained from each participant prior to the start of the experiment. Participants completed a demographics questionnaire that included their age and sex. Participants also completed the Edinburgh Handedness Inventory to obtain information about their handedness (Oldfield, 1971). As data collection did not continue as originally intended, no individuals were excluded from analysis based on handedness, to avoid further limitations on statistical power.

Materials

This study used desktop computers, Dell OptiPlex 7020 i7 with intel HD graphics and Dell P2014H 17-inch screen monitors. Participants were told that music would be playing in the background. An instrumental song, Ballade Op. 19 (Fauré, 1881), was presented through the computer's speakers, without headphones, at volume level 38 via RealPlayer. The song is approximately 14 minutes in length and played on a seamless loop to avoid interruption to the audio. The song had any of the frequencies below 80 Hz and above 4080 Hz removed from the range of frequencies. Using Version 2.4.2 of Audacity(R) software (Audacity, 2020) to edit the sound files, selected frequencies were amplified, depending upon experimental condition. Amplified frequencies were constructed by layering a second audio track that contained only either high (2080-4080 Hz) or low frequencies (80 Hz- 2080 Hz) from the same song onto all frequencies of the original audio track. Following the previous work (McCormick & Seta, 2012), the relatively higher frequencies were amplified a maximum of 12 decibels more than the lower frequencies to ensure there was no perceived volume difference. This method of track layering has the effect of amplifying the selected frequencies. The audio in the control condition only had frequencies below 80 Hz and above 4080 Hz removed but otherwise remained unchanged.

The task consisted of assessing ground beef, based upon how it was described to them, through a measure of four items. This was the same measure used in previous work (Levin, 1987; McCormick & Seta, 2012). The four items were as follows: "How greasy or greaseless is 85% lean/15% fat ground beef?", "How good or bad tasting is 85% lean/15% fat ground beef?", "How low or high in quality is 85% lean/15% fat ground beef?", "How lean or fat is 85% lean/15% fat ground beef?" Each of the four items included either the *85% lean* or *15% fat* description of the beef, depending upon experimental condition. The items were on a 10-point Likert-type (*1* = the "negative" descriptor, such as greasy or bad tasting, *10* = "positive" descriptor, such as greaseless or good tasting). Higher mean scores on this measure quantify a more positive appraisal of the ground beef. Participants were told to indicate their appraisal of the beef by clicking on the number, on the 1-10 range, that best represents how they felt about the beef.

Procedure

Participants were told that music would be playing in the background throughout the study. Participants read the instructions for the task. These instructions, similarly, used in the previous research (Levin, 1987; McCormick & Seta, 2012), were as follows: "We are interested in the associations or thoughts that come to mind when making consumer purchases. We are asking you to indicate which item in a pair of associates you are most likely to associate with a purchase of 85% lean/15% fat ground beef." Participants in the *positive frame* condition heard the ground beef described as *85% lean* while participants in the *negative frame* condition heard it described as *15% fat*. Following the reading of the instructions, participants proceeded to perform the task on the computer via Qualtrics v.5 (Qualtrics, 2020) as the music continued to play in the background.

Analysis

The experiment employed a 2 [frame manipulation, beef framed either positively (85% lean) or negatively (15% fat)] x 3 [the music heard by each participant, having either low frequencies (right hemisphere activation condition) or high frequencies (left hemisphere activation condition) amplified, or neutral with no selectively amplified frequencies] x 4 (the 4 items eliciting ground beef evaluations as a within-subjects factor) factorial design. Participants' evaluations of the ground beef, quantified by mean scores on the measure were the dependent variable.

