

Caffeine Dependence: The Proof is in the Cup

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Abstract: The controversy over caffeine and its effects have been presented to society ever since the beginning of advertisements. It seems like every year a new finding or study changes the opinion about caffeine. Coffee has been the focus of many of these studies and whether or not it leads to serious physiological complications has fluctuated as well. Coffee, with its backbone being caffeine, is considered one of the world's most popular beverages creating the ability to trace its evolution and its possible future in our culture. The purpose of this paper is to explore how Newton's Second Law of Motion can show how different forces regarding the caffeine debate, is leading society towards increased dependence on caffeine. Although many beverages consumed have caffeine, the focus will be more on its relationship to coffee. Different types and forms caffeine can be found in other sources will be mentioned but as aforementioned the main focus will be its presence in coffee.

Whether it's going from one destination to the next or changing to a new bodily position, these actions require motion. In physics, motion is defined as movement or a change in position over time. Clearly we are not static but dynamic individuals. Sir Issac Newton's Second Law of Motion is proof that he believed certain outcomes can be determined. He felt that an object succumbing to certain forces will have a definite direction and motion due to those forces. Our daily lives are filled with changes and the coping responses depend on the individual. It appears caffeine has become one of the more common forces that people turn to in order to deal with these changes. Caffeine and its effects are justified due to caffeine's role in many individuals' lives. The uncertainty about caffeine's overall psychological effects is the issue at hand due to the ambiguity it leaves us with about our future. If there was a way to eliminate this ambiguity, we would be able to stop arguing about who is right and focus on how to resolve the problem which is the overall effect

that caffeine is playing on society. By applying Newton's law we can see that forces in society are accelerating us towards increased dependence on caffeine.

In order for an object to move or change its orientation there has to be a force. Gerd Buchdahl is a German-English philosopher of science. He was the first lecturer in History and Philosophy of Science at the University of Cambridge and founded the Journal Studies in the History and Philosophy of Science. He explains this concept of movement by stating, "'An impressed force is an action exerted upon a body, in order to change its state, either of rest or of moving uniformly forward in a right line,' A short modern rendering of this would be roughly: Force produces acceleration" (Buchdahl 220). Buchdahl restates a component of Newton's Second Law. For an object to change its position a force needs to be applied. This object can be either moving or static. In other words, forces can determine the overall motion of an object. We can consider society as a moving body that changes and grows every day. It is pertinent to understand that although there can be varying degrees of forces; it is their sum that determines the overall direction. Therefore, certain aspects of the caffeine debate, such as its addictive nature or its overall biological effects, may seem insignificant on their own but their effects emerge once coupled with other related forces.

The major force on society is the debate on caffeine and its health effects. Every year it appears that a new study is released claiming to have found the true effects of caffeine on our bodies. One year researchers tell us to increase our consumption and the next they are telling us caffeine leads to complications. This constant pulling in opposite directions is the basis of the caffeine ambiguity. Many of the studies released are focused on coffee-based caffeine. This focus on coffee results in a guilt trip placed on society due to the common misconceptions about caffeine. For example, many of us have heard not to drink coffee because the caffeine in it is unhealthy; however coffee in itself is not unhealthy. Roseane Santos PhD, whose research focuses

on the bioactive compounds found in coffee at South University, and Darcy Lima PhD, whose research focuses on coffee's effect on human pleasure, explores the misconceptions presented about coffee. Santos and Lima state, "Black coffee is naturally diet and contains zero calories-it's how you 'dress up' your coffee with extras that can make a difference in its fat, sugar, and calorie count" (Santos and Lima 20). The authors are addressing the issue of how unhealthy certain sources make coffee appear to be. The coffee bean comes from a plant and if that bean is ground and mixed with water, there shouldn't be any calories. However, it is when you add milk, sugar, or coffee creamer that the calories and fat increase significantly. Therefore, coffee is in its healthiest state when it remains as close to its natural state as possible. Santos and Lima also mention that some of the substances found in coffee are beneficial for the body: "Coffee is rich in nutrients... Green coffee has proteins (11%) and amino acids (Less than 1%). Caffeine is the backbone of coffee; it is indestructible, while all other substances are not" (Santos and Lima 26). It is important to note they mention these substances are found in "Green coffee," which is the seed before roasting and after processing. The more beneficial compounds like amino acids and proteins are broken down when exposed to the high temperatures and processing during roasting. Caffeine is able to survive this process which is why it is the backbone of coffee; it will always be there. Even in decaffeinated products caffeine is present. The term "decaf" only means that the product contains less than 2.5% of caffeine. However, stating that caffeine will always be found in coffee opens the door for a paradox.

