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Utilization of the Fundamental Attribution Error with Increased Immune System Inflammation

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**Utilization of the Fundamental Attribution Error with Increased Immune System
Inflammation**

An Honors Thesis submitted in partial fulfillment of the requirements of Honors Studies
in Biology

By

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Abstract

Immune system inflammation is associated with sickness behavior, depressive mood, and alteration of decision-making processes. Because of these cognitive effects, inflammation may also lead to increased use of heuristics, for example the Fundamental Attribution Error (FAE). In the current research, inflammation was experimentally increased using the influenza vaccine, with participants receiving either the vaccine or a placebo injection and completing a measure that tests for the FAE. There were no significant differences between the two conditions regarding the number of personal, situational, or overall attributions made by the participants in the measure that would indicate use of the FAE. However, exploratory correlational analyses found that participants who were more concerned about COVID-19 were more likely to make personal attributions, which are indicative of the FAE. Future research should be conducted to establish a stronger link between inflammation and heuristic use.

Introduction

Humans experience many different situations every day. In order to process these situations and know how to act, people must make sense of an immense number of details which requires a lot of cognitive power. With such a large amount of attention given to deciphering the complex world around them, people often use mental shortcuts known as heuristics to make efficient and quick inferences. Heuristics are used more often when circumstances become more complex and it is difficult to practice precise thought (Biesnaz et al., 2001). Physiological processes that direct people's energy and attention away from complex cognition have also been linked to increased use of heuristics (Kim & Baron, 1988). Consistently, another state that may influence the use of heuristics may be when an individual is sick and experiences an increase in inflammation as the immune system fights to rid the body of pathogens. Inflammation involves responses from multiple pathogen-fighting cells that may also damage host tissues (Okin & Medzhitov, 2012), increasing energy needs for the immune system and decreasing energy allocation towards cognitive processes, potentially leading towards an increased use of heuristics. Inflammation has been shown to alter some cognitive processes such as mood and decision-making (Boyle et al., 2019), but heuristic use and social decision-making have not been directly studied. The present research directly examined whether increased inflammation leads to an increased use of heuristics.

Cognitive heuristics are broadly defined as mental shortcuts that people use when making judgements and inferences about the world around them (Shah & Oppenheimer, 2008). These shortcuts can be efficient and concise, meaning that an individual will not spend much time deciphering the situation. People are more likely to use heuristics when

they are physiologically aroused (Wilder & Shapiro, 1998), when they are tired (Gordon, Mendes, & Prather, 2017), or if they possess personality traits that favor high orders of structure and organization (Moskowitz, 1993; Neuberg & Newsom, 1993). Heuristics are utilized many times every day and appear to be beneficial to the individual. For example, the representativeness heuristic explains how individuals will create mental prototypes of events, people, and other aspects of their environment (Tversky & Kahneman, 1974). This heuristic is concerned with how likely something is to resemble a category that an individual may have created in their mind, meaning that the individual will group a new experience with a previous experience based on how similar the two experiences are. If an individual meets someone new who is physically fit, drinks protein shakes, and wears athletic clothes, they might assume that the new person is an athletic trainer instead of a history teacher because the individual has a mental image of what an athletic trainer likely resembles based on past experiences. This assumption would be helpful if someone was told to meet their new trainer on a busy street because they could easily use the mental image to differentiate the many types of people they will see. The representativeness heuristic can be beneficial to the individual making the assumption, allowing them to simplify their thoughts and situation in the world.

In reality, many heuristics can be problematic. The quick, simple judgments can easily lead to stereotyping and bias. For example, the negative effects of heuristics are commonly seen in clinical settings with healthcare workers, potentially leading to improper diagnoses, treatments, and patient outcomes. In a 2016 systemic review, it was determined that at least one heuristic was used among the majority of physicians, with the most common being the framing effect (Saposnik et al., 2016). The framing effect alters

one's decision-making process depending on how the information is presented to people or whether it is asked in question format. This review further explains how the use of heuristics in studied physicians lead to diagnostic inaccuracy in 36.5 to 77% of the cases studied. This study illustrates the importance of studying cognitive heuristics and understanding what factors contribute to an increased use of these heuristics.

