Towards an approach to studying micro-C creativity in non- humans: investigating curiosity in hamsters.

Isa-Jane Ensing (s3604772@vuw.leidenuniv.nl)
Media Technology, LIACS, Leiden University

Supervisor: Rob Saunders (r.saunders@liacs.leidenuniv.nl)
Media Technology, LIACS, Leiden University
and **Supervisor: Tessa Verhoef (t.verhoef@liacs.leidenuniv.nl)**
Media Technology, LIACS, Leiden University

Abstract

James Kaufman's 4C framework divides creativity into Big-C (sociocultural), Pro-C (professional), little-c (group), and mini-c (personal) levels of human creative achievement. This thesis explores an extension of the 4C model to include a micro-c level of creativity to encompass the precursors of creativity. Micro-c is envisioned to be particularly relevant to the study of the precursors of creativity in non-humans. The study conducted for this research focuses on curiosity in animals as one of the most important precursors of creativity. This study of animal curiosity differs from previous studies by focusing on the animal's umwelt (self-centered sensory world) and by applying the method of cultural probes from design research. The thesis presents a proof-of-concept study using cultural probes sent to pet owners to study curiosity in hamsters. The cultural probe study involved the pet owner introducing known and unknown stimuli to the hamster over seven days and recording their behaviour towards these stimuli. Observing these recordings showed the hamsters demonstrating diverse behaviours that largely aligned with the expected response to novel stimuli, the significance of which is only limited by the study size. The study demonstrates the practical application of this approach as a way to engage the general public in studies of non-human creativity at the micro-c level. The thesis describes how to design an experiment tailored to the umwelt of the subject species, offering valuable insights for the design of future studies of micro-c in animals.

Keywords: Non-Human-Cognition, Creativity, Curiosity, Hamsters, Cultural Probes, 4C framework

Introduction

Creativity, the act of creating something novel, is often seen as a uniquely human trait. However, the growing popularity of AI-creativity tools such as DALL-E has brought new attention to whether other entities, particularly non-humans, can be considered creative. There is a long history of studying non-human creativity, going back to Charles Darwin's study of creativity in apes (Glickman & Sroges, 1966). By focusing on animal creativity, we can gain insights into what it means to be creative in a broader sense, including human and computational creativity.

Popular assessment methods used to analyse computational creativity are based on the human experience of creativity. Since human creativity is inherently subjective and often assessed through self-evaluation, this approach can be problematic for developing accurate assessment methods for creative computational systems. Computational creativity, like animal creativity, should not be assessed using the same criteria as human creativity, given the unique qualities inherent in each. Although computational creativity is different from animal creativity in many ways, it is valuable to study animal creativity in this context because it will highlight the shared differences with human creativity.

Animal creativity can be described as behaviour that involves animal insight or problem-solving (J. C. Kaufman & Kaufman, 2004). There have been many studies on animal creativity, but a common hurdle is that, unlike human creativity, animal creativity cannot be critiqued by the end product. What might look creative and aesthetically pleasing to us humans does not per se mean that the animal is creative; the final product can also result from instinct or learned behaviour. Another hurdle is that human creativity is often judged based on the personal reflection of the creator. Basing creativity on self-reflection is also not an option when studying animal creativity. More recent studies on animal creativity focus on observational behaviour and the role of animals within their community (J. C. Kaufman & Kaufman, 2004).

In this thesis, we aim to examine creativity through a non-human lens, with a primary focus on animal creativity. We focus on how curiosity can be seen as a precursor of creativity and how this is reflected in animals. This thesis explores the extension of the 4-C framework by James Kaufman by suggesting a fifth c called micro-C, which includes the precursors of creativity, focusing on curiosity. through its research design, this thesis emphasises the importance of the animal's sensory world (umwelt). For this research, we applied the method of cultural probes from design research to investigate how studying micro-C in practice looks like. We will specifically look at how hamsters explore novel olfactory stimuli.

This paper continues with a literature review, a methodology chapter, results and then discussions and conclusion.

Literature review and micro-c

In the literature review we will discuss modern frameworks to study creativity and discuss how these apply to animal creativity. In the second part we will propose an addition to the frameworks discussed.

2.1.1 Defining Creativity and the 5 A's Framework

Creativity literally means "to bring something new into being." However, this concept can be, and has been, interpreted in many different ways. Creativity researcher Vlad Glăveanu, in his paper *"Rewriting the Language of Creativity: The Five A's Framework"* (V. P. Glăveanu, 2013), described the 5 A's framework (based on the 4 P's framework) that covers all the unique elements that play a role within the creative process. This framework is built on the understanding that creativity is not something that can be attributed to a singular act but is instead the outcome of a combination of many circumstances. The 5 A's stand for Actor, Action, Artifact, Audience, and Affordances.

