

The Effects of Capsaicin on Sociability

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Abstract

The purpose of this experiment was to discover a possible correlation between capsaicin and sociability. The hypothesis predicts that ingesting capsaicin would cause an increase in sociability. Current literature suggests ingesting capsaicin leads to an activation of the sympathetic nervous system. Capsaicin also triggers the pain response leading to a release in endorphins. When the human body detects pain, it immediately attempts to counteract that sensation by releasing endorphins. We tested this hypothesis on 33 participants, 17 of whom in the control group, 16 in the experimental group. This was determined by a random generator in order to implement random assignment. The control group was questioned, then given a cookie at the end. On the other hand, the experimental group was given hot sauce, then questioned, then given milk and a cookie. We measured the duration of the conversation to determine sociability. Our results were insignificant, but further research could prove otherwise. Some implications include an uncontrolled environment and differing personality types, both causing low internal validity. Due to the low internal validity of our experiment, our findings are inconclusive.

Keywords: capsaicin, sociability, endorphins, sympathetic nervous system, pain response

The Effects of Capsaicin on Sociability

There has been minimal research with regards to a correlation between capsaicin and sociability, but current literature does allow us to hypothesize a relationship by piecing together information from various sources. Some sources discussed the effects of capsaicin on endorphins, while other sources provided information on how endorphins increase the likelihood of sociability. Therefore, linking these sources together we hypothesized that ingesting capsaicin will increase a person's sociability.

Capsaicin, derived from plants, is an alkaloid and is naturally occurring (O'Neill, Brock, Olesen, Andresen, Nilsson, & Dickenson, 2012). It is an odorless, colorless, hydrophobic substance and is not water soluble which explains why drinking water does not alleviate discomfort after consumption (O'Neill et al., 2012). A widely used heat measurement for capsaicin is the Scoville Heat Unit. This measurement is the highest dilution of a chile pepper extract at which heat can be detected by a human taste panel. (Bosland, Coon, & Reeves, 2012). Capsaicin is not only the main ingredient in hot chile peppers and spicy foods, but also elicits a burning sensation and induces a pain response in the brain (Caterina, Schumacher, Tominaga, Rosen, Levine, & Julius, 1997). In fact, a person's brain will experience the same effect by them biting into a jalapeno pepper as it would by them touching a hot stove (Borbiro, Badheka, & Rohacs, 2015). The heat of a chili pepper is not actually a taste (Borbiro et al., 2015). That burning feeling comes from the body's pain response system (Borbiro et al., 2015). Capsaicin inside the pepper activates a protein in people's cells called TRPV1 (Borbiro et al., 2015). TRPV1 is responsible for sensing heat and alerting the brain of this possible threat (Borbiro et al., 2015). The brain then responds by sending a jolt of pain back to the affected part of the body (Borbiro et

al., 2015). Capsaicin activates sensory neurons called nociceptors to transmit information regarding noxious stimuli (stimuli that can potentially cause tissue damage) to the central nervous system (Caterina et al., 1997). Nociceptors are neurons responsible for relaying information from damaged tissue to pain-processing centres in the spinal cord and brain (Caterina et al., 1997). Nociceptors are particularly sensitive to capsaicin which explains why capsaicin activates the pain response (Caterina et al., 1997).

Our brain comprehends this stimuli as a burning pain and responds to it by releasing neurotransmitters called endorphins (Sprouse-Blum, Smith, Sugar, & Parsa, 2010). Endorphins, or more specifically beta-endorphins, are the neuropeptides involved in pain management and the natural reward circuits such as feeding, drinking, sex and maternal behavior (Sprouse-Blum et al., 2010). Beta-endorphins are synthesized in the anterior pituitary gland from their precursor protein, proopiomelanocortin (POMC) (Sprouse-Blum et al., 2010). A hormone known as corticotropin-releasing hormone (CRH) is released when the body is faced with stressful experiences, such as pain (Sprouse-Blum et al., 2010). The release of CRH signals the hypothalamus to synthesize POMC which then helps synthesize beta-endorphins (Sprouse-Blum et al., 2010). Chili peppers can lead to enhanced secretion of endorphins (Caterina et al., 1997). In the case of chili peppers, the spicier the pepper, the more endorphins are secreted (Caterina et al., 1997).