A frequently used heuristic in everyday life is the Fundamental Attribution Error (FAE), sometimes referred to as correspondence bias, which involves assumptions about an individual's actions. The FAE occurs when someone's actions are judged based on dispositional attributes of the individual and not situational attributes (Forgas, 1998). If a stranger cuts someone off in traffic, the driver who got cut off might assume that the stranger is a terrible driver and does not pay much attention to the road. In reality, the stranger may be a very good driver that happens to be late to a big job interview, so they are in a rush. Thus, the driver who was cut off is making a false assumption—assuming the stranger is a terrible driver—based on what they believe the stranger's traits are. Most of the time, people make similar dispositional judgments without pausing to think about potential situational factors that could have contributed to the observed behavior.

The FAE was first examined by Jones and Harris (1967) in a study of people's perceptions of speech authors' attitudes. Participants were asked to read and evaluate speeches. The key manipulation was that participants were randomly assigned to one of two conditions and told that the authors of the speeches were either free to choose their viewpoint or forced to write from a certain standpoint. The speeches were either pro- or anti-Fidel Castro, which was a relevant topic to participants at the time with Cold War tensions being high. After reading the speeches, participants were asked to rate pro-

Castro attitudes of the authors. When participants were told that authors had free choice in writing their opinion, they rated those that wrote favorably of Castro as having a more positive attitude of Castro. Yet, when participants were told that the authors did not get to choose to write their own opinion, participants still rated those that wrote favorably of Castro as having a more positive attitude of Castro. Participants believed that the speeches were sincere attitudes of the authors in both conditions, ignoring the fact that some authors were forced to write from a certain viewpoint. This study illustrates that the FAE was utilized by the participants because they all attributed the speeches ideas to the authors, regardless of whether or not they were forced to write a certain viewpoint or given circumstances that were out of their control.

People's reliance on the FAE varies depending on situational and personal factors. For example, mood has been shown to affect whether people use the FAE. Forgas (1998) conducted a study similar to the Fidel Castro Essay study, in which he manipulated participants' mood (happy, control, sad) and situational information about the authors (i.e., whether the participants thought the author chose their essay topic or was coerced toward one side). The essay content was for or against nuclear testing. Participants were asked to read the essays and rate their impressions of the authors. In the first experiment, Forgas concluded that inducing a positive mood increased the likelihood of using the FAE whereas inducing a negative mood decreased the use of the FAE. Participants in the positive mood condition, despite being told that the authors were forced to write from a certain viewpoint, judged the authors more positively if they wrote about being against nuclear testing and more negatively if they wrote in support of nuclear testing. Participants in the negative mood condition judged the authors equally positive. That is,

participants in the negative mood condition took into account the information about the author's situation (i.e., forced to write on this topic) when making their evaluation rather than being solely influenced by whether they personally agreed with the argument of the essay. Generally, the results of this study revealed that mood can lead to more or less utilization of the FAE.

In addition to personal factors like someone's mood, research has shown that physiological processes can relate to the use of heuristics. For example, when people are physiologically aroused, they tend to disregard other possibilities when making choices (Keinan, 1987), which is a key feature of the FAE. Besides being physiologically aroused, other biological processes such as inflammation or illness could be associated with heuristic use. To understand this connection, the basic principles of inflammation must be taken into consideration. The body's immune system becomes activated when it is introduced to a foreign molecule such as a pathogen. When this occurs, cytokines, which are the chemical messengers of the immune system, begin to activate the inflammatory response through the recruitment of pathogen-fighting cells. Interleukin-6 is one of these molecules that are responsible for increasing the inflammatory response and lymphocyte production. When individuals express higher levels of cytokines, they tend to show more behaviors that are termed "sickness behaviors" such as fever, withdrawal, sleepiness, loss of appetite (Dantzer & Kelley, 2007; Eisenberger & Moeini, 2020).