Actor refers to the individuals or groups engaged in creative activity while interacting with their environment. **Action** represents the creative processes that often involve social interaction. **Artifact** includes the product of creativity, as well as existing artifacts that contribute to new creative outcomes; these may be materialistic or symbolic. **Audience** refers to the diverse groups that engage with the artifact and the actor, including stakeholders, critics, or the general public. Finally, **Affordances** refers to the opportunities provided by the environment that facilitate creative actions.

More important than their individual definitions is the understanding that these concepts are intertwined and co-dependent.

2.1.2 The 4C Model of Creativity

Creativity researcher James Kaufman developed the 4C creativity framework, which describes four levels of creativity: Mini-c, Little-c, Pro-c, and Big-c (J. C. Kaufman & Beghetto, 2009). This framework is an adaptation of the earlier well-known dichotomy between Little-c and Big-c creativity.

Little-c creativity refers to creative activities that individuals engage in for themselves or others but not at a professional level—like making a painting for a friend. Big-c creativity, on the other hand, is reserved for a select group of people, such as Newton or Marie Curie, who are recognized as creative geniuses by large audiences either during their lifetimes or posthumously.

This division between Little-c and Big-c can be seen as exclusive and limiting, as it overlooks those who engage in creative endeavors at a high skill level but do not reach the iconic status of Big-c. Kaufman introduces the concept of Pro-c creativity to describe this "in-between" stage. Pro-c applies to individuals who pursue creative tasks with significant effort and skill but who may never achieve the widespread recognition associated with Big-c, for this, you can think of somebody who is great professional pianist but who never got a large fan base.

The fourth type, Mini-c creativity, is defined as the personal and meaningful interpretation of experiences, actions, and events. Kaufman explains this concept with the example of a child who combines two known concepts to create a novel term or idea. Another example of this is somebody making up a song in the shower. Mini-C does not necessarily result in a tangible product recognizable by others; it can also be a mental construct known only to its creator. This type of creativity is evaluated through self-assessment(J. C. Kaufman & Beghetto, 2009). Overall, the biggest differences between the different types of creativity are the different dimensions of rewarded appreciation. Big-c receives appreciation on a global level, Pro-c receives appreciation among its peers, Little-c among their inner circle and mini-c the appreciation towards the creative act comes from within them self and is more personal.

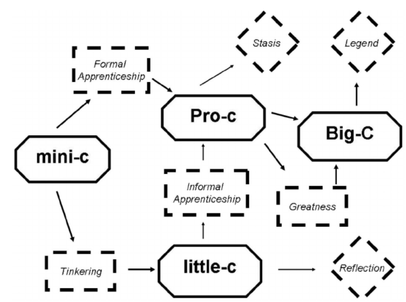

Figure 1: 4C model.

2.1.3 Applying the 4C Model to Animals

In the article "Applying Theoretical Models on Human Creativity to Animal Studies," A. Kaufman and Kaufman (2014) applied this 4C model to animals. Mini-c in animals is characterized by situation-specific innovations that an animal uses to achieve a goal, such as tool-making using available surroundings. When another animal observes and adopts this novel behavior (like tool-making), it can be described as Little-c creativity. Pro-c creativity in animals refers to those that become "expert innovators"—animals that become well-known for their innovations, either among their peers or to human caretakers who recognize their exceptional talents. Big-c creativity is less applicable to animals; though some fictional animal characters have achieved this status, it does not usually apply to real animals.

While this framework offers valuable insights into animal cognition, it is somewhat limiting, as it only highlights certain animals and specific instances. In their article "Applying a Creativity Framework to Animal Cognition" (Kaufman & Kaufman, 2004), Kaufman and Kaufman propose a three-tiered pyramid framework. At the top you have innovative behaviour, which aligns with the 4C framework. The middle layer is called "observational learning", this includes animals who learn to copy novel acts from their peers. At the base of this pyramid is the "recognition of novelty," which they describe as a basic prerequisite for creativity.

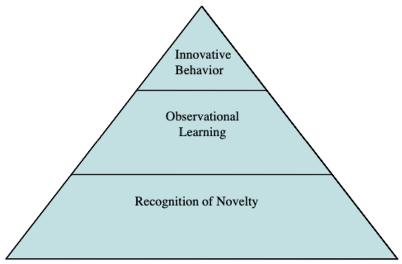

Figure 2: animal creativity framework

2.2.1 Micro-c: Curiosity and Creativity

We propose adding this concept of ”recognition of novelty” to the 4-C framework as a fifth C, called Micro-C. Micro-C includes instances where entities recognize novelty without necessarily producing it, indicating it as a potential precursor of creativity either immediately or at a later stage. We highlight curiosity as a fifth C because it allows many more entities to be considered potentially creative through observation and without self-assessment.

