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A Nicotine addicted dog

A mixed methods case study of the effects of limited metacognition and situational comprehension on a dog's addiction recovery potential

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Abstract

This investigation delves into the unique dimensions of addictive behaviours in canines. The study employs a mixed methods case study of a specific dog's persistent preference for nicotine, exploring the role of limited understanding in addiction recovery. The hypothesis suggests that nicotine craving in the dog is tied to her experienced withdrawal symptoms' intensity due to the absence of psychological factor that initiate and maintain addictive behaviour in humans. This implies that her craving for nicotine will dwindle as her withdrawal dissipates. This connection could, paradoxically, also hinder her ability to maintain abstinence without external aid, as the dog might simply forget recall the substance as pleasurable and its effects as non-harmful. A longitudinal, repeated measures design was adopted to illuminate this situation. A two-phased strategy comprised of an initial pilot with ten daily measurements (N=10), followed by a prolonged phase of five measurements taken every three hours for twenty days (N=100) was eomployed. The dog's choice between essential stimuli (food), addictive stimuli (nicotine), and neutral stimuli (toy) was the dependent variable. Time, the independent variable, was assumed to correlate negatively with the intensity of her withdrawal symptoms. The findings reveal an initial high preference for nicotine, followed by an increasing preference for food over time, with a significant difference in choices in the latter half of the experiment. These results imply that limited metacognition may positively impact her initial addiction recovery potential but limited situational comprehension may also hinder sustained sobriety without external intervention, as well as illustrating that species-specific addictive behaviours in non-human animals, such as dogs, might deviate from those in humans. While these findings are not conclusive, they open avenues for further research into animal addiction and species-specific behaviours in the context of addiction recovery.

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A Nicotine addicted dog

Addiction is a complex phenomenon that effect a significant minority of the general population (Sussman et al., 2011, pp. 40-42) and involves several intricate cognitive mechanisms. While these mechanisms and factors influencing addictive behaviours have been studied extensively in humans (Bonner et al., 2022; Garland et al., 2016; Hamonniere & Varescon, 2018; Hofmann et al., 2012; Kavanagh et al., 2005; May et al., 2014; Spada et al., 2014), understanding of these factors particularly in relation to limited metacognition and basic comprehension in animal addiction, remains limited. Lower levels of consciousness compared to humans (Edelman & Seth, 2009, pp. 476,477) may contribute to the dogs inability to understand the consequences of her actions, recognize it as harmful and thereby regulate her use. The role of metacognition and situational comprehension in relation to the dog's craving affecting, as well as their combined effect on her addiction recovery potential, is the focus of this paper.

Studying limited understanding regarding animal addiction, may help us determine the species-specificity of non-human addictive behaviours, i.e., the degree of translatability to human subjects one can attribute results from animals in addiction research.

The term "craving" has often been used to describe extreme instances of desire, however, in accordance with Kavanagh et al. (2005, p. 29), this paper will define this term to simply encompass the dogs desire for nicotine.

Metacognition

Metacognition (MC) can be conceptualized as "the ability to think about one's own thinking" (Norman et al., 2019, p. 417). A higher form of cognition where one is aware of the thoughts and desires that drive one's actions. There are several models of MC with a range of complexity and definitions (Norman et al., 2019, p. 418). However, according to Norman et

al. (2019, pp. 419, 417) one can define it simply as the “ability to reflect upon and let behaviour be guided by knowledge about one’s own mental states” which should be viewed as "a level of human functioning."

This suggests that MC is something inherently human, which one might justifiably assume. And while there is ongoing debate about the level of metacognitive functioning in non-human species, including dogs (Belger & Bräuer, 2018, p. 405; Jonathon & Allison, 2009, p. 14; Roberts et al., 2012, p. 105; Smith, 2009, p. 394), results are not entirely conclusive and calls for more research. The success of experiments regarding animal MC is in large part dependent on how one operationalise the concept and make it available for the animal, as also described by Roberts et al. (2012, p. 86). Furthermore, the level of cognitive capabilities will also variate between different breeds of dogs (Horschler et al., 2019, p. 196) and may also be dependent upon the training and mental stimulation a canine receives. It is not feasible to determine the degree of the dog’s cognitive capabilities in this instance, as it is generally challenging to define and measure animal cognition. On the other hand, it is fair to assume that canine MC is limited when compared to a humans metacognitive capabilities.

However, even if one assumes the dog has some level of MC, she still has no meaningful way of conceptualizing what she is craving or feeling, as she does not know what nicotine or addiction is due to her limited situational comprehension (SC), she can simply know that this substance will relieve her craving. Therefore, In the context of this paper, I am not interested in her information-seeking behaviour (Belger & Bräuer, 2018, p. 410), but rather her presumed limited MC compared to a human, in relation to the craving affection she experiences due to her preference for nicotine.

Situational comprehension

Consciousness, which involves self-awareness, awareness of others, and the ability to reason and process complex information, is obviously limited in the dog when compared to a human subject (Edelman & Seth, 2009). Consequently, the dog does not understand what nicotine or snus is and is thereby may be unable to grasp the long-term consequences of her actions, which also prevents her from recognising the negative impact of her preference for nicotine in general. The limited ability to process complex information is the reason for her inability to conceptualize, understand and comprehend the reasons for her intrusive craving for nicotine and their consequence. What this paper refers to as situational comprehension.

The term MC is defined in the context of this paper as to also encompass the cognitive qualities that would enable the dog to evaluate and elaborate upon her craving affection. While situational comprehension refers to the level of which she can conceptualize, understand, and comprehend her situation and the reasons for her addictive behaviour.

Addiction

The World Health Organization (2022) International Statistical Classification of Diseases and Related Health Problems, 11th edition, defines addiction as a behavioural disorder that develop as a result of the use of mostly psychoactive substances or repetitive and rewarding behaviours (p. 451), but it can be defined simply as "a disorder in which an individual becomes intensely preoccupied with a behaviour that provides a desired or appetitive effect" (Sussman et al., 2011, p. 4). An addiction may, in theory, involve any kind of behaviour or substance that is pleasant or subjectively rewarding and then repeated in a pattern of harmful use.