These sickness behaviors are also key symptoms of depression, indicating that inflammation plays a role in sickness behavior but also the social disconnectedness that one may experience while depressed (Eisenberger & Moeini, 2020). Eisenberger and

colleagues (2010) conducted a study in which participants were injected with an endotoxin or a placebo to examine social and emotional effects of inflammation on behavior. The endotoxin increased inflammation and mimicked people fighting off an illness. Then, participants were asked to rate their feelings of social connectedness using phrases such as “I feel like being alone” and “I feel connected to others.” Depression was also measured among participants. The study found that participants who were injected with the endotoxin showed more feelings of depressed mood and disconnection than those who were injected with the placebo. As expected, based on previous studies with inflammation, the participants who reported more depressed mood and disconnectedness showed increased levels of interleukin-6. This supports the hypothesis that increased levels of inflammatory cytokines can lead to feelings of social disconnectedness and depression. Results of this study indicate that inflammation is associated with social experiences and behaviors that are not found in those with a “resting” immune system.

Inflammation has also been linked to reward processing, impulsivity, and gratification. Gassen et al. (2019) measured immune system activation *in vitro* by mixing participants blood with an endotoxin in order to examine associations between inflammatory responses and personal behaviors such as impulsivity, delay in gratification, and present focus. Overall, the goal of this research was to document how inflammation impacted decision making processes in these individuals. The results showed that participants with a more active immune system (i.e., those whose blood had higher activity in response to the endotoxin, compared to those whose blood had lower activity) were more likely to be impulsive in their decision making. Participants were also less likely to delay gratification, implying that they wanted to be rewarded quickly.

A similar study by Boyle et al. (2019) studied alterations in reward processing that are often present with depression, but did so *in vivo*. At the beginning of this study, participants completed questionnaires and reward tasks before receiving the influenza vaccine. Participants were then injected with the influenza vaccine to elicit inflammation and increased levels of interleukin-6. The researchers observed that participants showed lower reward motivation after receiving the vaccine, compared to their own baseline, meaning they did not choose to complete harder trials on one of the studies tasks. Draper et al. (2017) completed a similar study in which participants were given a potent endotoxin to elicit an inflammatory response. When presented with a multitude of tasks that varied in difficulty, participants who received the endotoxin were more likely to choose not to complete the more strenuous trials in this study, compared to the placebo condition. These results are similar to the results of the Boyle et al. study. The possibility of a link between social behavior and inflammation has clearly been established and research is developing to solidify this connection. These results suggest that inflammation plays a key role in forming decisions and preferences, and may extend to people's use of heuristics like the FAE.

However, the relationship between heuristics and inflammation is not well established. It is known that energy needs for the body increase during inflammation, so there may not be as much energy for cognitive powers. If there is not much energy for cognition, will one be more likely to use heuristics as mental shortcuts? This honors thesis examined this relationship between inflammation and heuristic use.

Current Research

Inflammation is associated with increased use of heuristics and alteration of

decision-making processes, but little research has examined inflammation and the use of the FAE. In the current research, inflammation was experimentally increased using the influenza vaccine which was expected to result in increased IL-6 the following day (Boyle et al., 2019). Participants received either the vaccine or a placebo injection and completed the measure of FAE the next day. Use of the FAE was measured with a task used in prior research, which requires participants to read vignettes and determine if someone's actions are due to personal traits or situational factors (Kitayama et al., 2006; Na et al., 2010). The vignettes feature an individual performing a behavior that was seen as either desirable or undesirable and participants were asked to rate how much they thought the individual's behavior was due to internal factors of the individual or external factors. Higher emphasis on internal factors and lower emphasis on external factors would be consistent with use of the FAE.

I predicted that participants who received the vaccine, compared to those who received the placebo, will make significantly more dispositional attributions about the decision made by the individuals in the vignettes. This would indicate use of the FAE because the participants are making internal attributions and ignoring the situational factors that make be affecting the decision that was made.