Another neurotransmitter released by the brain in response to pain is dopamine. Dopamine in the basal ganglia (a cluster of neurons in the cerebral cortex) is involved in the pain response and contributes to individual variations in the physical and emotional pain experience (Scott, Heitzeg, Koeppe, Stohler, & Zubieta, 2006). Beta-endorphins, which are synthesized

during the stress response, bind to mu-opioid receptors and take primary action at presynaptic nerve terminals (Sprouse-Blum et al., 2010). They then exert an analgesic effect by inhibiting the GABA neurotransmitter release which results in excess dopamine production leading to increased pleasure (Sprouse-Blum et al., 2010). Dopamine, known as the happy chemical, and endorphins help people relax which leads to an overall warm affect (Pearce, Wlodarski, Machin, & Dunbar, 2017). In fact, dopamine effects brain processes that control movement, emotional responses and ability to experience pleasure and pain (Pearce et al., 2017). This increases excitability and sociability in humans (Pearce et al., 2017). Endorphins and dopamine play an essential role in facilitating friendships and social networks (Pearce et al., 2017). Researchers found that endorphins play a role in an individual's social predisposition (Pearce et al., 2017). Although endorphins were linked to a predisposition to being warm and helpful, dopamine was also linked to how well a person was connected to his or her social network (Pearce et al., 2017).

Due to the limited research we found based on a link between capsaicin and sociability, there has been many gaps in the current literature that have made it difficult to constructively build a strong foundation for our hypothesis. Although we were unable to find evidence that supported our specific hypothesis in the current literature, we did find evidence that suggests a link between capsaicin and pain management. (Sprouse-Blum, et al., 2010) This possible connection with pain management would entail the release of endorphins and dopamine, leading us to believe increased sociability is a plausible outcome of ingesting capsaicin. We did not find concrete evidence that supported our hypothesis, but we were able to infer about the possible outcomes capsaicin could have, such as sociability. We are inclined to research a possible connection between capsaicin consumption and increased sociability due to the severely limited

current research. By investigating this link, we will be helping to create a foundation for further research to build off of as well as attempting to connect existing information in order to create an entirely new claim.

Methods

Participants

Our study was comprised of students from California Polytechnic State University, San Luis Obispo. Based on Fall 2016 Cal Poly enrollment, the student body is made up of 10,821 men (53%) and 9,605 women (47%) (Cal Poly, 2016). The average age of the students is 20 years old. Out of these students, we had 10 males in the treatment group, and 6 females. For the control group, we had 5 males and 12 females, giving us 33 participants in all. We had one location for our experiment which we set up on Dexter Lawn between 10 a.m. to 12 p.m. on a Tuesday.

Apparatus and Materials

Before beginning the experiment, a consent form was given to the participant for them to sign. This ensured the university nor the researchers would not be liable for any allergies or bad outcomes during the experiment. We used hot sauce for the purpose of administering capsaicin to participants. We used Mad Dog 357 Hot Sauce for this experiment in order to get a great enough reaction from the participants when consuming such a small amount of hot sauce. As stated on the bottle, Mad Dog 357 Hot Sauce is 370,000 scovilles. Eight milligram plastic spoons were used for the purpose of measuring and providing hot sauce to the participants. All researchers wore latex gloves to ensure all materials remained sanitary. A coin was used to flip for randomly assigning respondents into either the treatment group or the control group. After the experiment

was completed, the participant was given a chocolate chip cookie. The cookie acted as an incentive for participating in the experiment. A five question questionnaire created by the research group was used to stimulate a conversation with the participant. The questions include: “tell me about your day,” “tell me about your major,” “why did you choose to come to Cal Poly,” “what do you like to do in your free time,” and “what makes you happy” in that order. The questionnaire created a standardized way for initiating a conversation to help prevent biases. The researcher could either respond with: “okay,” “that’s cool,” or “that’s too bad” in order to avoid differences between various researcher’s conversations. To measure the duration of the conversations, the researchers used a timer. The timer was started after the researcher asked the first question. Almond milk, soy milk, and regular milk were provided for participants if the hot sauce is too uncomfortable to handle. If the participant consumed milk before they finished answering the questions, their data was not included.

Procedure

This study attempted to identify whether or not ingesting capsaicin could predict an increase in sociability. The participants ingested capsaicin from an eight milligram spoon. Sociability was determined by the duration of the conversation between the researcher and the respondent. On Thursday March 22, 2018 from 10 a.m. to 12 p.m., our research group was set up on Dexter Lawn. There were four researcher positions, the data recorder, and the food distributor, the conversationalist and the timer. Some confounding variables that we controlled for included the time of day, day of the week, what was being conversed about, the setup of the table, who came to our table, and the length of our part in the conversation. We randomly assigned participants to the control group or to the experimental group by flipping a coin. Heads indicated

the experimental group while tails signalled the control group. Both groups were given a cookie while debriefing.