Nicotine Addiction

Nicotine dependence is a syndrome defined by the World Health Organization (2022, p. 510) International Statistical Classification of diseases and Related health problems (ICD-11) as “a strong internal drive to use nicotine, which is manifested by impaired ability to control use, increasing priority given to use over other activities and persistence of use despite harm or negative consequences.”. Given that she presumably does not experience it as harmful, and the absence of an understanding regarding the negative consequences of her use, it is worth noting that it may be problematic to compare the dog’s preference for nicotine with human nicotine addiction due to her limited SC, which is the reason for the term “Her preference for nicotine” as opposed to “addiction to nicotine” when referring to her situation.

Dependency to nicotine is “a disorder of regulation of nicotine use” which develops from repeated and continuous nicotine exposure over time and manifests as an abstinence syndrome “4–24 h following cessation of chronic use of nicotine-containing products" (McLaughlin et al., 2015, p. 1) and lasts tonically for 10 days (Shiffman et al., 2006, p. 183), an increase in craving has been observed during the first 3 days, before declining to reference within 3-4 weeks (McLaughlin et al., 2015, p. 1).

There are also cognitive effects of nicotine, such as enhanced memory and increased attention span, and thus, naturally, coherent negative cognitive effects when nicotine use ceases, such as reduced memory and difficulty concentrating (Heishman et al., 2010, p. 463). The cognitive deterioration that ensues cessation of prolonged nicotine use may explain why someone might return to nicotine use even after withdrawal symptoms cease to be prominent, as the enhanced cognitive effects will naturally diminish correlational to the amount of nicotine used (Heishman et al., 2010, p. 463) which may strengthen their recollection of nicotine as something pleasurable and beneficial.

Nicotine is associated with the neurotransmitter acetylcholine which affects the brainstem, forebrain, striatum, hippocampus, thalamus, basal ganglia, cerebellum and influence cognitive functions such as motivation, learning, memory and mood (MacNicol, 2017, p. 143).

Since "All substances of abuse ultimately activate the brain reward circuit via a dopaminergic effect and induce a period of decreased dopamine activity during withdrawal" (MacNicol, 2017, p. 143), and research on animals have been done to determine this (MacNicol, 2017, p. 143), the translatability of the effects of this damaged reward circuit is presumably at least partially valid. This suggests that the dog will experience to some extent a similar experience of nicotine withdrawal as a human would, but no research was found on the cognitive effects of nicotine in dogs.

Addiction recovery potential

Addiction recovery potential (ARP) can be defined simply as, the likelihood of an individual's ability to overcome addiction and maintain sobriety.

According to the Elaborated Intrusion Theory of Desire (Kavanagh et al., 2005; May et al., 2014), cravings originate from intrusive thoughts which may be triggered by environmental cues such as smell or sight, or internal states such as hunger or restlessness. These intrusive thoughts are then maintained by cognitive elaboration, which is an active, conscious process, where the person imagines scenarios related to the desired substance which in turn makes the desire more vivid and intense. Kavanagh et al. (2005) notes that one important distinction in this context is that "desires are direct experiences rather than MCs" (p. 447), but the evaluation and rating of one's desires is a metacognitive process. In other words, the dog's intrusive craving is a direct, automatic process, while her evaluation and mental elaboration upon that sensation is a metacognitive process.

Metacognitive beliefs are positively correlated with addictive behaviour (AB) (Bonner et al., 2022; Hamonniere & Varescon, 2018). According to a systematic review, "metacognitive beliefs contribute to the initiation and perseveration of addictive behaviour because they promote harmful thinking styles and dysfunctional coping strategies" (Hamonniere & Varescon, 2018, p. 60). Both positive and negative metacognitive beliefs regarding ones desires and mental capabilities have been shown to be in large part associated with the severity of AB (Hamonniere & Varescon, 2018, p. 61). On the other hand, MC is also an important component of many cognitive-behavioural therapies (CBTs) and Mindful-based interventions, both of which have been shown to be effective in treating addiction (Garland et al., 2014, p. 12; Garland et al., 2016, pp. 60-61; Hofmann et al., 2012, p. 428). MC allows individuals to recognize their cravings, identify the thoughts and feelings that trigger these cravings, and develop healthier coping strategies(Garland et al., 2014, pp. 11-12; Garland et al., 2016). I.e., being aware of one's vulnerability with regard to intrusive desires and consequently changing one's behaviour to avoid relapse, is also in and on itself, a metacognitive capability.

In summary, MC plays a crucial role in the initiation, maintenance, and cessation of AB. MC may be crucial for maintaining AB. But without understanding the causes behind one's abstinence and merely recalling the substance as pleasurable due to limited SC, it raises the question of whether the AB under scrutiny can ever be recovered from. In essence, as the withdrawal dissipates, so might the intrusive desires, but the absence of the mindful ability to change one's behaviour to avoid relapse may interfere with the ability to maintain abstinence over time. This suggests that lack of metacognitive awareness may increase an individual's potential for initial recovery due to the lack of mental elaboration upon desires but might paradoxically also interfere with the ability to maintain sobriety over time without external aid.

Research question

Considering that MC is a crucial factor in initiating, maintaining, and ceasing AB, it raises the question of how the dog's limited metacognitive capabilities may affect her ARP. What would occur if a non-human, non-operant, nicotine-dependent dog with limited MC functioning and understanding was given a choice between three distinct stimuli (e.g., nicotine, food, and neutral stimuli) over an extended period while maintaining forced abstinence? Would the dog's preference for nicotine alter over time and, if so, could it be negatively correlated with her presumed withdrawal symptoms?

In other words, will she crave it forever, or will her desire for nicotine diminish over time?

Hypothesis

A dogs metacognitive abilities, as studied by Belger and Bräuer (2018) and Roberts et al. (2012), may play a role in the dog's inability to fully comprehend her craving affection, which may cause her to not experience the same mental factors that maintain and increase the severity AB in humans (Bonner et al., 2022; Hamonniere & Varescon, 2018);(Kavanagh et al., 2005; May et al., 2014), implying her intrusive craving for nicotine might be linked to her withdrawal symptoms. The main hypothesis is that the dog, being non-consciously aware of her preference for nicotine beyond her craving affection, will not comprehend the reason for or elaborate upon her intrusive craving. Thus, the intensity of her craving for nicotine is likely dependent upon the level of withdrawal symptoms she experiences at any given time.