If caffeine is always found in coffee then the concern over possible health consequences cannot be disregarded. Studies have shown that caffeine has led to increased discoveries of cancer in various parts of the body. A study performed at Harvard Medical School found connections between caffeine and ovarian cancer. Their research concluded, "Caffeine was found to be inversely associated with ovarian cancer risk in a large retrospective case control study... this association was stronger in postmenopausal women and never oral contraceptive

users” (Tworoger 2). The study was taken in postmenopausal women at the primary stage of ovarian cancer. Using a questionnaire the study was to determine the significance of certain risk factors such as smoking, caffeine and alcohol consumption. Although those who smoked and consumed more alcohol showed signs of tumors elsewhere, those who consumed more caffeine had higher occurrences of ovarian cancer. Even with these published results, the study does not leave the public with a clear understanding of the effects of caffeine. Those who drank alcohol and smoked could have had a suppressed immune system making them more susceptible to cancer. It is possible caffeine may not have anything to do with it as age may play a part as well. The study should have included the ovaries of both postmenopausal and premenopausal women to determine the effect of time. Consumers are still left asking if caffeine leads to this type of cancer in only postmenopausal women.

When exploring the other side of the physiological effects of caffeine, a separate epidemiological study was performed by Karin B. Michels, ScD on Swedish women to observe the occurrence of breast cancer in these individuals. Michels’ purpose was to provide evidence of an association between caffeinated beverages and the risk of breast cancer. The researchers found, “Among this cohort of women assembled in two counties of central Sweden—a country with the highest per capita consumption of coffee in the world...we found no association between self-reported coffee, black tea, and caffeine consumption and subsequent breast cancer incidence” (Michels 1). Similar to the Harvard study, these researchers also used statistical methods in order to reach their conclusion. The fact that the research was done on Swedish women is a significant contrast to the ovarian cancer study. Michels found Sweden to have the highest consumption of coffee in the world. Therefore, their caffeine consumption should be higher as well. If there were not a relationship between breast cancer and caffeine people would feel more at ease about drinking caffeinated beverages. Unfortunately, breast cancer is also only one type of cancer. This study may not have been focusing on the ovaries of these women where cancerous cells could

be forming. The study was also taken on a similar age bracket as the Harvard study. Ages 40-76 or postmenopausal women were given the questionnaire leaving younger women still in doubt about caffeine’s effect on them. Similarly, these studies weren’t performed on men, so the carcinogenic nature of caffeine is being portrayed as gender specific. Such ambiguity leads to uncertainty about what to believe as a fact or what to take with a grain of salt. This uncertainty forces some individuals to just ignore everything and continue about their daily routines; some of which include high consumption of caffeine throughout the day. What these researchers need to realize is that they should communicate between themselves.

The scientific community believes that a hypothesis cannot be proven but only disproven. This rule has led to the scientific community constantly attempting to outshine or disprove one another. Research labs have become a modern day warzone where the weapons of choice are pipettes and victories are publications. It seems like each scientist approaches a commonly accepted view on a topic and devotes time to disprove it by making new discoveries. Scientists’ research each focuses only on a specific location of the body when what is needed is a clear understanding of how caffeine affects the body as a whole. Cathy Davidson, a professor and researcher into human behavior, understands the consequences of focus when she states:

Without focus, the world is chaos; there is simply too much to see, hear, and understand and focus lets us drill down to the input we believe is most useful to us. Because focus means selection, though it leaves us with blind spots and we need methods for working around them...and that’s the annoying lesson of attention blindness. The more you concentrate, the more other things you miss (Davidson 2).