Furthermore, upon asking people if they wanted to participate in our study we stated: “We’re testing people’s responses to different types of food. Would you like to participate in our study? You’ll get a free cookie by the end of it.” If they were assigned to the control group, we waited 10 seconds after they ingested the hot sauce before beginning to ask the questions. If they were assigned to the experimental group, the cookie was used as an incentive and was given after the participant had been questioned. The food distributor gave the spoon of hot sauce to the participant, and once consumed, the researcher waited 10 seconds before asking the questions. After the hot sauce had been ingested, we stated “We will give you 10 seconds and then we will ask you a few questions,” and then did not interact with the participant for the 10 seconds. After the question had been asked, the data recorder started the timer. The conversationalist followed the guidelines described in the “Apparatus and Materials” section when replying to the subject’s response. Once the participant had finished their reply, the researcher asked the next question. After the conversation had gone through each of the five questions, the data recorder stopped the timer and recorded the duration of the conversation on a spreadsheet.

We then debriefed the participant to explain the true purpose of the study. We read directly from the debriefing form which can be found in the Appendix section. The cookie was given to the participant while they were debriefed. The participant was told the purpose of the experiment was to test people’s responses to different types of food before they were debriefed, but after the experiment the researchers explained the purpose of the study was actually to test capsaicin’s effects on sociability.

Once the data had been collected, it was calculated and graphed. The researchers performed a t-test and determined if there is a statistically significant correlation between ingestion of capsaicin (measured in scovilles) and an increase in sociability (measured in minutes and seconds).

Results

We hypothesized that an increase in capsaicin (hot sauce) consumption will lead to an increase in sociability. This hypothesis was tested using a t-test, and our data shows no significant effect, $t(31) = -.909, p = .37$, of capsaicin consumption increasing sociability. The table below summarizes the data collected by providing the mean, standard deviation, and standard error mean of the treatment and control groups.

Table 1

Mean Time Spent Conversing (in Seconds), Standard Deviation, and Standard Error Mean as a function of the conditions: Hot Sauce or No Hot Sauce.

<u>Condition</u>	<u>n</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Standard Error Mean</u>
Treatment: Hot Sauce	16	43.55	14.398	3.6000
Control: No Hot Sauce	17	49.5212	22.225	5.390

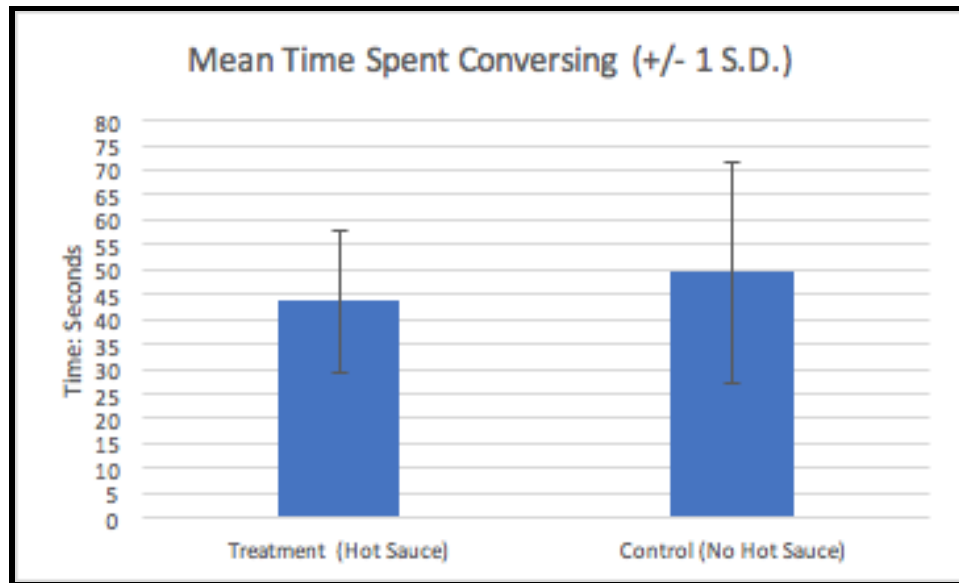


Figure 1. Mean Time Spent Conversing Bar Graph. This figure illustrates a bar graph of the mean time spent conversing between the treatment group and control group with error bars representing +/- one standard deviation. The mean time spent conversing of the treatment group was 43.55 seconds (SD = 14.398). The mean time spent conversing of the control group was 49.5212 seconds (SD = 22.225).

