Curiosity, A Complex Emotion

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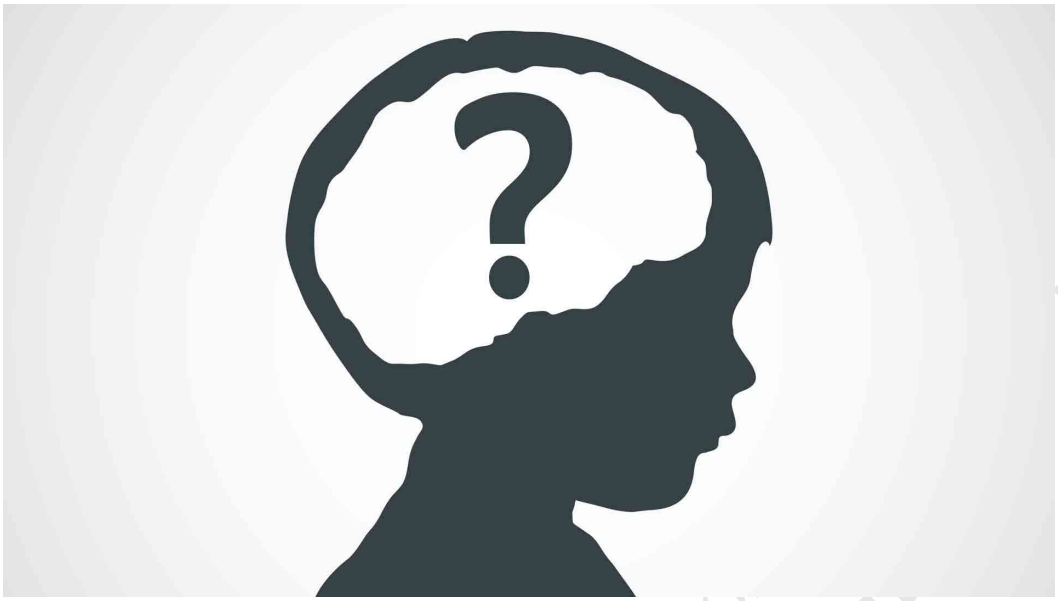

In this assignment for the Affective Computing Course at SFU, we conducted a deep dive research project on a distinct emotion. I chose to research curiosity due to my own innate curiosity. In section 1 Curiosity is described, listing associated social signals, biological descriptions, representations, and cite a few different experiments exploring curiosity. In Section 2, Datasets of different forms are used to explore curiosity, and research is conducted on current affective computing systems In section 3. Finally, section 4 describes pathways future research on curiosity could take.

Additional Key Words and Phrases: datasets, neural networks, gaze detection, text tagging

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1 DESCRIPTION

1.1 General Description

I had a deep interest in learning more about the complex emotion of curiosity, as it was an emotion that propelled me to gain a higher education. The Canadian Oxford dictionary describes curiosity as "an eager desire to know," and evokes a state of inquisitiveness [4].

Robert Plutchik, the creator of the psychoevolutionary theory of basic emotions, lists curiosity as a dyad; a dyad is a mixture of two primary emotions [11]. Furthermore, curiosity is a dyad with a mixture of the trust and surprise basic emotions [11].

1.2 Social Signals and Biological Description

Curiosity's associated social signals include eye gazes and AU4 facial expressions, manipulating of curious objects, and hand gesturing [1][12].

Curiosity's associated physiological expressions are due to inquisitive and exploratory internal states which are directly linked to production of dopamine in the brain; dopamine can modulate reinforcement learning in brain physiology, and is produced usually in response to anticipation of a reward [3].

In one experiment, participants viewed images of magic tricks while undergoing functional magnetic resonance imaging (fMRI); while evoking curiosity from viewing magic tricks, participants had activated the anterior cingulate cortex, and left dorsolateral prefrontal cortex areas of the brain [10].

1.3 Representations and Classifications

There are many different scales for representing and classifying curiosity emotions, including Plutchik's description of curiosity as a trust + surprise dyad described previously.

There is the Litman I-EC and D-EC scales measuring curiosity in two dimensions; I-EC corresponds to Interest, or a drive for information gathering to increase positive emotions, and D-EC corresponds to deprivation, or a motive to reduce negative emotions from a lack of information [2].

In 2018, a new scale was proposed called the five dimensional curiosity scale (5-DC scale); the five dimensions of 5-DC are joyous exploration, deprivation sensitivity, social curiosity, stress tolerance and thrill seeking [2]. This scale was build due to further analyze how different people experience and express curiosity [8].