Data was analyzed using SPSS (IBM, 2019). An alpha level of .05 was used to determine significance. A 2 x 3 x 4 mixed analysis of variance (ANOVA) was conducted, with the four items of the measure examined as a within-subjects factor to examine the relationship between experimental manipulations and participants' evaluations of the ground beef, and if this evaluation was consistent across the four items. A 2 x 3 analysis of variance was then conducted for each of the four items in the measure to determine the relationship between the manipulations and the evaluation on each item. Because evaluations on the measure showed high internal consistency, Cronbach's $\alpha = .81$, the scores were combined into a four-item composite score. The effects of the independent variables on this score were also examined via a 2 x 3 ANOVA. The analysis completed by McCormick & Seta (2012), in which the "fatty or lean" and "greasy or greaseless" items on the measure were combined and analyzed as a dependent variable via ANOVA. This was performed to replicate the previous study's analysis and explore the relationship between current results and that of the previous study by McCormick & Seta (2012).

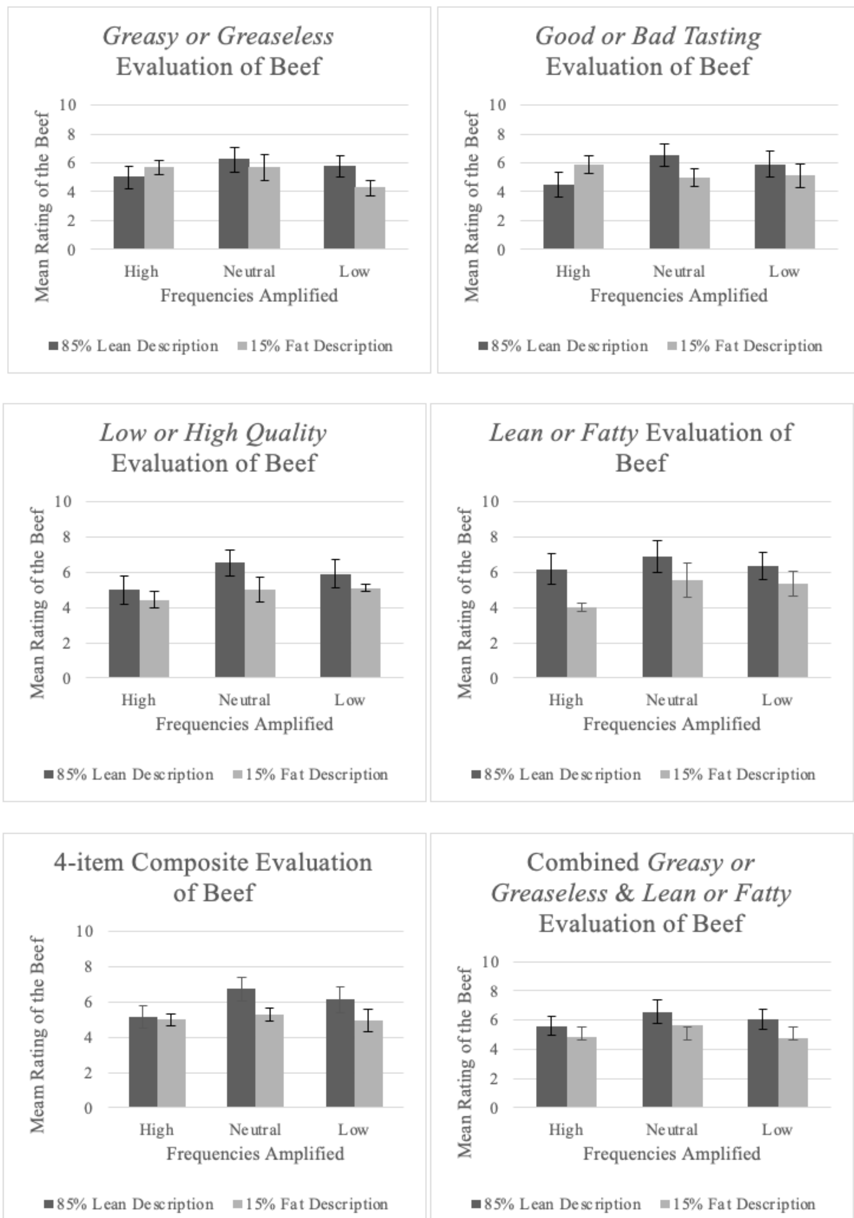
Results

In evaluating the beef as "greasy/greaseless", there were no main effects or interactions, $p > .05$. In evaluating the beef as "good/bad tasting," there were no main effects or interactions, $p > .05$. The analysis revealed that for the question asking participants to rating how "low or high quality" they found the ground beef, there was a significant main effect of attribute frame, *F*

$(1,54) = 5.469$, $p = .023$, $\eta_p^2 = .092$ (see Figure 1), whereby participants in the *positive frame* condition rated the beef as significantly higher in quality than those in the *negative frame* condition (see Table 1 for means and standard deviations).