Table 2

The Five Number Summary and Interquartile Range of Time Spent Conversing (in Seconds):

Hot Sauce vs. No Hot Sauce

<u>Five Number Summary & IQR</u>	<u>Treatment: Hot Sauce</u>	<u>Control: No Hot Sauce</u>
Minimum	18.63	20.5
First Quartile	30.7275	31.39
Median Value	42.74	43.8
Third Quartile	52.625	66.09
Maximum	67.58	103.23
Interquartile Range	21.8975	34.7

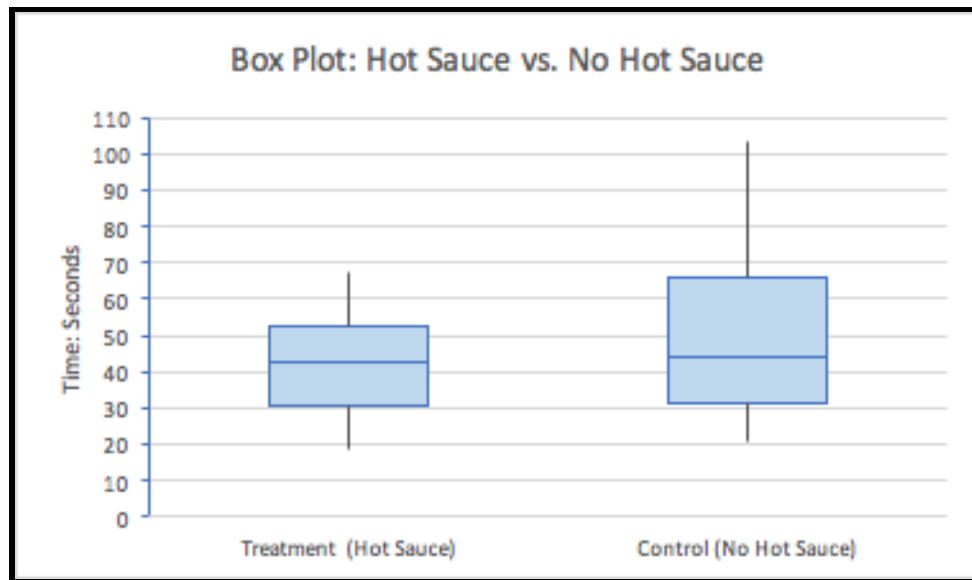


Figure 2. Box plot: Hot Sauce vs. No Hot Sauce. This figure illustrates a box plot has three main components: the median, the interquartile range box, and the whiskers. The treatment group has a median of 42.74 seconds. Most of the participants in this group had conversations between 30.7275 and 52.625 seconds, but some participants had conversations as low as 18.63 seconds and as high as 67.58 seconds. The control group has a median of 43.8 seconds. Most of the participants in this group had conversations between 31.39 and 66.09 seconds, but some participants had conversations as low as 20.5 seconds and as high as 103.23 seconds.

Discussion

We found no statistically significant ($p = .37$) findings between ingesting capsaicin and increased sociability. Our data displays that the hot sauce group had a relatively lower average of time conversing compared to the control group, which was the opposite of what we hypothesized. Our previous findings led us to theorize that because capsaicin induces a pain response, which is correlated with the brain response of releasing the neurotransmitters

endorphins and dopamine, the influx of these chemicals may provoke an increase in sociability. However, since our data and calculations produced a large p-value (> 0.05), our experiment indicates weak evidence against the null hypothesis, and so we fail to reject the null hypothesis. We can interpret our finding by researching other effects of capsaicin on the body. Capsaicin not only induces a pain response but also stimulates the sympathetic nervous system (Matsumoto et al., 2000). The sympathetic nervous system activates the fight-or-flight response and the body responds by preparing the individual to flee or face the immediate danger head on (Heber et al., 2010). In humans, the heart's beating speeds up, breathing will quicken, and an increase in blood flow will occur to give the body a boost of energy (Heber et al., 2010). In our study, the lower average conversation time with participants who ingested the hot sauce can be due to individuals wanting to flee thus decreasing the conversation time.

To go along with this, the lack of findings to support our hypothesis can also be a result of several confounding variables we were unable to control. One of the confounding variables was that the experiment was conducted outside on Dexter Lawn instead of inside. This may have affected our sample from Cal Poly students in that we were limited to the diversity of the people we interacted with because we were only outside at this specific location. Relating to this, the time we conducted our experiment could also be a confounding variable. We conducted our experiment between 10 a.m. to 12 p.m. on Dexter Lawn, which could have restricted our research to only students present in this specific place for the couple of hours we were there. Furthermore, we could have controlled for these variables by conducting our experiment in various locations, over the course of week at different times. In addition, the interviewers could have been a confounding variable due to the fact that we had multiple people in our group

reading off the questions for time sake, and to try and get as many subjects in the allotted two hours we had. The interviewers' appearance, facial expressions, tone of voice and gender could have been possible factors to do with this confounding variable, and in turn, could have skewed the data obtained from each conversation. We believe that this confounding variable could be the main reason why the control group has a large standard deviation.