As mentioned in the nicotine addiction section, we may observe an increase in her craving for nicotine during the first experiment (Shiffman et al., 2006, p. 183), before declining to baseline within four weeks. Her craving for nicotine should decrease during the course of the second experiment and negatively correlate with her withdrawal. The number of days elapsed

since the start of the experiment should correlate positively with her increased preference for food and the proportion of food chosen should be significantly higher in the latter part of the second experiment as her symptoms reach baseline (McLaughlin et al., 2015).

The secund part of my hypothesis is regarding her ability to maintain sobriety over time without external forced abstinence. It is quite possible that her limited MC aid her in her initial abstinence, but her limited SC might hinder her in maintaining sobriety on her own initiative, since she may not elaborate upon the reasons for her abstinence or recollect the substance as harmful, but rather as pleasurable and/or beneficial. If her preference for nicotine declines steeply with a large effect of change or diminishes completely in the latter part of E^2, this will suggest she is able to forget about her desire for nicotine and thereby maintain abstinence on her own initiative. THE AUTHOR predict a bi-directional effect of limited understanding on her ARP.

Method

Ethical Concerns

This experiment has been discussed with the Norwegian Food Safety Authority, which oversees animal experiments in Norway. Since there was no nicotine given to the dog and no one aided her addiction in any way, this was not considered an invasive experiment and did not require further clarification. It should be noted that the dog's access to nicotine is limited, and she only consumes it when she finds or steals it, which happens rarely. The study was designed with the utmost care to minimize any potential harm or distress to the dog. The study was conducted in a familiar and comfortable environment to reduce anxiety, and the dog's behaviour was closely monitored throughout the experiment to ensure that she did not experience undue stress or discomfort. Additionally, the dog was not deprived of food or other essential needs during the study. The addictive stimulus (snus) was placed in a highly

perforated container, making it inaccessible to the dog to prevent ingestion and associated health risks. The experimenter was also trained in animal handling and committed to adhering to animal welfare guidelines.

Subjecting the dog to continued reminders of nicotine may in turn increase her general craving, restlessness, and anxiety. This effect is mitigated by systematically removing all cues and reminders from her environment during the experiment to minimize her exposure to the cues related to the smell of nicotine to try to reduce her overall discomfort due to her intrusive craving.

Subject

One dog, estimated to be 5 years old by a veterinarian, is a female mixed-breed terrier, see Picture 1. She was given to me in 2019 by the police, as her previous owner was no longer able to take care of her. The only information I received from her former owner was that she steals snus. However, it became apparent that she had developed a strong and rigorous addiction to this Scandinavian tobacco product, called snus. Please refer to the appendix for further information on my subject's AB.

Design

To investigate the effect of limited MC and SC on the ARP of the dog, a longitudinal, repeated measures design was employed. The study consisted of two phases. The first phase was a pilot experiment with ten daily measurements (N = 10) conducted to determine whether the dog would make a choice and to observe any possible trend in her preference. This was followed by a seven-day break. The second phase consisted of five measurements, taken three hours apart, every day for twenty days (N = 100). The dependent variable was the dog's preferred choice between essential stimuli (food), addictive stimuli (nicotine), and neutral stimuli (toy). The independent variable was time, which was assumed to be negatively correlated to the

dogs' withdrawal symptoms. A log of the dog's daily behaviour and appetite was kept, observing any possible withdrawal symptoms and/or behavioural changes during the experiment.

Stimuli

The experiment employed three distinct stimuli as dependant variables (DV). The first was five grams of ecological raw, ground beef from Gilde, with 14% fat, which was purchased on the same day as the start of the experiment and immediately frozen at -3^0 degrees Celsius to prevent deterioration during the experiment. Before each trial, it was thawed in the fridge at 2^0 degrees Celsius. As the dog is accustomed to regular dry pebble food, this stimulus was expected to be more tempting than her regular food.

The second stimulus was snus, which is a tobacco containing nicotine that is absorbed dermally through the skin by placing tobacco under one's lip, in small fabric pouches (lund, 2022). It has a distinct smell of tobacco and ammonia and can cause a stinging sensation on the lip upon administration. More specifically, one piece of General G.3 "no.11 super strong TNT", which contains tobacco, water, acidity regulator (E 500), aroma, including smoke aroma, and others. The box indicates a 2.6% nicotine content but does not specify whether this is for each snus or the entire box. The brand is an old classic Swedish brand from Match AS, chosen primarily for its high nicotine content and the convenience of the researcher's own use. It is also of the darker kind, for which the dog has indicated a preference. Between measurements, the snus was kept in a sealed commercial snus box in the researcher's car to prevent it from smelling before or between experiments.

As a control, the dog's favourite toy (Picture 3) was included, which is a squeaky toy leopard made of fabric. The toy is the dog's go-to in every playful situation, and she will eagerly look for it if she cannot find it.

Setup

The experiment was conducted in a familiar place and setting (see Picture 5). The dog was placed on a leash by the entrance until she was released to make a choice. Three distinct stimuli were placed 30 centimetres apart (see Picture 6), with the dog sitting on a leash at the starting point, 2 meters from the stimuli (see Figure 3). The snus and meat were placed in separate, highly perforated containers made of cardboard and taped to a mat on the floor (see Picture 2) to prevent the dog from ingesting them. The dog watched as the researcher placed each item in a randomly assigned order generated from an online random number generator (https://www.random.org/). The meat was labelled as number 1, the snus as number 2, and the toy as number 3. The first column represented the bottom left point from the dog's perspective, and so on, see Figure 2. This was done to ensure random placement of each stimulus for every trial and to mitigate the dog's practice effect and demand characteristics. The same procedure was followed for the order in which the dog was allowed to smell each stimulus before it was placed. Picture 7 serves as an example of the setup.