1.4 Appraisal Description

Research from a 2017 study on the five dimensional curiosity scale, found curiosity is caused by a motivation to "seek out, explore, and immerse oneself in situations with potential for new information and/or experience," on a short term scale, and "expand knowledge, build competencies, strengthen social relationships, and increase intellectual and creative capacities" on a long term scale [8].

Furthermore, deep reading, examining visual imagery, manipulating interesting objects, observing people's behaviors, risk taking to acquire new experiences, taking on challenging tasks, and asking a lot of questions are activities curious people have found to take on in daily life [8].

1.5 Associated Phenomena

From research using the 5-DC scale, 4 subtypes of curious people have been found. Furthermore, curious people can be categorized into fascinated, problem solvers, empathizers, and avoider subgroups [8].

The fascinated group includes people that are usually social, enthusiastic, assertive, well educated, and are natural born leaders; the problem solvers are hard working people who are independent, and goal oriented while being less interested in socializing; the empathizers group are people that are socially perceptive, but enjoy observation rather than participation; the avoiders group are the least curious, least educated, and often have issues handling confrontation [8].

The last two groups were associated with increased stress levels over the first two groups [8].

1.6 Measurement & Induction Methods

Most experiments on curiosity in humans are conducted by questionnaire, and most resent experiments favor the 5-DC scale. Some questionnaires are done directly through self-reporting while others are done indirectly through observation.

One experiment was conducted nationally in the US on 3,000 adults using an online survey. Induction methods included questions about: participant's personality traits using adjectives, 8 value categories (tradition, duty, independence, status, hedonia, social justice, environment, and romance), and consumer habits [8].

Another experiment was conducted using a Hebrew version of the 5-DC scale on 266 Israeli adults [2]. This sample of participants was highly educated of which 88% of the participants held academic degrees [2]. The experiment was conducted by online survey [2]. Furthermore, induction methods included open ended questions, 6 value categories (personal well-being, moral values, religious values, social ideology, and environment), and demographic questions [2].

A different experiment was conducted on child developmental and scientific curiosity. Furthermore, questionnaire-based experiments on childhood curiosity are not effective as children's brains are still developing. This experiment extracted user actions from an exploratory computer game called "Underwater Exploration!" [7]. 200 Preschool children played the computer game.

The player's point of view was inside a submarine with two closed windows; children were asked which window to explore, and each had a variety of images of fish [7]. The game logged mouse-click responses for a number of trials in each child, and scores measured "total uncertainty explored, number of more-uncertain choices, and final preferred level of uncertainty" [7].

The game inducted curiosity in participants by introducing a number of "information gaps," and 60 different fish of which two of the same were never shown [7].

2 DATASETS AND EXAMPLES

One study used the emoReact dataset to analyze recognition of the curiosity emotion through images with hand gestures. As mentioned in description section, curiosity was found to be associated with gaze shifting, tilted head, and breathy voice, but certain hand gestures were found to take part in curiosity state as well [9]. For example, children curious about objects usually would manipulate the objects to gain more knowledge while other children would put a hand on chin, or rest their head on their arm [9].

2.1 EmoReact Dataset

EmoReact is a scientific multimodal emotion dataset containing short video clips of children age four and fourteen years old, and annotated with different emotion categories; the dataset is also a part of a peer reviewed publication [9].

This dataset contains 1102 video clips with audio, and 63 different children. Video clips annotated with the 'curiosity' label included 386 videos, and 51 different children [9].

Video clip annotations were conducted using a crowd sourcing platform of which nine different workers annotated each emotional affect [9]. Each label had two different agreement levels, being moderate [0.4-0.6], and substantial [0.6-0.8] agreement levels [9].

Curiosity was rated 0.41 on the agreement scale [9]. The dataset can be found here: https://www.behnaznojavan.com/emoreact

2.2 Lab Controlled Hand Gesture Data

One study used the emoReact dataset to analyze recognition of the curiosity emotion through images with hand gestures. As mentioned in the description section, curiosity was found to be associated with gaze shifting, tilted head, and breathy voice, and certain hand gestures were found to take part in a curiosity state as well [1].

For example, children curious about objects usually would manipulate the objects to gain more knowledge while other children would put a hand on chin, or rest their head on their arm [1]. The dataset can be found on the emoreact web page in the previous section.

2.3 Discussion on EmoReact & Hand Gesture Data

The emoReact dataset is the largest dataset of its kind, however much more data must be used to improve accuracy of affective systems. Labeling was conducted using a crowd sourcing platform which may have influenced the low agreement levels of annotations. Audio labels had a strong correlation to correctly predicting emotions, however only for a few emotions.