Figure 1

Mean Evaluations of Ground Beef as a Function of Selective Auditory Frequency Amplification



Note. Participants' mean evaluation on the 4 items of the experimental measure as a function of frame and the SAFA manipulation. On the 0-10 scale, lower numbers quantify a more negative evaluation of the beef while a higher score quantifies a more positive evaluation. Error bars denote Standard Error.

Table 1

Evaluations of Ground Beef as a Function of Frame and Selective Auditory Frequency Amplification

Amplified Frequencies	Greasy/Grease-less	Good/Bad Tasting	Low/High Quality	Lean/Fatty	4-Item Composite	2-Item Greasy/Greaseless & Lean/Fatty Composite
	M(*SD*)	M(*SD*)	M(*SD*)	M(*SD*)	M(*SD*)	M(*SD*)
High						
85% Lean (n=11)	5.00(*2.57*)	4.45(*2.84*)	5.00(*2.65*)	6.18(*2.82*)	5.16(*2.10*)	5.59(*2.10*)
15% Fat (n=9)	5.67(*1.41*)	5.89(*1.76*)	4.44(*1.51*)	4.00(*.71*)	5.00(*1.05*)	4.83 (*.90*)
Low						
85% Lean (n=11)	5.73(*2.41*)	5.91(*2.55*)	6.55(*2.62*)	6.36(*2.46*)	6.14(*2.27*)	6.05(*2.23*)
15% Fat (n=9)	4.22(*1.64*)	5.11(*2.37*)	5.11(*2.37*)	5.33(*2.12*)	4.94(*1.01*)	4.78(1.73)
Neutral						
85% Lean (n=11)	6.18(*2.86*)	6.55(*3.08*)	7.27(*2.41*)	6.91(*2.98*)	6.73(*2.43*)	6.55(*2.73*)
15% Fat (n=9)	5.67(*2.74*)	5.00(*1.87*)	5.00(*2.12*)	5.56(2.*88*)	5.31(*1.94*)	5.61(*2.65*)

Note. Descriptive statistics for the evaluations of the ground beef as a function of frame and SAFA manipulation, quantified by mean score on items in the measure. On the 0-10 scale, lower numbers quantify a more negative evaluation of the beef while a higher score quantifies a more positive evaluation.

On rating the beef as "lean or fatty", there was a significant main effect of attribute frame, F (1, 54) = 5.539, p = .022, $\eta_p{}^2$= .093 (see Figure 1), in which participants in the *positive frame* condition rated the beef as significantly more lean than those in the *negative frame* condition (see Table 1 for means and standard deviations). There was no interaction, p > .05. There were no main effects or interactions of SAFA or attribute frame on the composite evaluation of the ground beef, p > .05. Table 1 shows means and standard deviations for the composite evaluation. The mixed ANOVA had no significant main effects or interactions, p > .05. Analysis of the impact of the independent variables on the 2-item composite for the "greasy or greaseless" and "lean or fatty" items revealed no main effects nor interactions, p > .05. Means and standard deviations for this analysis are shown in Table 1.

Discussion

The goal of this study was to examine previous findings (McCormick & Seta, 2012) about the activation of the right hemisphere through SAFA by attempting implementation of a novel presentation of the stimulus. To determine if hearing specific amplified frequencies, while reading a message, would be as effective in evoking a framing effect as listening to the same message being spoken with the same selectively amplified frequencies, this study implemented a novel technique of SAFA in task-irrelevant background music. The results of this study do not provide sufficient evidence that task-irrelevant SAFA enhances the attribute framing effect. There was support for the attribute framing effect itself, with medium-large effect sizes, providing evidence that the manipulation was successful.