Procedure

The measurements were taken between 09:00 and 10:00 AM for the first trial and at 09:00 AM, 12:00 PM, 03:00 PM, 06:00 PM, and 09:00 PM for subsequent trials in the secund experiment. To maximize hunger and prevent the dog from not choosing meat due to satiation, every measurement was taken before her regular mealtimes and after her daily walks three times per day. Before the start of each trial, the dog was placed on a leash near the entrance and allowed to smell each item. The snus, meat, and toy were placed in separate, highly perforated cardboard containers, which were then taped to a mat on the floor to prevent the dog from ingesting them. The order in which the items were placed was determined randomly for each trial using an online random number generator. The dog was released from the leash with the experimenter's back turned to the stimuli to minimize the experimenter's influence on

the dog's choice. If the dog chose the snus or meat, the experimenter allowed her a few seconds to attempt to get a hold of it before calling her, to ensure that her choice was not influenced by accessibility. After the dog made her choice, the experimenter turned around and gently called her, but did not praise or reward her in any way. The dog was then taken to another room while the experiment was cleared away to minimize the potential for practice effects or demand characteristics. To eliminate any stimuli or cues that might remind the dog of snus and potentially initiate a craving state, the experimenter systematically removed all such cues from the environment. This included the experimenter's own use of snus, which was strictly kept away from the house for the duration of the experiment. The experimenter also brushed his/her teeth before interacting with the dog and kept no snus in or around the house for the duration of the experiment. Her walks were limited to minimize her exposure to any nicotine cues outside. The last time the dog was found with a snus from outside the house was approximately one week before the start of the experiment, but this is not certain.[1]

Data analysis

Her behaviour throughout the experiment is extensively documented in a running journal and will be analysed using my subjective reasoning. This will be supplemented by a nonparametric bivariate correlation analysis in IBM SPSS Statistics Version 28.0.1.1 to investigate Spearman's correlation coefficients between my variables. I chose the Spearman coefficient as my data being non-normal and my sample is small (Field & Field, 2018, p. 344). To investigate the effect of change in her preference, I ran a proportion test between the first ten days and the last ten days of the second experiment using a two-tailed analysis. Both dependent variables were also analysed in a descriptive analysis and scatterplot to assess

[1] Since I do not have a log of her nicotine use before the experiment, and she often hides away when she obtains it, I have no way of being sure of her abstinence beforehand, but rather only during the experiment.

skewness and kurtosis of my measurements. This was done to investigate the distribution of her choice of snus and to examine the effect of her change in preference.

Results

I have included a short demo video of the first three trails: https://clipchamp.com. One can see in the first video that the container wobbles, this was corrected by better taping.

First Experiment (E^1)

E^1 results are presented in Tables 1 and Table 2, providing an overview of the results for each day of the study as well as percentage and means. The test revealed a tendency towards addictive stimuli when given the choice, whereas she only chose meat a total of three measurements, which is 30% of all trials in the first study. A total of seven clear nicotine choices out of nine trials were recorded, which is 70% in favour of nicotine. In the first trial, she went straight for the snus, and I was a bit startled by how fast she was going, so I called her back a bit strictly. In the second trial, she went straight for the snus without hesitation. In the third trial, she went for the nicotine but immediately rushed over to the meat before going back to the nicotine and sniffing it intensely, licking her mouth on her way back. The fourth trial was deemed a failure, as I was getting tape, she got loose, and went for the meat before I could react. She toppled the container and ate the meat. I obtained a new sequence the following day and ran the test again, and she went for the meat. In the fifth trial, possibly affected by the day prior, she went straight for the nicotine, but she did glance at the meat as I called her away. In the sixth trial, she went towards the nicotine first but then shifted and went for the meat. In the seventh trial, she went straight for the nicotine, with no hesitation or shifting of interest. In total, she went for nicotine seven out of ten times measured, she never went for her toy, and went for the meat a total of three times, of which only two valid measurements were included in the data analysis.

Her preference for nicotine was higher than expected, possibly due to the increase in craving during the first period of her withdrawal. Her preference showed small signs of decreasing during the last five days of the experiment due to a slight increase in preference for meat. I wondered if her desire for nicotine would continue to decrease correlational to the presumed withdrawal symptoms she experienced. Based on the success of the first experiment, I decided to conduct another experiment in the exact same manner as the first experiment but with five measurements per day for a total of 20 days to obtain a sample from which I could analyse.

Second Experiment (E^2)

The results of the E^2 are presented in Tables three and Table four, providing an overview of the results for each day of E^2. In the second experiment, the dog's preference for addictive stimuli (nicotine) and essential stimuli (meat) fluctuated throughout the 20 days. The dog chose nicotine in fifty-four out of one hundred trials which is 54% and meat in forty-six out of one-hundred trials which is 46%, with no instances of choosing the toy.

Her participation was high during the entire duration of E^2, and she was excited for every measurement. I.e., she seemed to enjoy the situation.

Data analysis

Figure four serves as a graph with noted skewness and kurtosis.

Correlation analysis

A bivariate Spearman correlation analysis was conducted to examine the relationship between the number of days passed in the experiment and the number of meat and snus chosen. As presented in Table five, the results of the nonparametric correlation analysis indicated a statistically significant ($p < .001$) and moderately strong negative correlation (-.71) between the number of days passed and number of snus chosen.

This Suggests that as time passed, the dog chose snus less often. On the contrary, a significant positive correlation was found between the number of days passed and the number of essential stimuli chosen indicating that the dog chose food more frequently as the experiment progressed. Specifically, as the number of days passed in the experiment, the dog tended to choose fewer addictive stimuli (i.e., snus) and more essential stimuli (i.e., food).

Proportion test

As presented in Table six, a two-sample proportion test was performed with a binary input of her choice as my test variable, and the number of trails taken as my grouping variable. The proportion test comparing the first ten days and the last ten days of the second experiment revealed a statistically significant (p=.008) change in the dog's preferred stimuli. The proportion of snus chosen decreased from 36 (72%) in the first ten days to 23 (46%) in the last ten days, while the proportion of meat chosen increased from 14 (28%) to 27 (54%). which means the rate of change in her preference for food over nicotine was 93% while the rate of change in her preference for nicotine was -36%. The effect size of change in her preference for nicotine was -.26 which indicate that her preference for nicotine decrease as her preference for food increase. This is, according to Cohen's d, this is a small effect which translates to a small effect of change in preference.