Curiosity can be described as the desire to know, and there are different types of curiosity. Most important for this research is *perceptual curiosity*, which means having an interest in novel sensory experiences (Gross, Zedelius, & Schooler, 2020).

Currently, there is little to no empirical proof that directly links curiosity to creativity or explains how they might be connected. However, there is evidence suggesting that people who are considered curious are also often deemed creative. This leads us to posit that if subject A shows curiosity, it is more likely to be creative compared to subject B, who does not exhibit curiosity(Gross et al., 2020). Understandably, this is a weak connection, but it becomes particularly interesting when applied to animals.

Most assessments of creativity are human-evaluated, relying on either self-assessment or an observer’s description of the subject’s actions as creative. Judging animal creativity is challenging because animals cannot self-assess, and observations may be biased by human interpretations of creativity. Curiosity, on the other hand, is easier to observe, such as by counting the number of times an animal interacts with a new object compared to a familiar object. This method highlights potential creativity indicators without using human-centric evaluations.

2.2.2 Defining Micro-c

As stated before the differences between the types of creativity are the dimensions of rewards of appreciation. With Micro-c the reward of appreciation is not an external being praising them for recognizing something novel, nor is it the entity reflecting on them self and appreciating their recognition of novelty. It is the experience of the novelty that is the reward. If, for example a dog gets two treats, that the dog both likes, one that it has all the time and one that is new, choosing the new one creates a new experience regardless of the fact that both treats are tasty.

In the paper ”Applying Theoretical Models on Human Creativity to Animal Studies” (A. Kaufman & Kaufman, 2014), Kaufman and Kaufman apply the 5 A framework to animal cognition studies. In the paper ”The Creativity Matrix: Spotlights and Blind Spots in Our Understanding of the Phenomenon” (V. Glăveanu & Kaufman, n.d.), the authors develop a matrix where they discuss what the 5 A’s look like within the four levels of Small-C, Little-C, Pro-C, and Big-C creativity. For this paper we tried to see what this would look like for micro-c and for animal-creativity.

- **Actor:** This is the animal.
- **Action:** This is how they observe and engage with this novelty, this is depending on which actor and which artifact.
- **Artifact:** This is the novelty that the actor is engaging with
- **Audience:** The audience could be compared to their herd or pack (if the animal lives in a herd) or, in a domestic environment or zoo, their caretakers.
- **Affordances:** Affordances, described by opportunities provided by the environment, could be compared to the umwelt of animals, their unique sensory world.

2.2.3 Studying Micro- C

Studying curiosity in animals has a long academic history. For instance, in 1874, Charles Darwin observed how monkeys exhibited curiosity by opening bags that contained controlled risks. This early observation laid the groundwork for more structured studies on animal curiosity, such as the one conducted by Glickman and Sores in their article “Curiosity in Zoo Animals”(Glickman & Sroges, 1966).

In this study, 232 zoo animals are examined for their reactions to novel objects to observe how curiosity differs across species. While the researchers acknowledge that certain stimuli have different significance for different species, their goal was to create a general understanding of the differences in response to specific stimuli within animals in captivity (Glickman & Sroges, 1966).

The study involved placing (for each animal the same) novel objects into the animals’ cages. For a period of six minutes, the animals were observed on how they reacted to these novel objects by recording their orienting and contact responses. With ’orienting response’, the researcher meant that the animal turned their eyes to the object. With ’contact response’, the researchers meant that the animals intentionally touched the object. Additionally, the researchers noted how each animal interacted with the object, such as sniffing, biting, or chewing.

The results showed that different species exhibited varying levels of curiosity, with some animals showing a high degree of interest in the novel objects while others were more indifferent. For example, primates and certain carnivores were likelier to engage with the objects, demonstrating both orienting and contact responses. In contrast, some herbivores showed minimal interaction (Glickman & Sroges, 1966).

The scientists discuss how the results of their experiment with zoo animals would most likely differ greatly if they had tested with animals in their natural habitat because animals in zoos tend to be stimulus-deprived. Although it is uncertain whether animals in their natural habitat would be more curious, it is important to highlight the unique setting of the experiment.

In general, this study offers a good first look at how animals react to specific stimuli. But animals are stimulated by different senses and also react differently with each other to these stimuli. When wanting to know more about how a specific species, a more detailed and larger study should be done focusing on the umwelt of this species.