As explained by Davidson, the reason why research must focus on a specific topic is because the body and its functions are too vast to tackle all at once. However, this attention blindness leads to missing the big picture. The researchers in Sweden who concluded caffeine is somewhat safe because there wasn’t evidence of breast cancer in individuals were

not looking at women's ovaries like the researches at Harvard. Yet how can we blame them when, the ovaries were not their focus. If every researcher took their smaller focuses and combined them, we would be able to see caffeine's effect on the body as a whole. Some of the ambiguity would be cleared and this force could be eliminated as an issue.

Furthermore, when exploring Newton's ideas we learn that a force, imposed on an object results in acceleration of that object. Gerd Buchdahl explains, "Acceleration is the fundamental aspect under which force is henceforth to be considered. The definition implies that it is possible to determine some circumstances in a complex situation in which a certain body(particle) is given a certain acceleration- this circumstance being called a force" (Buchdahl 221). The author analyzes the force and acceleration relationship from another perspective. He claims it is possible to predict certain forces that produced acceleration, if that acceleration value is given. According to Newton's Second Law force is directly proportional to acceleration. Therefore, if we are able to determine the acceleration given a force, we should also be able to determine force given acceleration. Interestingly, we can also apply this to human behavior.

Caffeine's chemical effects on our brains are clearly another force while society's overall dependency is Newton's component of acceleration. As we consume caffeine it appears to be having an effect on our brains that alters our behavior. Joyce H. Lowinson, in her book Substance Abuse: A Comprehensive Textbook, discusses various substances that are commonly abused and their effects on the human body. She mentions caffeine as one of these substances and the relationship between caffeine and behavior is further explained, "Caffeine is a widely used mood-altering drug that shares some features with classic drugs of abuse (e.g., use despite harm, difficulty stopping use, withdrawal, tolerance). Therefore, it's not surprising that caffeine is sometimes labeled a drug of abuse or addiction" (Lowinson et all 415). Caffeine can be considered addictive because its effects on the

body shares some of the characteristics usually associated with other commonly abused drugs. These similarities further the idea that caffeine has some health risks. Some scientists deem caffeine worthy to be on a list next to drugs such as cocaine or alcohol due to the similarities of effects on the body. Symptoms like withdrawal and difficulty refraining from use puts the direction of our society into perspective. We have come to a point where after extended use we cannot go throughout our days without caffeine. Evidence of this challenge is also explored by Lowinson who states, "There are no published reports of treatment interventions designed to assist individuals who would like to completely eliminate caffeine...one study involving very heavy caffeine consumers found 4 week structured fading program was more effective than self-guided reduction" (Lowinson et all 416). Here, there is a reference to a study performed by Stavric B whose research focuses on pharmacophysiological effects of coffee/caffeine. This study, as described in Jack E. James' article "Caffeine Fading: Behavioral Treatment of Caffeine Abuse" in the Behavior Therapy Journal, outlines how chronic caffeine consumers were observed attempting to reduce their consumption to healthier levels. There were three groups; one tried quitting through self-reduction, another tried specific guidelines for gradual reduction or "fading", while the final group tried fading plus relaxation. Those who used the fading techniques showed significantly lower dependence in the same amount of time than the self-reduction group (James et all 1). Lowinson argues that caffeine is so addictive that once someone is hooked, they cannot completely be free of it, or it takes a while to wean down to lower dosages. His statement strengthens the argument that caffeine should be listed in the addicting drugs column among alcohol or cocaine. In some ways, people could argue that caffeine addiction is worse. Although the chances of fatality among chronic cocaine users seem higher than that of chronic caffeine drinkers, according to Lowinson there are no rehab programs or caffeine detoxes available for caffeine consumers. The study resulted in a 4 week reduction in caffeine usage but not complete refrain from use because caffeine needed to be

continually consumed to avoid withdrawal symptoms including dizziness and cramping.