Behavioural analysis

Her behaviour remained consistent during both experiments, her hunger seemed to be regulated at a normal level, and her searching behaviour appeared to decrease during the second half of E2. Her searching behaviour was demonstrated by her digging through her bedding and regular hiding places, sniffing the rubbish, smelling people's lips, and generally appearing to search for something. This might be attributed to the frequent and peculiar reminders of nicotine, which may have amplified her overall intrusive craving for nicotine

throughout the day. This factor could have also influenced her choice of stimuli, a point further discussed in the limitations section.

She exhibited no observable signs of increased anxiety, and her searching behaviour was carried out in a relatively calm manner. She did look for me on several occasions before making her choice in the experiment, suggesting that my presence might have influenced her choice of stimuli. In her daily life, she would be reprimanded if found in possession of nicotine, a circumstance that would undoubtedly also influence her in this experimental setting, as she would be aware of my presence. However, this was not deemed a significant limitation, as she would still opt for nicotine despite her awareness of my presence.

She did not seem to get tired of the experiments and seemed eager on every occasion. She ate well throughout the experiment and was always hungry when given her breakfast after each measurement, sometimes a bit more than usual. Her excitement when smelling the nicotine stimuli was higher than expected and was obviously competing with her arousal for the meat in almost every occasion when smelled. She showed little effort in obtaining the desired substance after making her choice in the first experiment. This turned out to be simply due to my presence and was corrected by adjusting my placement and calling her back sooner, which increased her effort in obtaining the desired substance.

Discussion

This study sought to examine the dog's addiction recovery potential and the role of limited MC and SC in relation to her ability to recover from her preference for nicotine. The dog's preference for nicotine versus essential stimuli (food) was observed in two separate experiments ($N^1 = 10$, $N^2 = 100$) over an extended period of 30 days total with a seven-day break between experiments, while being kept abstinent.

The main hypothesis was that the dog, being non-consciously aware of her addiction to nicotine due to her having lower levels of consciousness compared to humans (Belger & Bräuer, 2018, p. 398; Edelman & Seth, 2009, pp. 476-484) would not experience the same mental factors that maintain AB in human subjects (Bonner et al., 2022; Hamonniere & Varescon, 2018; Kavanagh et al., 2005; May et al., 2014), making her initial intrusive desire for nicotine dependent upon the level of withdrawal she experiences at any given time. In other words, the absence of metacognitive evaluation of her cravings would positively affect her initial ARP. My hypothesis was partly based upon the Elaborated Intrusion Theory of Desire (Kavanagh et al., 2005; May et al., 2014), which posits that cravings are influenced by intrusive thoughts and can be maintained by cognitive elaboration, the impact of metacognitive beliefs in maintaining AB. (Bonner et al., 2022; Hamonniere & Varescon, 2018), as well as the importance of SC with regard to the ability to changing one's behaviour to avoid relapse. To investigate this, I examined the correlation coefficients between her preference for food and the amount of time passed, which was presumed to be negatively correlated to the intensity of her withdrawal symptoms.

The secund part of my hypothesis was regarding her ability to maintain sobriety over time without external aid. I hypothesized that her limited MC would indeed cause her to forget about her intrusive craving more readily as her withdrawal symptoms dwindled but, paradoxically, her limited SC would cause a decrease in her ability for self-maintaining sobriety over time due to her simply remembering the substance as pleasurable and beneficial, not recollecting it as harmful. To investigate this, I examined the effect of change in her preference and to what degree her preference changed overall during the experiment.

The first experiment revealed a significant preference for nicotine (4) over food (1) in the first half of the experiment, with a slight increase in her preference for food (2) compared to nicotine (3) during the second half. These results prompted further research, and a second

experiment was then employed to gather more observations (N=100) for a statistical analysis. Her behaviour during the first experiment was consistent, with an observable increase in her general craving behaviour. Her appetite remained stable, which may have mitigated the confounding variable of hunger, although there is no objective method to measure her hunger. This implies that my observations regarding her hunger are purely subjective.

The results of the second experiment showed a general decrease in the dog's preference for addictive and essential stimuli over time, with a 26% decrease in her preference for addictive stimuli between the first and last half of the secund experiment. There was also a moderate and negative correlation between the amount of time passed and the number of snus chosen ($R\ (98) = -.71,\ P = .001\ 95\%\ CI[-.88, -.38]$), which was presumed to be subsequently correlated to the amount of withdrawal symptoms she would experience, as described by Shiffman et al. (2006) nicotine withdrawal timeline.

The observation of the dog's substantial appetite following the experiments also serves as an interesting point of discussion. In any regular situation, she would bypass her regular dry pebble food in favour of raw meat. However, when presented with the choice between snus and meat, she would frequently opt for snus, despite remaining hungry afterwards. This suggests that the intensity of her craving for nicotine may supersede even her physiological need for food or in some way. This is in accordance with Kavanagh et al. (2005, p. 462), who predicted that episodes of desire might interfere with other tasks and blend with essential cravings, such as hunger.

The results from the second experiment suggest that the lack of mental factors that maintain AB in humans, facilitate and increase her initial recovery potential. However, it was observed that the dog's craving for nicotine appeared to be maintained throughout the experiments, as she would still opt for nicotine even at occasions in the end of E^2. Her desire did not

completely diminish even after 37 days and the effect of change was small (-.26). The observable decrease in addictive stimuli was not linear but slightly skewed. This interpretation is reinforced upon examining Figure 4, where one can observe a slight skewness in her decrease in preference for nicotine. This outcome supports the second part of my hypothesis, which predicted a complete absence in her preference for nicotine in the end of the experiment, as well as a substantial effect of change in her preference for nicotine, to confirm her ability to maintain abstinence on her own and thereby reject my hypothesis.