Method

Participants

A total of 79 individuals participated in the study (24 male, 55 female). Participants were recruited from the city of Fayetteville, Arkansas, using local flyers, online advertisements, and word of mouth. Participants were compensated with a \$40 gift card. To be eligible, participants had to be between the ages of 18-40. Screening criteria

were used for each participant to ensure that they fell within a normal BMI range for their height, did not take an array of medications that could influence immune system inflammation (e.g., antidepressants and anti-anxiety drugs), did not use tobacco products, and did not have a condition from a predetermined and approved list (e.g., thyroid disorders and immunodeficiencies). Participants were randomly assigned to condition, 39 ended up receiving a placebo and 44 ended up receiving the vaccine. Male and female participants were equally distributed between the two conditions. Participants were blind to their condition until the end of the study, as were the experimenters conducting the study session.

Participants were on average 24 years old ($M = 24.39$, $SD = 5.62$, range: 18-38). Participants also reported their political and religious affiliations; political affiliation was reported using a 1 to 10 scale (1 = very liberal, 10 = very conservative) and religious affiliation was reported using a 1 to 10 scale (1 = not religious at all, 10 = very religious). Participants were slightly more liberal than the midpoint of the scale ($M = 3.92$, $SD = 2.06$) and around the midpoint for religiosity ($M = 5.14$, $SD = 2.69$, range: 1-10). Three independent samples t-tests revealed that there were no differences between the two conditions regarding age, religion, and politics (p 's > .161).

Participants self-reported their race as Caucasian (65.8%), Asian (5.1%), African American (3.8%), Hispanic (12.7%), Native American (2.5%), more than one race (8.9%), or other (1.3%). Participants reported their educational background as some highschool (1.3%), highschool diploma or GED (7.6%), some college with no degree (41.8%), associate's degree (5.1%), bachelor's degree (15.2%), master's degree (21.5%), and doctorate or professional degree (7.6%).

Because data were collected in the midst of the COVID-19 pandemic, we also asked participants some COVID-19-related questions. Only 13.9% of participants reported that they had been sick with COVID-19 with a confirmed test whereas 75.9% of participants said they have not gotten COVID-19. The majority of participants (82.3%) were fully vaccinated. When asked how concerned or anxious they felt about COVID-19 at the moment on a scale of 1 (not at all) to 100 (extremely concerned or anxious), participants reported being less concerned than the midpoint of the scale ($M = 43.22$, $SD = 26.13$). A small number of participants reported that they were sick (illness not specified) in the week before they participated (3.8%) and the majority reported they were not (96.2%).

Procedure

After submitting an interest form, participants were contacted by a research assistant via telephone and completed an eligibility screening and consent form. Once screened and eligible, participants were scheduled for their supply pick-up, clinic appointment, and zoom session. Study materials were picked up from a research assistant at the University of Arkansas. Participants were informed that their appointment was at the UAMS Northwest clinic, and they would be receiving either a placebo or the flu vaccine (and that they would find out their condition at the end of the study). Within the study materials packet, each participant was given two tubes to provide saliva samples that would be given back to the research coordinator. The participants were instructed to provide a saliva sample one hour before going to the UAMS clinic so that changes in cytokine levels could be measured before receiving the vaccine or placebo. The day after receiving the vaccine or placebo, participants met with a research assistant on Zoom to

complete a series of psychological tasks. Participants waited a day to complete their Zoom session so that their immune system had adequate time to become activated (Boyle et al., 2019). The day of the Zoom meeting, participants were asked to provide their second saliva sample an hour before the meeting, measuring cytokine levels that indicate inflammation of the immune system.

During the Zoom session, participants completed a task assessing the use of the FAE, along with several other psychological tasks. The FAE task included 4 vignettes that were adapted from previous research (Kitayama et al., 2006; Na et al., 2010). The vignettes portrayed an individual who had to make a decision that could be judged as influenced by personality or by contextual factors. An example vignette is below:

“Sara Martin is a top executive of a company “XinK Int.” “XinK Int.” is one of the leading pharmaceutical companies in the US. However, the company has experienced a decline in their public image which has led to a decline in sales in the last half a year. Recently, the company started several activities, which were focused on the stabilization of their leading position in the pharmaceutical market.