2.2.4 How to approach the umwelt of an animal?

The concept of umwelt is described as 'an organism's unique sensory world' (Encyclopaedia Britannica, 2024). This refers to how an individual animal experiences the world around them. We are never fully able to comprehend the umwelt of an animal because their senses and consciousness are vastly different from ours, nor are we 100% able to understand how they experience their world. When looking for animals being creative, we often see videos online that show animals performing tricks that we may deem as creative. In reality, these tricks are not necessarily performed out of creativity but may serve other purposes, such as attracting a mating partner. Thus, while we cannot look into the minds of the animals, we can study their behavior.

Methods

This chapter contains our methodology in how to study micro-c and our protocol discussing how exactly our experiment took place.

3.1: Hamsters

To demonstrate our concept of micro-creativity (micro-c) and to further explain how this approach would work in practice, we have developed a proof of concept focusing on one specific entity and their unique umwelt: the hamster. The idea of working with hamsters was done after careful consideration and advice from the LU/LUMC Animal Welfare body. We chose to work with hamsters because there have been many studies on comparable rodents, such as mice and rats, and they are common pets in the Netherlands. We decided not to focus on a specific species of hamster, as there is not enough known about the differences in umwelt between different hamster species. This experiment aims to learn more about curiosity and creativity in hamsters and to compare how creative the owners perceive their hamsters to be with the observational behaviors of creativity discussed earlier.

3.1.1 Cultural Probe Research In short, this proof of concept is designed as a cultural probe research study to examine how hamsters react to novel stimuli. During the familiarization phase, hamsters are given two treat boxes every day with identical smells. During the experimental phase, one of the boxes will have a different smell. Through observation, we assess how curious the hamster is towards the novel object. Before and after the experiment, we ask the participant to rate how creative and curious they think their hamster is to see if their perception aligns with the observed curiosity.

3.1.2 The Unique umwelt of the Hamster Hamsters primarily rely on their senses of smell and hearing. According to the Merck Veterinary Manual, these sensory modalities are the most developed in hamsters and play a crucial role in their behavior and interaction with their environment (Frohlich, 2021). We consulted with a rodent shelter to obtain detailed information necessary for this research. Based on their recommendations, we opted not to use essential oils for the scents, as these can be too potent or potentially harmful to hamsters. Instead, we created natural scents using water and fruit, specifically apple and papaya, which were suggested by the shelter to be equally appealing to hamsters. Additionally, the shelter informed us that hamsters require approximately 24 hours to acclimate to a novel situation. We incorporated this guidance into our research design to ensure that the hamsters had sufficient time to familiarize themselves with the objects used in the experiment.

3.1.3 Animal Testing When involving animals in any research project, proper care of the study subjects is crucial. According to Dutch law, an experiment is classified as an animal test when it induces more pain or stress than a needle injection, including emotional stress (Centrale Comissie Dierproeven, n.d.). Judging the extent of an animal's suffering is challenging and requires the approval of the Animal Welfare Body. For this study, we decided not to participate in animal testing due to the complicated approval process and potential harm to the animals. We believe that observational studies can provide valuable insights into animal behavior, which is the essential focus of this research.

3.1.4 Testing with Pets For this study, we have decided to focus on pets. While similar to the paper "Curiosity in Zoo Animals" (Glickman & Sroges, 1966), this approach may not fully reflect how hamsters in the wild would react to novelty, it allows us to focus on how pet owners perceive their hamsters as curious and creative. We reached out to pet hamster owners in Belgium and the Netherlands through a Facebook group dedicated to hamster owners.

3.1.5 Why Cultural Probes Testing with pets on location and face-to-face with the owner can be challenging. Specifically, testing on a larger scale would be difficult to organize, and face-to-face testing could face inevitable hindrances (e.g., the hamster being asleep). Because face-to-face research is impractical, a cultural probes approach is a suitable option. Cultural probes involve giving the participant an assortment of prompts, questions, and instructions along with artifacts for recording thoughts and feelings (Foundation, 2024). This cultural probe consists of instructions for the pet owner and objects for the hamster to interact with.

3.2: Methodology

3.2.1 Phases This experiment has three phases: an initial phase, a familiarization phase, and an experimental phase.

3.2.1.1 Initial Phase On day 1 of the experiment, the owner places two treat boxes without any scent inside the hamster cage. This phase is intended for the hamster to get used to the boxes. The owner can do this at any time of the day, preferably when the hamster is awake. The owner recorded how the hamster approached the boxes.