These findings suggest a possible dichotomy in the impact of the dog's limited cognitive capabilities on her ARP. This is however purely speculative, as I cannot measure how she recalls the substance or how she experiences her withdrawal. And I do indeed speculate, that her limited MC cause her to overcome her craving sensations more readily after initial use, but her limited SC cause her to merely recall the pleasurable sensation of craving release. She might not comprehend the reasons for her abstinence due to a lack of understanding regarding the negative consequences of her use, which may, in turn, render her incapable of maintaining abstinence on her own initiative. This interpretation would explain my general observations of her extended periods without nicotine, but her subsequent return when given the opportunity. As well as the absence of visible cravings in her everyday life. As I cannot be sure of the causality of the effect I am observing, one may only speculate in the reasons for her response. Whether she can maintain abstinence on her own initiative remains uncertain.

Conclusion

In conclusion, the results imply that the dog's preference for nicotine is significantly influenced by the amount of time elapsed since her last dose of nicotine, which is presumed to correlate with her level of withdrawal. The limited SC exhibited by the dog may contribute to her inability to fully comprehend the nature of her cravings, which might have prevented her

from experiencing the same metacognitive factors that sustain AB in humans. (Bonner et al., 2022; Hamonniere & Varescon, 2018; Kavanagh et al., 2005; May et al., 2014), as well as the important MC factors that initiate and maintain abstinence (Garland et al., 2016; Hofmann et al., 2012). The correlation between the number of addictive stimuli chosen and amount of time passed, as well as the increase in the proportion of essential stimuli during the second half of E2, supports the hypothesis that the dog's lack of MC may positively impact at least her initial ARP under controlled conditions. Additionally, the secund part of my hypothesis was also supported as her desire did not diminish completely but rather fluctuated throughout also the end of the experiment. She chose nicotine at occasions even after 30 days of abstinence, indicating a possible dichotomy in the effect of her limited MC and SC on her ARP. Whether these results imply she will struggle to maintain abstinence over time requires further research.

This study tentatively supports the hypothesis that a dog's limited SC and MC may positively impact her ARP. These findings shed light on the role of MC and SC in addiction recovery in animals, hinting at a species-specific AB in dogs, which may not directly translate to human subjects. Although primarily exploratory in nature, this investigation does underscore the potential importance of a conscious will and determination in overcoming addiction and could influence strategies employed in forced abstinence programs. Due to the novel and unique circumstances of this case, this paper concludes with a call for additional research to strengthen these findings and extend their relevance to other species or addictive substances.

This acknowledgement underscores the inherent limitations and translatability issues in such an investigation, which primarily serves as an interesting foray into the realm of addiction recovery in non-human subjects.

Limitations

The foundation of this study rests on the assumption that the dog lacks the conscious understanding and cognitive comprehension regarding her addiction and associated craving affection. As the dog cannot articulate her experiences, this assumption is essentially grounded on my general observations and subjective evaluation of her behaviour, which may not accurately represent the reality. As I cannot measure her withdrawal, my assumption regarding her withdrawal symptoms and their time-limit may also not represent reality. I also cannot be sure that the cognitive abilities I blame for this effect is the reason for her increased ARP, the results of this study only suggest a correlation between her preference for nicotine and the amount of time passed. More research is needed to determine the causality.

The study design may have introduced validity and reliability issues. The measurement taken may in fact measure her persistence in obtaining nicotine, and the decrease in her preference might simply be due to her losing interest as she gets used to not obtain the desired effect. The measurement may have investigated the dog's reaction to being reminded of nicotine in a frequent and particular manner, which may not have reflected her genuine desire for the substance but rather her attempt to change her behaviour in hope of obtaining the desired substance. It is uncertain whether the same effect was measured on each occasion as the stimuli availability and the experimental context differed from the dog's regular nicotine encounters in her everyday life. The study may have simply captured the dog's response to the smell of nicotine, which was more readily available than in her usual environment.

The study's design may have introduced confounding variables as well, such as hunger and an general increase in her intrusive craving, which may have impacted the dog's behaviour during the experiment. It is not feasible to objectively measure the dog's hunger or craving levels in advance.

Furthermore, Ideally, this study should have been conducted over a longer period with more observations overall to obtain more conclusive results. In retrospect, the initial study should have been conducted with a larger set of observations to ensure that each outcome occurred at least ten times in each proportion (Agresti & Franklin, 2009), this way I could obtain a more significant analysis using the proportions test between the two experiments instead of E^2. Also, my sample in E^2 is too small for a good correlation analysis, as I should have somewhere around 250 observations overall. The lack of observations is due to changes in the research plan and subsequent time-limitations.

It is important to note that this study, its results, and conclusion as well as the dog's AB are not generalizable, this study serves a novel purpose.

Ethical considerations and limitations

Due to restrictions on the possibility of obtaining formal approval for such an experiment, ethical considerations had to be taken to ensure the legality and morality of the study itself. These restrictions have implications for the study, as documenting the dog's nicotine addiction and ensuring that her choice is based on her genuine craving and not on her increasing excitement for the possibility of obtaining the substance.

To mitigate issues related to the validity and reliability of the study, I believe that the experiment would benefit if the dog maintained her addiction for a period under medical supervision before the experiment to reduce her excitement for nicotine, as well as ensuring she experiences withdrawal symptoms as of the start of the experiment, increasing construct validity. The assumption that the dog’s withdrawal symptoms start at the same time as the experiment may not accurately represent reality.

Additionally, making the addictive substance more accessible would have resulted in a more valid measurement based on a truly "free" choice and mitigated the effect the peculiar and

continues reminder of nicotine might have on her. However, this is a complex ethical issue that was not suitable for a bachelor's thesis due to the lengthy process of formal approval as well as the medical supervision required. Therefore, the study was conducted using a completely non-invasive method, which forgoes some of these possible strengths related to the experimental design.

Further research

Future research should build upon this study by conducting a similar experiment, but with modifications to the methodology. The intervals between measurements should be gradually increased to mitigate the impact that nicotine cues have on intrusive cravings. This study should also extend over a longer period to observe a potential complete diminishment in her craving for nicotine and determine if she can maintain abstinence on her own management.