However, it is important to the integrity of the scientific method to address experimental limitations. The *a priori* ideal sample size was calculated via G* Power, using the large effect from the original study as reference (McCormick & Seta, 2012). With only 60 participants, this did not reach an optimal power of 95% (Faul et al., 2007), which would have required 100 participants. The post-hoc power analysis using G*Power determined that the current study reached a statistical power of around 80%. Due to being underpowered, concrete generalizations cannot be drawn from this data. Future research must include a sufficient sample size.

This study attempted to introduce a technique of indirect differential hemispheric activation through using task-irrelevant stimuli. The SAFA method was designed broadly following the framework of DFF theory, which explicitly states that attention is first directed to task-relevant information before being differentially processed by the hemispheres. While more statistical power may have provided more robust evidence, the findings reported in this study may support that, indeed, the DFF theory's framework of lateralization of information processing styles applies only to task-relevant information. It is possible that hemispheric sensitivities towards preferentially perceiving and processing stimuli based upon relative frequencies may require conscious attention to the stimulus. It may be the case that task-irrelevant auditory stimuli do not differentially activate the hemispheres to an extent necessary to appeal to lateralized information processing styles as has been theorized by DFF theory. It is also possible that, following cognitive load theory (Lavie, 2005), the cognitive load demanded by a framing effect task is not high enough to increase processing of the task-irrelevant stimulus. Because of the low cognition required for the framing task, since it is considered an automatic cognitive bias (Guo, Trueblood, & Diederich, 2017), there may be a remaining capacity for top-down cognitive control of attention towards the task only. This is supported by the lack of interactions between the SAFA manipulation with the framing manipulation– potentially, the task-irrelevant auditory stimulus was not processed.

Approaching this line of research again in the future is warranted because of the potential benefits of the methods used here. Task-irrelevant SAFA may provide a way for researchers to amplify lateralized cognitive functions in studies without requiring consciously directed attention to the stimulus. Additionally, a valid and simple method of enhancing the attribute framing effect has potential applicative value. For example, as the attribute framing effect may allow for persuasion, there are implications in marketing. A convenient approach, such as background music containing SAFA, would be advantageous in the design of advertisements or messages promoting healthy behaviors. As previous studies (Du et al, 2020; Zhang et al., 2006) have done, future work in this area may include EEG as way of measuring brain activity in response to the task-irrelevant stimulus. To determine if the auditory stimulus is processed enough to impact differential hemispheric processing, and performance on a primary task, it may be useful to determine if there are neural potentials consistent with the processing of the task-irrelevant stimulus.

References

Audacity Team (2020). *Audacity(R): Free Audio Editor and Recorder* (Version No. 2.4.2). Audacity. https://audacityteam.org/

Beeman M. (1993). Semantic processing in the right hemisphere may contribute to drawing inferences from discourse. *Brain and language*, *44*(1), 80–120. doi:10.1006/brln.1993.1006

Brownell, H. H., Carroll, J. J., Rehak, A., & Wingfield, A. (1992). The use of pronoun anaphora and speaker mood in the interpretation of conversational utterances by right hemisphere brain-damaged patients. *Brain and language*, *43*(1), 121–147. doi:10.1016/0093-934x(92)90025-a

Christman, S. D., Henning, B. R., Geers, A. L., Propper, R. E., & Niebauer, C. L. (2008). Mixed-handed persons are more easily persuaded and are more gullible: interhemispheric interaction and belief updating. *Laterality*, *13*(5), 403–426. doi:10.1080/13576500802079646

Detweiler, J. B., Bedell, B. T., Salovey, P., Pronin, E., & Rothman, A. J. (1999). Message framing and sunscreen use: Gain-framed messages motivate beach-goers. *Health Psychology, 18*(2), 189–196. doi:10.1037/0278-6133.18.2.189

Du, M., Jiang, J., Li, Z., Man, D., & Jiang, C. (2020). The effects of background music on neural responses during reading comprehension. *Scientific Reports*, *10*(1). doi:10.1038/s41598-020-75623-3

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175-191.