3.2.1.2 Familiarization Phase On days 2, 3, 4, and 5, the owner placed two treat boxes with identical scents inside the hamster cage. Half of the hamsters experienced an apple scent, and the other half a papaya scent. This phase is designed for the hamster to get used to one familiar scent. The owner conducts this activity at any time of the day, preferably when the hamster is awake. The owner recorded how the hamster approached the boxes.

3.2.1.3 Experimental Phase On days 6 and 7, the owner places two treat boxes inside the hamster cage. One box had the familiar scent (apple for one group, papaya for the other), while the other box had a novel scent (papaya for the apple group, apple for the papaya group). This phase aimed to observe how the hamster responds to the novel scent. The owner could do this at any time of the day, preferably when the hamster is awake. The owner recorded how the hamster approached the boxes.

3.2.2 Hypothesis Hamsters will show increased exploration or preference for the box with the new scent due to their curiosity and interest in novelty. There will be varied responses to the novel stimuli based on the character of each individual hamster.

On the first day of the experiment, we expect various results depending on the hamsters' characters and their familiarity with the object. We expect the hamster to show increased exploration on day 2, the first day of the familiarization phase, which will gradually decrease as the object becomes less novel. On day 6, the first day of the experimental phase, we anticipate an increase in exploration, which will gradually decrease on day 7. For clarification, we illustrated the expected curve.

3.2.3 Subjects For this experiment, we had the participation of two owners: one with two hamsters and one with three hamsters. We tested three Djungarian hamsters and two Roborovski hamsters.

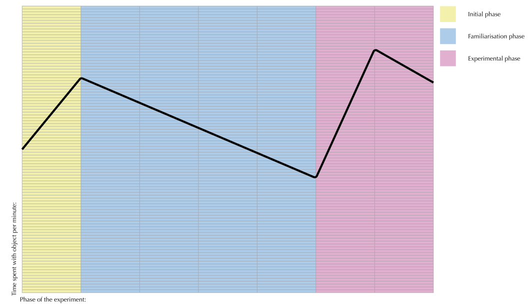

Figure 3: Expected curve of exploration over time.

3.2.4 Control Variables To minimize stress and ensure consistency, the hamster owners had to conduct the experiment in their homes, with the hamsters in their familiar cages. While each owner's setup is be different, the hamsters have not experienced any change in their environment. Owners were asked to perform the experiment at the same time each day and place the boxes in the same spot in the cage each time. Each box will contain the same hamster treats and scents. Since this is cultural probe research, we could not control each part of the experiment; we expected the caretakers to follow the protocol closely, changes are noted.

3.2.5 Designing the experiment for the general public Since the demographic we target does not per se have a scientific background, we focused on making the experiment look and feel like a fun activity to do with your hamsters. For this, we created a name for the experiment; "de curieuze neusjes (translating to "the curious little noses") and a branding that was consistent with the instructions and the boxes. The box was designed in a way that it was both approachable for adults but also a fun activity to do together with younger children.

Figure 4: cultural probes box

3.6 Data Analysis The data from the three phases has been collected and analyzed through observation. We have looked at how each hamster responds to the familiar object and the novel object to see if they spend more time with the novel object compared to the familiar object and how this aligns with the previous description of the hamster. Also, we looked for any general trends of behavior towards the objects.

3.7 Observation We have analyzed the recordings sent by the owners and have counted the time spent exploring each box. This is based on the paper "curiosity in zoo-animals," where they count the time spent looking at and interacting with the box. We chose not to include the "looking at" because it is hard to judge if the hamster is really observing the box and also because vision is not one of the primary senses of the hamster. Smelling is, but it is hard to judge if the hamster is actively smelling and noticing the object from a distance.

4. Results

In this results chapter, we present the outcomes of our experiment, where we observed the behavior of five hamsters towards familiar and novel stimuli over a duration of seven days.

4.1 General Overview of Observations

There were 15 responses to the Facebook post, who collectively had over thirty hamsters. However, only three of these respondents filled in the form and received the package. We assume this is due to a Facebook error where direct messages between the researcher and respondents were not visible to the latter. Additionally, one respondent who received a package could not participate in the experiment because their hamster passed away shortly after receiving the package.

We collected one hour of footage of the five hamsters. The videos vary in length, as caretakers stopped filming when hamsters lost interest. For the initial phase, there are 311 seconds of footage; for the familiarization phase, 1841 seconds; and for the experimental phase, 1355 seconds.

The caretakers of Hamsters A, B, and C completed the experiment in seven days. The caretakers of Hamsters D and E took a one-day break between days three and four, extending the experiment to eight days.

All hamsters showed interest at least once in the components of the treat boxes. They smelled the scents, found and ate the candy, and nibbled on the boxes.