However, other researchers argue that the negative effects of caffeine can be avoided through coffee consumption. Santos and Lima suggest, “The chronic intake of coffee can lead to tolerance to the humoral and hemodynamic effects of caffeine, which prevents caffeine from being a more consequential risk factor to human health” (Santos and Lima 33). When the authors mention humoral and hemodynamic effects, they are referring to the immune system’s response to caffeine and its effects on circulation respectively. However, is this truly a solution? What Santos and Lima propose is simply replacing one addiction with another. Unfortunately the message has already been sent and its force has contributed to society’s direction toward dependence. The National Coffee Association (NCA) is a trade organization dedicated to protect the interests of coffee companies. Part of their job entails recording the average coffee consumption annually. The NCA recorded a seven percent increase in consumption from 2011 to 2012 alone (NCA 1). Drinking more coffee is not solving the issue of caffeine’s negative effects instead it is only masking it. People start to believe that they are safe from the side effects of caffeine as long as they continue drinking coffee. This thought process leaves them with only one direction to take; the one towards dependency.

Moreover, the forces producing acceleration not only works for one object but multiple ones as well. Newton proved in his Second Law that multiple masses in motion, when exposed to the same forces, will have the same end result. Buchdahl states, “[Newton] infers from his pendulum experiment that since different masses have identical constant accelerations...a constant force is acting the magnitude of which is proportional to the masses of the bodies concerned” (Buchdahl 225). Buchdahl explains that regardless of the magnitude of the masses, they will all have the same constant acceleration. Due to the relationship between force and acceleration the force will also be the same on the masses. Applying this component of the law on society shows us that

the same forces or circumstances act upon all of us, regardless of our individuality. This also suggests that everyone experiences the same acceleration. This does not mean that we all are going to be addicted to caffeine; it simply infers that society as a whole will be moving in the direction of overall dependence on the stimulant.

Caffeine’s power and its hold over our brains are evidence of its addictive quality. Through this capability the world is exposed to the effects caffeine can have on our social behaviors. The ways we interact with others or make it through an eight hour workday are all altered when we consume caffeine. Once people succumb to a caffeine addiction guised as a coffee one, evidence of their dependency is found in their behaviors. Astrid Nehlig PhD, a French research director at the French Medical Research Institute, explores this evidence in her book Coffee, Tea, Chocolate, and the Brain. For example many people cannot start their days properly without a cup or two of coffee in the morning. Nehlig explains why when she states:

In a survey of 19 studies on humans receiving dietary doses of caffeine 17 reported increases in epinephrine, 4 of which also showed increased norepinephrine....The increase in epinephrine has been observed under resting conditions, in the laboratory and at home, and in the workplace during periods of normal work demand (Nehlig 121).

When someone is placed under stress the body has certain mechanisms to deal with it and to return itself back to a level of normalcy. Here Nehlig’s survey revealed people who had moderate or normal amounts of caffeine showed an increase in catecholamines which are hormones also known as Epinephrine and Norepinephrine but, more commonly known as Adrenaline and Noradrenaline. When the body experiences stress, the adrenal medulla in the sympathetic nervous system (SNS) triggers the release of catecholamines. The SNS is responsible for our fight or flight response, which essentially helps us decide the best way to escape a stressful and sometimes dangerous situation. If this study showed an increase in catecholamine release, even when the body is not under stress, the conclusion would reveal a lot about the effects of caffeine on

our brains. Caffeine manipulates our SNS to increase our alertness and ability to process certain situations. The body becomes accustomed to this manipulation and later becomes dependent of these new levels of alertness; evidence of caffeine's addictive nature.