Fauré, G., [Bartje Bartmans]. (1881). *Gabriel Fauré - Ballade Op. 19 (1881).* [Video]. Youtube. https://www.youtube.com/watch?v=tZcKii9Sd-o

Gainotti G. (2019). Emotions and the right hemisphere: Can new data clarify old models? *The Neuroscientist*. *25*(3), 258-270. doi:10.1177/1073858418785342

Gallagher P., Dagenbach D. (2007) Manipulating noise frequencies alters hemispheric contributions to decision making. *Brain Cogn., 64*(1), 42-9. doi:10.1016/j.bandc.2006.10.004.

Goel V., Tierney M., Sheesley L., Bartolo A., Vartanian O., Grafman J. (2007). Hemispheric specialization in the human prefrontal cortex for resolving certain and uncertain inferences. *Cereb. Cortex 17*, 2245–2250. doi:10.1093/cercor/bhl132

Guo, L., Trueblood, J. S., & Diederich, A. (2017). Thinking fast increases framing effects in risky decision making. *Psychological Science, 28*(4), 530–543. doi:10.1177/0956797616689092

Hamid AI Abd, Yusoff AN, Mukari SZ, Mohamad M. (2011). Brain activation during addition and subtraction tasks in-Noise and in-Quiet. *Malays J Med Sci., 18*(2), 3-15.

Harlé, K. M., & Sanfey, A. G. (2015). Unilateral hand contractions produce motivational biases in social economic decision making. *Neuropsychology, 29*(1), 76–81.

IBM Corp. Released 2019. IBM SPSS Statistics for Macintosh, Version 26.0. Armonk, NY: IBM Corp.

Ivry, R. B., & Lebby, P. C. (1993). Hemispheric differences in auditory perception are similar to those found in visual perception. *Psychological Science, 4*(1), 41–45. doi: 10.1111/j.1467-9280.1993.tb00554.x

Jasper, J. D., Woolf, J., & Christman, S. D. (2014). Responding to framed health messages: Different strokes for different (handedness) folks. *Psychology & Health, 29*(6), 671–686. doi:10.1080/08870446.2014.881999

Krishnamurthy, P., Carter, P., & Blair, E. (2001). Attribute framing and goal framing effects in health decisions. *Organizational Behavior and Human Decision Processes, 85*(2), 382–399. doi:10.1006/obhd.2001.2962

Kühberger, A. (1998). The influence of framing on risky decisions: A meta-analysis. *Organizational Behavior and Human Decision Processes, 75*(1), 23–55. doi:10.1006/obhd.1998.2781

Lavie, N. (2005). Distracted and confused?: Selective attention under load. *Trends in Cognitive Sciences, 9*(2), 75–82. doi:10.1016/j.tics.2004.12.004

Lavie, N. (2010). Attention, distraction and cognitive control under load. *Current Directions in Psychological Science, 19,* 143–148. doi:10.1177/0963721410370295

Levin, I. P. (1987). Associative effects of information framing. *Bulletin of the Psychonomic Society, 25(*2), 85–86. doi:10.3758/bf03330291

Levin, I. P., & Gaeth, G. J. (1988). How consumers are affected by the framing of attribute information before and after consuming the product. *Journal of Consumer Research, 15*(3), 374–378. doi:10.1086/209174

Levin, I. P., Schneider, S. L., & Gaeth, G. J. (1998). All frames are not created equal: A typology and critical analysis of framing effects. *Organizational Behavior and Human Decision Processes, 76*(2), 149-188. doi:10.1006/obhd.1998.2804

Marcel, A., Tegner, R., & Nimmosmith, I. (2004). Anosognosia for plegia: Specificity, extension, partiality and disunity of bodily unawareness. *Cortex, 40*(1), 19–40. doi:10.1016/s0010-9452(08)70919-5

McCormick, M., & Seta, J. J. (2012). A new method for selectively enhancing hemisphere processing: Voice frequency amplification influences the strength of attribute framing. *Laterality: Asymmetries of Body, Brain and Cognition, 17*(6), 727–735. doi:10.1080/1357650x.2011.626559