4.2 Individual Hamster Analysis

4.2.1 Hamster A Hamster A is a female Roborovski hamster born in April 2023. Before the experiment, the caretaker described Hamster A as slightly curious and slightly creative. After the experiment the caretaker described the hamster as a little curious and a little creative. On Day 2,3,4,5 the hamster was given the apple treat. On day 6 and 7 the apple and papaya treat.

- Total recording time: 764 seconds
- Time interacting with treat boxes: 47 seconds (6.1%)
- On day 6: 0% of the total time engaging with the novel object and 2.5% with the familiar object
- On day 7: 0% of the total time engaging with the novel object and 0% with the familiar object

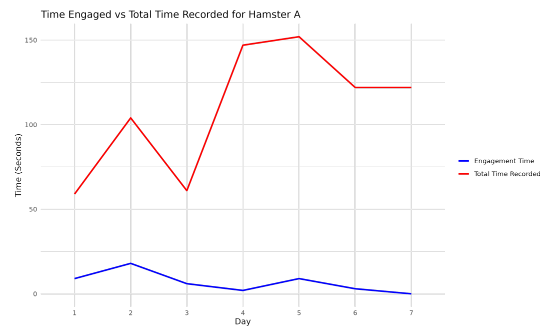

Figure 5: curve of exploration over time, hamster A.

4.2.2 Hamster B Hamster B is a female Roborovski hamster born in April 2023. The caretaker described Hamster B as not curious but slightly creative. After the experiment the caretaker described the hamster as curious and creative.

On Day 2, 3, 4, 5 the hamster was given the apple treat. On day 6 and 7 the apple and papaya treat.

- Total recording time: 1054 seconds
- Time interacting with treat boxes: 533 seconds (51%)
- On day 6: 86% of the total time engaging with the novel object and 3% with the familiar object
- On day 7: 74% of the total time engaging with the novel object and 2.5% with the familiar object

Figure 6: Hamster B on day 6 exploring boxes and showing interest in the novel box.

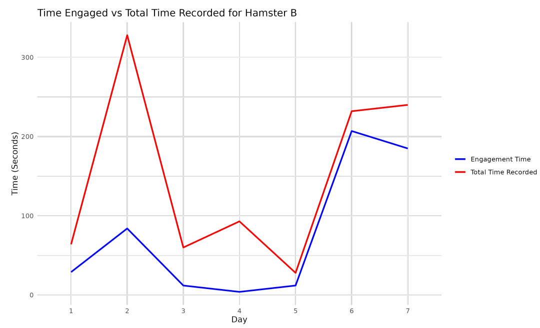

Figure 7: Curve of exploration over time, Hamster B.

4.2.3 Hamster C Hamster C is a Djungarian female hamster, with its age unknown to the caretaker. The caretaker described Hamster C as slightly curious and slightly creative. After the experiment the caretaker described the hamster as a little curious and a little creative. On Day 2,3,4,5 the hamster was given the apple treat. On day 6 and 7 the apple and papaya treat.

- Total recording time: 357 seconds
- Time interacting with treat boxes: 100 seconds (28%)
- On day 6: 25% of the total time engaging with the novel object and 6% with the familiar object
- On day 7: 27% of the total time engaging with the novel object and 18% with the familiar object

Figure 8: Hamster C exploring boxes on day four

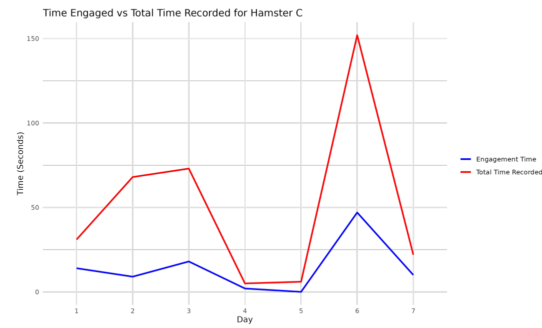

Figure 9: curve of exploration over time, hamster C.

4.2.4 Hamster D Hamster D is a male Djungarian hamster, born in January 2023. The caretaker described Hamster D as slightly curious and slightly creative. Hamster D had experience with toilet rolls used as treat boxes and had eye troubles during the experiment, which likely affected the results. After the experiment the caretaker described the hamster as curious and creative.

On Day 2,3,4,5 the hamster was given the papaya treat. On day 6 and 7 the papaya and apple treat.