Some methodological limitations to our study have to do with the actual consumption of hot sauce. We could not physically force students to volunteer to try hot sauce, and that maybe the subjects who were willing to participate were more open to trying new things, and more likely to be more chatty with the interviewers. Another limitation may have been the setting in which the experiment was conducted. As stated previously, we setup our experiment outside on Dexter Lawn, and many times during a conversation, an outsider would interrupt asking what was going on, or the actual subject would get distracted by the surrounding people who were being noisy with questions.

Future studies will want to consider these confounding variables and limitations when replicating our study. The primary goal of initial future studies would be first to improve the internal validity. Researchers can perform their research in a more controlled setting such as a lab to prevent possible disturbances from other people or influences from surrounding the area. Also, limiting the number of interviewers to just one researcher can help control the variability among the differing characteristics of each interviewer. If future research can find evidence in supporting our theory, the next goal will be to improve external validity. Researchers could focus on collecting a random sample from a more diverse population so that the research could be generalized to a broader population. Ideally, a simple random sample of the world population

would be best. More realistically, researchers can perform a stratified random sampling technique at a university. Strata can be based on the school year, and after the population is divided, the researcher randomly selects the sample proportionally.

A possible area of future research can address the effects of varying levels of Scoville on sociability. Testing whether or not an increase in Scoville score will lead to an increase in sociability. Our study only examines the effects of one hot sauce at 370,000 Scovilles. So it would be interesting if future research can use a range of hot sauces with differing Scoville levels. Researchers can randomly assign each participant to a different hot sauce group with a determined Scoville level. Then perform a similar conversation procedure to measure sociability. The data collected can then be used to determine if there's a link between an increase Scoville levels and sociability. Overall, the Spicy Five hopes future research will help clarify the relationship between the effects of capsaicin and sociability.

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Appendix A

Conest Form

I, _____ acknowledge that I am participating in the indulgence of eating very spicy foods which may or may not cause abdominal and or gastrointestinal discomfort as a result of my own action in eating the food given. The experimenters have made it clear to me that this spicy sauce is extremely hot. I also acknowledge that eating any concentration of spicy foods that have the spicy pepper ingredients may or may not cause gastrointestinal or abdominal distress for an unknown period of time and to an unknown extent. I hereby state that I have no known or unknown health condition(s) including respiratory or cardiac illnesses that may be aggravated by such and in case there is, California Polytechnic State University San Luis Obispo, Max Diep, Olivia Martinez, Ryan Untalan, Hannah Fin, Brando Phillips, and Shaun Perisho, its employees or affiliates shall not be held responsible or liable for any action in which I elect to consume any food that may or may not aggravate or cause any condition as a result of my consuming or over consuming these spicy foods that contain distilled vinegar, 3 million Scoville chilli extract, evaporated cane juice, fresh Habanero peppers, garlic, onion, 160,000 Scoville Cayenne pepper, spices, and xanthan gum. While it has been made clear to me that highly intense spicy foods have been known to cause undesired effects such as overall discomfort, abdominal or gastrointestinal discomfort, flush, dizziness, extreme burning sensation, tearing, numbing, tingling and post digestive discomfort on a temporary and or possible permanent basis. Should I experience any of these affects I shall hold California Polytechnic State University San Luis Obispo, Max Diep, Olivia Martinez, Ryan Untalan, Hannah Fin, Brando Phillips, its employees or affiliates harmless for my indulgence in such and any undesired result thereafter due to any activity that includes consuming extremely spicy foods or overindulgence therein.

Signed: _____ Date: _____

Participant Printed Name: _____

Witness Sign: _____ Date: _____

Witness Printed Name: _____

Appendix B

Outline of Interview Questions and Guidelines

Preface the questions with saying: “Okay, now I’m going to ask you a few questions.”

Start Timer after question 1 is said.

Questions include:

- 1) “Tell me about your day.”
- 2) “Tell me about your major.”
- 3) “Why did you choose to come to Cal Poly?”
- 4) “What do you like to do in your free time?”
- 5) “What makes you happy?”

This questionnaire will create a standardized way for initiating a conversation to help prevent biases.

Guidelines to what we can respond: “Okay” (with head nod), “That’s cool”, or “That’s too bad”