To bolster the construct validity of subsequent research, it is suggested to incorporate more advanced methodologies, such as the use of specialized electroencephalogram (EEG) equipment for dogs. This would allow for a more nuanced exploration of the dog's neural responses to distinct stimuli, providing insights into the neurophysiological underpinnings of her AB which may be used to increase both reliability and validity.

Moreover, comparative studies involving dogs with different addictions could provide a broader perspective on the nature of non-human addiction. Such investigations could also delve into the experiential differences between human and canine addiction, shedding light on the universality or species-specificity of ABs (Spanagel, 2017).

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Tables

Table one

Frequency table for the first experiment.

Day	1	2	3	4	5	6	7	8	9	10
Stimuli	1	1	1	0*	1	0	1	1	0	1

Table 1. Results from the first study. N = 10 *Failed trail, repeated the following day.

0= Meat 1= Nicotine. Results: Meat = 2, Nicotine = 7.

Table two

Frequency, mean and percent table for the secund experiment.

	FREQUENCY	MEAN	SE	PERCENT
SNUS	7	0.7	.15	70
MEAT	3	0.3	.15	30
TOY	0	0	0	0

Table 2. Descriptives from the first study. N = 10

Table three

Frequency table for the secund experiment.

Day	1	2	3	4	5	6	7	8	9	10
Nicotine	4	5	4	3	4	3	5	2	3	3
Food	1	0	1	2	1	2	0	3	2	2

Day	11	12	13	14	15	16	17	18	19	20
Nicotine	4	2	2	3	3	1	2	2	3	1
Food	1	3	3	2	2	4	3	3	2	4

Table 3. Results from the second study. N = 100

Results: Meat = 59, Nicotine = 41, Toy = 0.

Table four

Frequency, mean and standard error for the secund experiment.

SIMULUS	FREQUENCY	MEAN	SE	SD	PERCENT
SNUS	59	2.95	.26	1.1	59%
MEAT	41	2.1	.26	1.1	41%
TOY	0	-	-	-	0%

Table 4. Results from the second experiment. Note: N = 100

Table five

Bivariate Correlations between Days Passed, Number of Meat Chosen, and Number of Nicotine Chose

	Days passed	Nicotine chosen	Food chosen
Days passed	1.00	-	-
Nicotine chosen	-.71*	1.00	-
Food chosen	.71*	-1.00*	1.00

Table 7. Spearman correlation Coefficient and significance levels.

Note: The number of days passed negativly correlate with the amount of addictive stimuli chosen, $R_s\ (98) = -.71,\ P = .001$ 95% CI$[-.88, -.38]$,

While the number of days passed positivly corralte to the amount of essential stimuli chosen, $R_s(98) = .71, p = .001$ 95% CI [.38, .88] This is a moderate correlation, which indicates a significant effect. $N = 100, *$ Significant at the $p < .001$ level (two − tailed).

Table six

Proportions of Meat and Snus Choices in the First and Last 10 Days of the Second Experiment

Stimulus	Sample one proportion < 11	Sample two proportion >11	Difference in proportions
Nicotine	.72	.46	.26
Food	.28	.54	-.26
Total	1.00	1.00	0

Table 5.Results from the proportion test. N=100

Note. A two-tailed proportion test was conducted to calculate effect size and to investigate whether the proportion of meat and snus chosen differed significantly between the first and last 10 days of the second experiment. The results showed that there was a significant difference in meat and snus choices between the first 10 days, 28% meat, 72% snus, and the last 10 days, 54% meat, 46% snus. A difference in proportions of -.26 (26%). $Z = -2.64, p = .008$ 95% $CI\ [-.43\ -.07]\ (Agresti - caffo)$.

Figures

Figure one

Figure 1. Each stimulus is placed thirty centimetres apart and two metres away from the dogs' starting point. The order of placement of the item is randomised.

Figure two

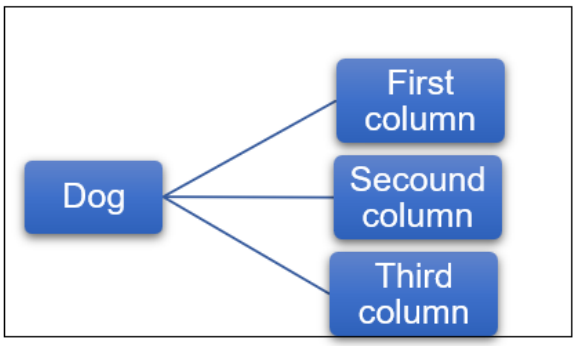


Figure 2. Assignment of each column in the sequence obtained from the random number generator.