- Total recording time: 891 seconds
- Time interacting with treat boxes: 600 seconds (67.3%)
- On day 6: 90% of the total time engaging with the novel object and 0% with the familiar object
- On day 7: 75% of the total time engaging with the novel object and 9% with the familiar object

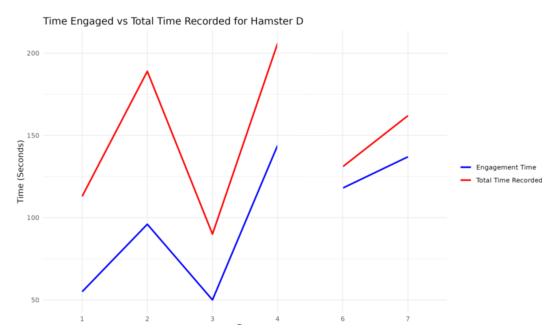

Figure 10: curve of exploration over time, hamster D.

4.2.5 Hamster E Hamster E is a male Djungarian hamster, born in January 2024. The caretaker described Hamster E as slightly curious and slightly creative, noting that this hamster always looks up when hearing sounds like a door opening. During the experiment the owner noted that the hamster would pay more attention to them and the phone camera than the treat boxes, describing the hamster as being easily distracted. After the experiment the caretaker described the hamster as a little curious and a little creative.

On Day 2,3,4,5 the hamster was given the papaya treat. On day 6 and 7 the papaya and apple treat.

- Total recording time: 545 seconds
- Time interacting with treat boxes: 125 seconds (22.9%)
- On day 6: 19.7% of the total time engaging with the novel object and 7.8% with the familiar object
- On day 7: 7.3% of the total time engaging with the novel object and 3.1% with the familiar object

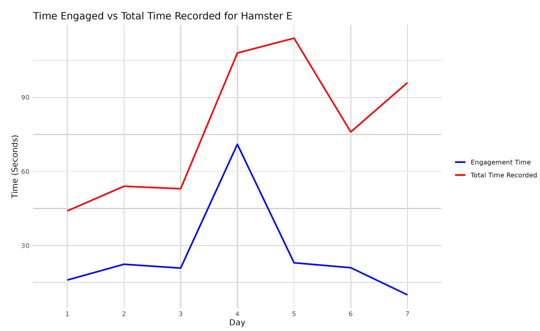

Figure 11: curve of exploration over time, hamster E.

4.3 Complimentary observations

Although not part of this research, the caretakers noted that hamster B and hamster D showed interest towards the treat-boxes at later points during the day as well. Both of the hamster took the treat-box to another place within their cage; a place where they normally rest as well as they started nibbling on the treat box and slowly tearing it apart.

Figure 12: Hamster A moving their treat-box

Figure 13: Nibbled treat-box of hamster D

4.4 Analysis

Each hamster exhibited varying levels of interest towards the treat boxes. Generally, hamsters that showed higher interest in the treat boxes on day 1 (the initial phase) continued to show higher interest throughout the experiment compared to those with lower initial interest. From the limited data collected, we cannot conclusively determine whether hamsters become less interested about the familiar treat boxes over time but we do notice a trend in most hamsters that their engagement time lowers on day 3, 4 and 5. Four out of five hamsters showed increased engagement on day 6 (when the novel scent was introduced) compared to day 5. On day 7 (the second day with the novel scent), the percentage of time interacting with the objects decreased again.

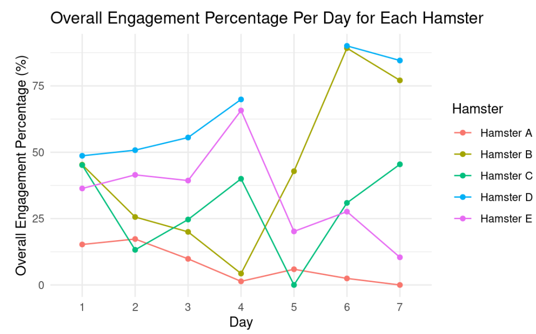

Figure 14: curve of exploration of all hamster in percentage.

4.5 Summary of Findings

The experiment's findings indicate that Hamster B and Hamster D were the most engaged with the treat boxes and preferred the novel stimuli introduced on day 6. In contrast, Hamster A displayed the least interest, and Hamster E's engagement decreased significantly on day 7. The results support the hypothesis that hamsters would show increased curiosity towards novel stimuli on day 6. While four out of five hamsters displayed increased engagement initially, overall engagement decreased by day 7.

4.6 Limitations and Considerations

A notable limitation is the variability in the duration of the videos sent by the caretakers. Some videos were very short (9 seconds), while others were much longer (up to 4 minutes), affecting the data consistency. Additionally, most hamsters continued interacting with the treat boxes on subsequent days, but this study only focused on the initial interactions. Future studies should consider the impact of video length and the potential for ongoing interactions.