McCormick, M., & Seta, J. J. (2016). Lateralized goal framing: How health messages are influenced by valence and contextual/analytic processing. *Psychology & Health, 31*(5), 535–548. doi:10.1080/08870446.2015.1117082

McElroy, T., & Seta, J. J. (2003). Framing effects: An analytic-holistic perspective. *Journal of Experimental Social Psychology, 39*(6), 610–617. doi:10.1016/S0022-1031(03)00036-2

McElroy, T., & Seta, J. J. (2004). On the other hand am I rational? Hemispheric activation and the framing effect. *Brain and Cognition, 55*(3), 572–580. doi:10.1016/j.bandc.2004.04.002

Molina del Río, J., Guevara, M. A., Hernández González, M., Hidalgo Aguirre, R. M., & Cruz Aguilar, M. A. (2019). EEG correlation during the solving of simple and complex logical–mathematical problems. *Cognitive, Affective & Behavioral Neuroscience*, *19*(4),1036–1046. doi: 10.3758/s13415-019-00703-5

Mukherjee, K. (2010). A dual system model of preferences under risk. *Psychological Review, 117*(1), 243–255. doi:10.1037/a0017884

Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh inventory. *Neuropsychologia*, 9, 97113. doi:10.1016/0028-3932(71)90067-4

Prichard, E., Propper, R. E., & Christman, S. D. (2013). Degree of Handedness, but not Direction, is a Systematic Predictor of Cognitive Performance. *Frontiers in psychology*, *4*, 9. doi:10.3389/fpsyg.2013.00009

Propper, R. E., McGraw, S. E., Brunye, T. T., & Weiss, M. (2013). Getting a grip on memory: Unilateral hand clenching alters episodic recall. *PLoS ONE*, 8(4): e62474. doi:10.1371/journal.pone.0062474

Ramachandran, V. S. (1995). Anosognosia in Parietal Lobe Syndrome. *Consciousness and Cognition, 4*(1), 22–51. doi:10.1006/ccog.1995.1002

Sergent, J. (1982). The cerebral balance of power: Confrontation or cooperation? *Journal of Experimental Psychology: Human Perception and Performance, 8*(2), 253–272. doi:10.1037/0096-1523.8.2.253

Snodgrass, L. L., & Harring, K. E. (2004). Right hemisphere positivity bias in preconscious processing: Data from five experiments. *Current Psychology, 23*(4), 318–335. doi:10.1007/s12144-004-1004-3

Sperry, R. W. (1974) Lateral specialization of cerebral function in the surgically separated hemispheres. In B. McGuigan and R. A. Schoonover (Eds.), *Psychophysiology of Thinking* (pp. 209-229). New York: Academic Press.

Sperry, R. W. (1982). Some effects of disconnecting the cerebral hemispheres. *Science, 217*(4566), 1223–1226. doi:10.1126/science.7112125

Stein, J. M. (2012). Framing effects: The influence of handedness and access to right hemisphere processing. *Laterality: Asymmetries of Body, Brain and Cognition, 17*(1), 98–110. doi:10.1080/1357650x.2010.536552

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, 211(4481), 453–458. doi:10.1126/science.7455683

Whitney, P., Rinehart, C. A., & Hinson, J. M. (2008). Framing effects under cognitive load: The role of working memory in risky decisions. *Psychonomic Bulletin & Review, 15*(6)*,* 1179–1184. doi:10.3758/pbr.15.6.1179

Zhang, P., Chen, X., Yuan, P., Zhang, D., & He, S. (2006). *The effect of visuospatial attentional load on the processing of irrelevant acoustic distractors. NeuroImage, 33(2), 715–724.* doi:10.1016/j.neuroimage.2006.07.015

The data for this paper was obtained using Qualtrics software, Version 2020 of Qualtrics. Copyright © 2020 Qualtrics. Qualtrics and all other Qualtrics product or service names are registered trademarks or trademarks of Qualtrics, Provo, UT, USA. https://www.qualtrics.com