Figure three

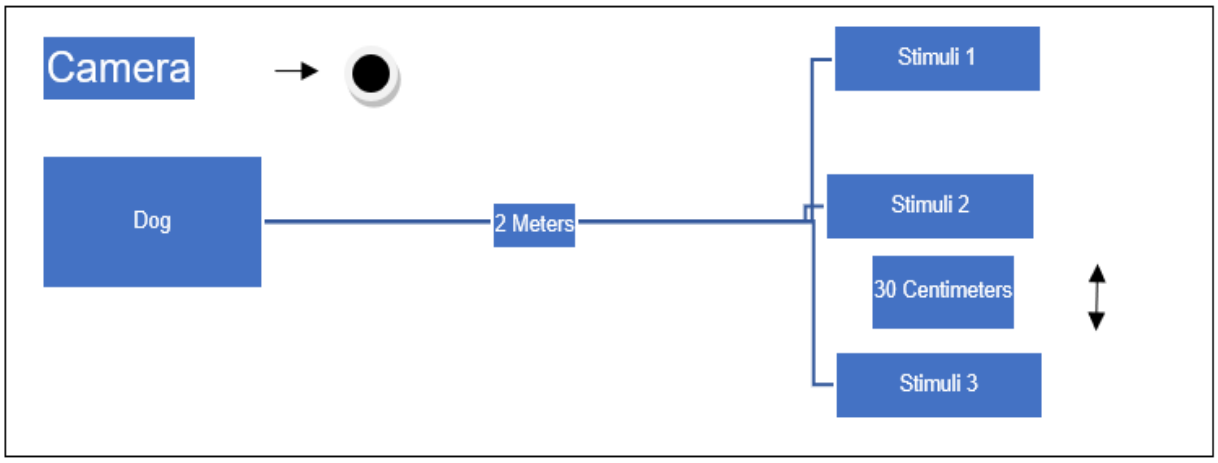


Figure *3. Complete setup with distance and camera placement*

Figure four

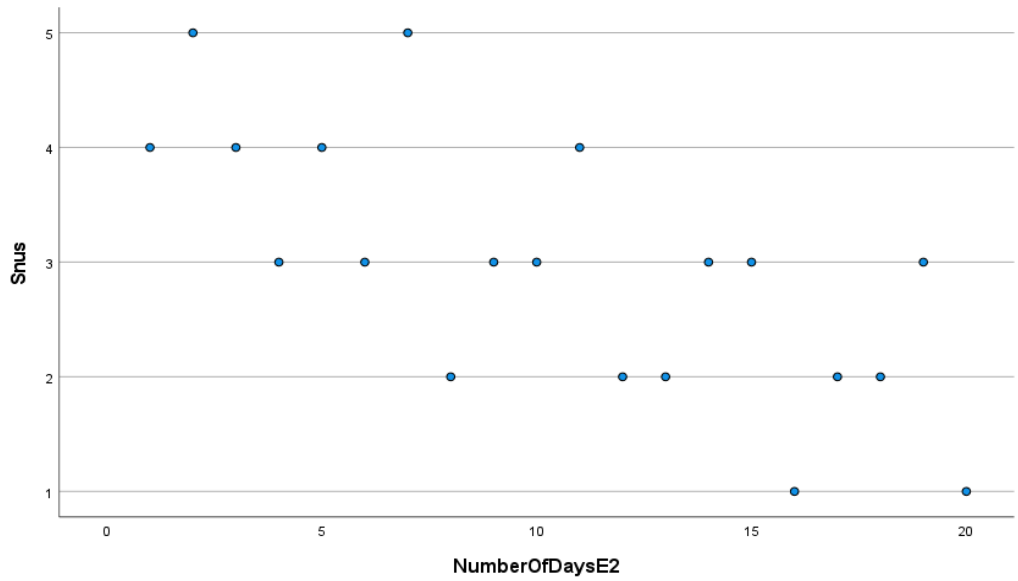


Figure 4. Scatterplot with the number of snus chosen represented in blue and the number of meats chosen represented in green. Note: The skewness of the number of snus chosen was found to be .11 (SD=.51), indicating normality in the distribution of observation and greater number of smaller values. The skewness of the number of foods chosen was -.11 (SD=51), indicating a greater number of larger values. The Kurtosis of the number of snus chosen was found to be .47 (SD=1.0), while the kurtosis of food was -.47 (SD=1.0).

Pictures

Picture one

Picture 1. Myte, a 5-year-old female mixed-breed-terrier with a rigorous nicotine addiction.

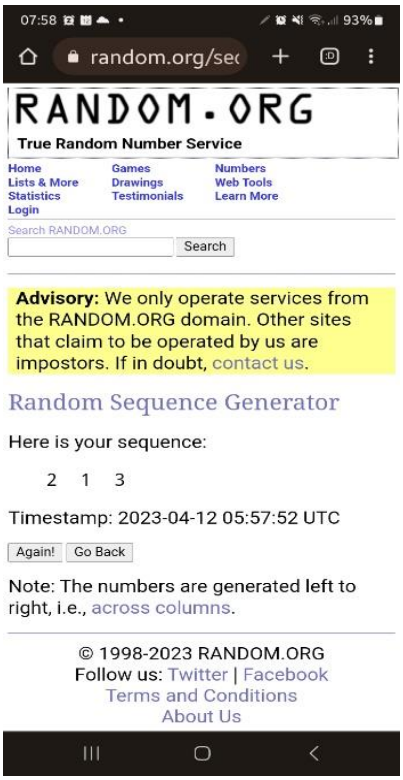
Picture two

Picture two. The cardboard containers used, taped to the mat underneath them.

Picture three

Picture 3. Her favourite toy.

Picture four



Picture 4. Example of the result given from the Random.org random number generator

Picture five

Picture 5. My view when she makes her choice.

Picture six

Picture 6. Distance between stimuli

Picture seven

Picture 7. Example of the setup, taken from trail one.

Appendix

The dog's addictive behaviour

The dog's name is Myte, given to her by her original owner which I met as I was volunteering at a crisis centre. Her previous owner had gotten into trouble and used me as an emergency contact, I was therefore offered custody of the dog by the authorities. I have not gotten a hold of her previous owner since, the origin of her preference for nicotine is thereby a mystery one can only speculate in. I do hypothesis that she may have mirrored her previous owner's behaviour as a young pup, and in that manner ingested nicotine and consequently formed a habit with it.

She can go for long periods without being caught with nicotine in any form, but will react in the same excited manner when reminded of nicotine, no matter how long it has been since I caught her with the substance. I have at no point observed any visible withdrawal symptoms, discomfort or stress in her everyday life as e consequence of her preference for nicotine. This is however not measurable, and thereby only speculative.

Her way of administration is also an interesting point of discussion, as she does not eat snus, but gently puts it down in front of herself and puts her lip over it accompanied by a pleasurable grunting sound, resembling genuine enjoyment. This allows dermatological nicotine absorption through the thin skin under her lip, just like it would in humans. This is quite different compared to more regular ways of administration in animal addiction research (Spanagel, 2017). They way she administers her nicotine is to peculiarly close to the way a human would and allows her to regulate her own use.

She appears to have taste preferences as well, as she rarely steels the new white kind, and she gets particularly excited if someone pulls out a box of the old, brown, and smelly brand. I have tried giving her nicotine free snus, which she shows little to no interest in. If she cannot find snus, she will go for old cigarette butts which indicate together with her total lack of interest in nicotine free snus, that she either likes tobacco or may in some way understand

what substance in the tobacco she is craving, she then presumably smells nicotine by itself, but this is purely speculative.