5. Discussion

In this chapter, we will discuss the results in relation to the literature study and the hypothesis.

5.1 Overview of Key Findings

With this proof of concept study, we proposed a method of studying animal curiosity and creativity by designing a study based on the entities' umwelt and analyzing their behavior, as well as comparing them to other animals of the same species. We focused on hamsters and their response to novel olfactory stimuli.

Our hypothesis, that interest in the stimuli would decrease on days 3, 4, and 5 and then spike on day 6, is confirmed by the fact that four out of five hamsters showed an increase in initial engagement towards the novel stimuli. This leads us to assume that hamsters have increased curiosity towards novelty. Our sample size is not large enough to show any statistical significance, but the results do suggest potential for further research.

The results between the hamsters were quite contrasting. Hamsters B and D showed high engagement levels, while Hamster A showed low engagement levels. This experiment demonstrated how individual personalities reflect in their behavior towards novelty.

The duration of the experiment was seven days, and this proved to be successful. We would suggest future researchers maintain this framework because it limits the amount of work requested by the pet owner volunteers, but it also proved to be sufficient to observe how the hamsters became familiarized with stimuli and intrigued by novel stimuli.

5.2 Implications for Future Research

5.2.1 Improving Study Design **Larger Sample Size:** For future research, a larger sample size would be ideal to gather more data from different types of hamsters. With this data, we can understand if curiosity in hamsters is linked to specific traits such as species, age, sex, and personality. During this experiment, there was not much room to explore hamster personalities and how they correlate to curiosity; this could be considered for future research.

Standardization of Data Collection: During this research, the caretakers were making the videos themselves without much instruction. For future studies, it would be ideal to instruct the caretakers more on how to record so that the videos would have the same length and angle. We suggest videos being at least a minute long; in scenarios where hamsters show engagement for over a minute, filming should be stopped when the hamster stops showing engagement.

Prolonging the Studies: Currently, this experiment only focuses on the initial curiosity towards novelty. Future studies could focus on how the hamster interacts with the stimuli over a longer period. We considered focusing on how the hamster would interact with the treat box during the day, and we gained some insights into this through observations by the owners, showing us that hamsters continue being intrigued by the treat boxes post the initial interaction. However, for future research, a standardized experiment to study the prolonged interest towards the stimuli would be advised.

Pet-owners' Influence: One of the hamsters we tested with (Hamster E) showed, according to their caretaker, more interest towards them and the camera than the treat box. In future studies, this element should be considered.

5.2.2 Focus on pet-owner relation Currently our research includes a small questionnaire where we ask the pet owners before and after the experiment how curious and creative their pet is. Although this already shows new insights into how accurate the pet owners can judge their pet, future research could focus more on this relationship. Pet owners know their pet the best and their knowledge on the pets unique character could teach us a lot.

6. Conclusion

This thesis aims to explore creativity from a non-human perspective and highlight human biases in current assessment methods of non-human creativity studies. The main focus within this thesis is animal creativity; however, this study highlights the importance of studying animal creativity in the broader context of creativity, including humans and computers as well. This thesis explored the extension of the four-C framework by James Kaufman, including a fifth C, called *micro-c*, emphasizing curiosity as a precursor of creativity.

Through a cultural probe research inspired by design research, we set up an experiment that included special emphasis on the animals' unique sensory world. We set up a proof of concept where hamster owners gave their hamsters two treat boxes a day for a week. For most of the experiment, the treats in the boxes were the same; this changed on days 6 and 7, where a novel treat was introduced. Four out of five hamsters showed a preference for the novel treat, which leads us to believe that hamsters are curious when taking into account their *umwelt*. This method of cultural probes shows great potential for future studies into curiosity in animals and into the relationship between pets and pet owners.

Although this specific case study is focused on hamsters, we believe that our method is applicable to many other animals if proper consideration is given to the specific animal's *umwelt*. This research was not designed to provide any definitive answers regarding how curious hamsters are, but our research does suggest that hamsters are curious and that their unique character plays a big role in how curious they are compared to each other.

For future research, we would suggest standardizing the time of recording because this can affect the data significantly. We would also recommend a more standardized way of recording interest in novelty beyond the initial interaction. This research only briefly explored the relationship between pets and pet owners, but interestingly, the described level of curiosity matched the results of our observed data, showing that pet owners' experiences can be considered valuable insights for future research.

Overall, this thesis shows great promise in its method of exploring curiosity as a precursor of creativity in animals, *micro-c*. We hope that this research contributes to the broader understanding of creativity, offering a non-human perspective. We also hope that this thesis can serve as an inspiration for future research into non-human curiosity and creativity.

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