Not too long ago, “XinK Int.” developed a new drug for treating malaria. Shortly after that several African countries experienced an outbreak of malaria. As soon as Sara Martin found out about this event, she decided to donate a lot of medicine to the regions in Africa that needed assistance. Local mass media showed different reactions to this news.”

After reading each vignette, participants were asked to rate how much they agreed with statements pertaining to internal attributions and external attributions made by the individual when considering the decision that was made. The questions used a 1 to 7 scale to rate agreement (1 = strongly disagree, 7 = strongly agree). The following questions were used to judge participants’ inclinations of internal attributions: “Sara Martin’s personality primarily influenced her behavior” and “Sara Martin would have

acted differently if her personality had been different.” Two questions judged participants’ inclinations of external attributions: “Particular circumstances primarily influenced Sara Martin’s behavior” and “Sara Martin would have acted differently if the particular circumstances had been different.” The last question provided a score averaging the number of internal and external attributions made by the participant: “Overall, what influenced Sara Martin’s decision more?”. An average rating was computed for the two internal attribution questions and for the two external attribution questions. If participants agreed more with the statements that personality was more influential, the FAE was being committed by participants.

Results

I used independent samples t-tests to test my prediction that participants who received the vaccine would report more internal attributions and fewer external attributions than participants who received the placebo. When examining the two statements concerning personal attributions, the placebo condition ($M = 5.07$, $SD = 0.69$) did not differ significantly from the Flu shot condition ($M = 5.06$, $SD = 0.91$), $t(68) = 0.06$, $p = .953$. Similarly, with the situational attributions, the placebo condition ($M = 5.33$, $SD = 0.84$) did not differ significantly from the Flu shot condition ($M = 5.28$, $SD = 0.67$), $t(68) = 0.28$, $p = .782$. Finally, regarding which attribution was more influential overall, the placebo condition ($M = 1.90$, $SD = 0.93$) did not differ significantly from the Flu shot condition ($M = 1.89$, $SD = 0.97$), $t(67) = 0.06$, $p = .950$.

I next conducted exploratory analyses to examine whether people’s worries about COVID-19 were associated with use of FAE. Correlation analyses showed that participants who reported that they were more concerned about COVID-19 were more

likely to attribute the behaviors shown in the vignettes to personality factors ($r = 0.29, p = .017$). Concern about COVID-19 was not correlated with situational attributions ($r = .341, p = .004$) or overall judgments ($r = .516, p = .000$).

Discussion

This study attempted to identify if cognitive heuristic use, specifically the FAE, increased when the immune system became activated. Immune system inflammation was experimentally manipulated, with participants being randomly assigned to a placebo condition or influenza vaccine condition. After receiving either one of the injections, participants completed a series of psychological tasks, including a task designed to test for the FAE. This task featured four vignettes that described a behavior displayed by a fictitious individual and included statements about the influence that personality or situational factors had on the behavior. Participants rated the degree to which they agreed with each statement regarding personality or situational attributions being influential in the displayed behavior. Overall, the hypothesis was not supported; participants in the two conditions did not differ in the extent to which they evaluated behaviors in the vignettes as being due to personality factors or external factors. Thus, findings suggest that increased immune system activity does not increase the use of the FAE. It is worth nothing, however, that for these analyses we are assuming that participants in the vaccine condition experienced increases in circulating cytokines based on data from prior research (Boyle et al., 2019). After assays have been performed, future analyses will be able to examine (1) whether participants in the vaccine condition actually exhibited increases in cytokines and (2) whether cytokine levels are associated with use of FAE.