Individuals, who cannot function until they consume caffeine, show how functionality can become dependent on caffeine. Some also need multiple doses of caffeine simply to keep them alert and get them through the day. Furthermore, society uses caffeine to not only stay awake but to assist when socializing with others. Santos and Lima explore this aspect of our behaviors when they claim, "The aroma also has an impact on areas which play key roles in social attachment and friendship reward mechanisms. This may explain why coffee is a unique socializing beverage..." (Santos and Lima 13). The aroma, they concluded, has a chemical effect on our bodies. This effect is observed in the social attachment and friendship mechanisms that are triggered inducing our need to socialize. During many social gatherings coffee is a common beverage in attendance. Coffee makes the social atmosphere more casual by allowing us to interact more openly with one another. Society has reached a point where something as second nature as social interaction needs the assistance of coffee. Many venues for small meetings or places to unwind tend to be scheduled at Starbucks or local coffee houses. Santos and Lima clarified why coffee makes us feel more sociable but their point introduces us to another force accelerating society deeper into dependence.

The media plays a role and is invariably another force. Not only is the media the medium in which the caffeine debate is delivered to society, but it is also a biased tool used to further push society into dependence. Many advertisements are for energy drinks loaded with caffeine or for the grand opening of a new Starbucks. You rarely find an advertisement for information on how to decrease caffeine consumption. Similarly television shows often picture coffee as the standard drink. The popular show *Friends* had its main socializing location at the corner coffee shop where the show's characters were pictured laughing

and enjoying themselves; clearly it wasn't water the characters were supposed to be drinking. Society views these images and it is no wonder why everyone feels obligated to drink caffeine. Portrayed as the norm, drinking coffee leads to the assumption that people drink coffee just because everyone else does.

The vulnerability of society to external forces is not to be taken lightly. As we have seen certain forces when combined can have negative effects such as dependency. However, some scientists argue that the Second Law may not be applicable to natural processes. Dr. Jos Uffnik is a researcher who devoted his life to explore this uncertainty. He states:

An important aspect of reading 'possibility' in this way is that the question of whether a process is possible or not, is not decided by the theory, but by 'the furniture of the world', i.e. the kinds of systems and interactions there actually are... It is not a claim to be judged by a theory, but a constraint on all physical theories, even those to be developed in the future. Clearly, the idea that the second law is such a claim helps explaining why it inspired such feelings of awe (Uffnik 8).

Uffnik's main concern is the definition of possibility. If a universal understanding of what is possible is defined then perhaps the Second Law can be applied to natural processes. Therefore, the ambiguity of caffeine's true physiological effects complicates the application of the Second Law to human lives. Uffnik feels that some theories should not define the world's capabilities. In other words, if the Second Law claims that there is only one direction of acceleration, that doesn't mean there can't be another direction. He feels there should be a more holistic view on the law; other theories coupled with it could define possibility. Uffnik's point serves as a metaphorical light at the end of the tunnel for society. Overall dependence and addiction doesn't have to be its fate. If the proper steps are taken, we may be able to go back to the way it was before the caffeine debate began but those steps are still unknown.

In the 18th century, Newton revolutionized the way the world of science understood objects in motion, and he appears to still be teaching us nearly 285 years later. Newton's Second Law is a template for all

bodies in motion and society fits well within it due to our dynamic state. Although each person leads individual lives, with separate changes, and different outcomes, the truth of the matter is we are all connected in some way. Whether it's through social media or cultures one's actions effects another's even if it is indirectly. Therefore, due to our relationships with each other, the forces applied effects the entire mass and moves it as a whole in a certain direction. The ambiguity of that direction is what leads to controversies and research to explain the unknown. We all want to know what the future holds. In the case of caffeine, the answer to whether it is healthy or unhealthy is not so simple. The amount of growth society needs to endure, to understand effects of caffeine, is still significant and seems to be taking society on an interesting ride accelerating towards dependence. However, once we fully understand the physiological effects and are rid of these growing pains, we can focus on moving in the opposite direction of dependence.

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