There are several possible explanations, regarding both social psychology and

biology, for the lack of findings between the conditions. First, humans are complex biological organisms that have extreme variability. How one person responds to a vaccine or pathogen could be completely different from someone facing the same situation (Kuhlman et al., 2018; Jolink et al., 2022). Kuhlman and colleagues (2018) found that changes in IL-6 levels between pre- and post-influenza vaccination varied considerably between participants. Immune system inflammation for one person could be entirely more severe than that of another. Thus, participants in this study likely experienced highly variable increases in immune system activation, which may have altered results. Second, there was methodological variability that could have precluded me from finding results. Although all prior research used a within-subjects design (Boyle et al., 2019; Kuhlman et al., 2018; Jolink et al., 2022), the present research used a between-subjects design in which participants either received the vaccine or a placebo injection. A placebo injection can still technically be considered a foreign ‘pathogen’ to the body and the injection may have been followed by some inflammation, just not at the level of a vaccine. The level of inflammation could also vary depending on the time of day, with higher cytokine levels being observed during times of rest and early activity (Comas et al., 2017). Because of the high complexity of the study, there was no way to standardize the time of day for clinic appointments or Zoom sessions between participants. Future analyses examining actual cytokine levels will also control for the time of day that each sample was taken and the time between samples. Finally, participants may have had more variability in their cytokine levels at baseline than could be produced following the vaccine. Although saliva samples were collected the day after the clinic appointment, which is expected to be around the peak of inflammation (Boyle et al., 2019), some

people's cytokines in general may have been significantly higher or lower than others. Thus, examining actual cytokine levels and changes may still find a connection between inflammation and use of FAE.

Regarding social psychology, using a survey to distribute measures could have introduced possible confounds. Surveys often produce a psychological phenomenon known as response bias, which occurs when a participant gives one answer or type of answer more than another (American Psychological Association, n.d.). Response bias tends to become visible when it is clear that participants want to answer survey questions in a way that seems socially desirable. Participants may have thought they would be judged for providing a certain answer, leading them to rate agreements in the FAE task with the impression that there was a socially correct answer. Thus, the results could possibly not reflect the true feelings of the participants and mask a significant result indicative of FAE use. Because the study was designed around self-report measures, participants may have also not devoted a significant amount of attention to the survey's and only focused on receiving the compensation. The FAE task was the last section of the survey and participants may have lost some of their attention span and focus when they reached this measure. Overall, there are several issues that are common to survey measures which could possibly be seen in this research design.

Although the two conditions did not differ in attributional aspects, an interesting exploratory finding emerged: participants who reported being more anxious about COVID-19 were also agreeing more with statements about personal attributions, meaning that they viewed the decision made in the vignettes was more attributable to the individual than the circumstances. One explanation for this correlation is that people have

become focused on individual actions necessary to stop the spread of COVID-19.

Governmental regulations in response to COVID-19 have emphasized the individual's ability to inhibit social behavior and adhere to strict guidelines. If someone does not wear a mask properly, a participant who falls within this correlation will likely be focused on their actions as a person and not the situational factors that may have caused the person to wear the mask improperly. Living through the COVID-19 pandemic may have attuned people to use the FAE more frequently when there is worry about a resurgence of cases.

Limitations

There are several limitations to this study. The unfortunate arrival of COVID-19 altered many of the initial plans that were in place for this study. Participants were originally going to complete the majority of the study in-person. They would meet a research assistant at the clinic, come to the lab to complete the different tasks, and provide their saliva samples in-person. With COVID-19, these procedures were all arranged so that there was little contact with lab personnel. Research assistants were forced to hope that they had participants undivided attention during the zoom session. The design of this study also relied on participant's ability to adhere to written instructions, whether it be providing saliva samples at the correct times, keeping those samples frozen until they were dropped off, picking up study supplies, and dropping those supplies off at the end of the study. Because participants were completing study tasks at home, they may have been more distracted than if they were in the lab. These alterations added a lot of unstandardized variability to the study.

Another limitation of this study was the relatively small sample size. Despite strong recruitment efforts, we could only get 79 participants through the study. This

could be due to participants not following the instructions that were provided, participants failing to follow-up with lab emails about scheduling, narrow windows of time for clinic appointments, and stringent eligibility criteria. Moreover, people may have been less interested in participating because the study involved getting a vaccine. The politicized quick development of the COVID-19 vaccine may have led some people to rethink their attitude towards vaccines as a whole. Alternatively, because of social distancing and focus on COVID-19, people may have become desensitized to the threat posed by the influenza virus. Having more participants would likely provide better statistical analyses and allow the results to be more representational.

A third limitation could be the vignettes that were used to assess use of FAE. The vignettes have been successfully used in past research (Kitayama et al., 2006; Na et al., 2010). However, those studies focused on cross-cultural differences in social cognitive processes and did not attempt to manipulate a situational factor. The sample of participants in this study was largely homogeneous (65.8% Caucasian American) and analysis of cross-cultural effects was not conducted. Overall, the vignettes in this study may be more likely to capture chronic patterns of social cognition and less sensitive to capture any fluctuations. A future study would benefit from using methods that have been used to capture fluctuations, such as those used by Forgas (1998) or Jones and Harris (1967). Using Jones and Harris' (1967) design, speeches could be written similarly to the vignettes used in this study, describing a fictitious individual who makes a decision that could be attributed to either their personality or situational factors. Participants would be told that the authors of the speeches were allowed to choose if they agreed with the decision that was made, or were forced to write from a certain viewpoint. After reading

the speeches, participants would rate the pro-decision attitudes of all of the authors, despite which method they were given to write the speech. Based on the results of studies using this design that were able to assess differences between experimental conditions (Jones and Harris, 1967; Forgas, 1998), this would be a better research design for noticing small changes in participants attitudes. I was not able to use this design because it required four conditions to be used instead of two, and I knew that sample size would be a problem for the study. With a larger sample size in future research, using four conditions would likely elicit a more directional response from participants.

Future Directions

It would also be beneficial to consider conducting research looking at other types of heuristics that could be affected by inflammation. For example, the representative heuristic involves using stereotypes to make judgements about people and situations (Tversky & Kahneman, 1974; American Psychological Association, n.d.). If someone behaves or dresses in a way that is consistent with a stereotype that someone possesses, they will quickly group that person within the stereotype. This heuristic could be harmful when making judgements about people that one has never met before. Many fields of work include social interaction that could be faulted by a quick judgement that is not representative of other individuals. Thus, it would be interesting to determine if inflammation causes someone to make stereotypical judgements that are detrimental to a future interaction with an individual

Another important future direction would be to explore the link between immune system inflammation and the FAE with regards to the field of healthcare. Many healthcare workers are around pathogen threats every day, and it could be reasonably

assumed that their immune systems are more activated than the common person. If future research determines that the FAE is linked to immune system activation or replicates the link between worries about a potential illness and use of the FAE, healthcare workers could introduce serious biases and inequities for patients by not considering circumstantial factors of the patient's health. For instance, if a patient is not following their medication regimen, a doctor might become frustrated and blame this issue on the patient without thoroughly considering or asking about their circumstances. The patient may have a bad home life, work multiple jobs, or be dealing with a stressful life event. All of these factors contribute to the patient not taking their medication correctly, which is not a concern of the patient's personality, but rather the situational issues they are currently dealing with.

Conclusion

This thesis is one of the first endeavors to link the Fundamental Attribution Error and heuristic social cognition processes with inflammatory processes within the immune system. Because previous research has linked inflammation to other cognitive processes such as mood and reward-seeking, this research aimed to connect inflammation to the use of a cognitive shortcut which has many implications for society and various fields of work (Forgas, 1998; Keinan, 1987; Eisenberger & Moeini, 2020). There was no difference in the use of FAE in the present study that was attributable to increases in immune system inflammation after receiving the influenza vaccine. Nevertheless, understanding how biology interacts with psychology in various situations will allow future researchers to dissect and grasp aspects of social cognition that are currently unknown.

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