Scores were higher using a combination of emotion factors, ie. multimodal analysis to determine an emotion, rather than unimodal. Hand gestures were found to be associated with curiosity in one study, however hand gestures were difficult for an affect system to pick up. Furthermore, in some cases hands would cover a participants face, and lower accuracy of emotion prediction.

The data is homogeneous since that all videos are of similar aspect ration, video quality, and each child is acting out all of the required emotions. The data is also heterogeneous in the fact that video clips had differing lengths.

Ages of children were between age four and fourteen; younger children inevitably posed challenges understanding the purpose of experiments, and were difficult to record in some situations, while older children understood the purpose and worked towards a common goal.

2.4 Naturalistic Street Magic Data

One interesting example of in-the-wild data was found from people participating in street magic performed in the Netflix reality TV show, 'Magic for Humans,' staring magician Justin Willman [13].

The show was not attempting to compile emotion affects for scientific purposes, however it does provide an interesting use case for extracting curiosity data from facial expressions and body language. Two notable segments of the show were called 'Trick Questions', and 'The Invisible Man.'

In 'Trick Questions' Justin showed participants a magic trick and then asked them a question. Usually participants were so dumbfounded from the curious state induced by the magic trick, they couldn't respond to a question afterwards. One participant stated, "I literally cannot process what just happened" [13]. Furthermore, video clips taken from the show would be very unique because participants had the most genuine expressions during and after the magic tricks took place.

In the other segment, 'The Invisible Man,' Justin hired an audience of actors to pretend they witnessed an unknowing participant become invisible [13]. During the magic trick, the unknowing participant wandered around the park interacting with the audience, curious why no one could see them.

The magic trick became a viral internet challenge; people shared videos tricking their friends, and family into believing they became invisible [6]. Furthermore, data could be extracted from the original and internet challenge videos as well. 'Magic For Humans' data can be found on Netflix, and the 'Invisible Man' trick can be found here: https://www.youtube.com/watch?v=fu3TFib-JK4&t.

2.5 Discussion of Magic For Human's Data

Since Magic for humans is a reality TV show, an issue is raised about the validity about participants in the show. How do we know they are not paid actors in on the tricks? We don't know for sure, but Justin states that his tricks are not edited or have camera tricks, and stated in the 'Invisible Man,' trick that the audience was in on it. Data is also not homogeneous because videos are taken in different locations, and not to be uniform, but participants are of differing age, sex, and race.

2.6 HiHo Kids Data

One final example of curiosity data is from the YouTube channel, 'HiHo Kids.' Kids on the show usually try new things, or interact with adult participants to learn about new topics. Learning and childhood development are key components in curiosity which made this dataset interesting. Furthermore, this content introduces one new unique modality: taste. In one segment in the

YouTube series, kids try new foods. This lab controlled data could be similar to the emoReact dataset, and should require further analysis. The channel can be found here: https://www.youtube.com/channel/UCqa2MPu8bLY1PwVFUpSyVhQ.

3 COMPUTATIONAL PROCESSING AND SYNTHESIS

The affective system tested in the 2016 study of emoReact data is an interesting system to review due to its ability to predict emotions using a combination of different modalities. Furthermore, the affective system used cues taken from participant's facial action units, head positionorientation, auditory voice quality, and auditory pitch information to determine emotions in children [9].

Different facial action units included eye brow, eye lid, nose, cheek, jaw, lips, and blinking movements [9]. Head position and orientation categories included head nods, and shakes while auditory information included distinct tense, creakiness and breathiness of speech [9].

The curiosity affect specifically, was linked to head rotation, head gaze shifting, breathiness, and tenseness of speech [9]. The accuracy of the system left much to be desired with most accuracy scores hovering around 68%, including curiosity [9].

Keywords for this study are: Emotion Recognition, Nonverbal Behavior Analysis, Audio-Visual Sensing, Facial Analysis.

One 2019 paper called 'Social behaviour as an emergent property of embodied curiosity: a robotics perspective,' aimed to provide a basis for producing an environment for a computing agent to learn social behaviours through human curiosity drive interaction (G. Gordon, 2019). Furthermore, this basis was thought to resemble behavioural patterns in babies [5]. The agent used face detection, tracking, and responded to attention grabbing facial expressions [5].

To teach the agent about facial expressions, datasets were taken from the sitcom 'Big Bang Theory' for its visual and social environments [5]. To teach the agent to respond to visual stimuli, it was taught its own set of behaviours, such as happy, sad, yawning, thinking, and nodding facial expressions. Furthermore, the agent learned complex behaviours like crying to get attention [5].

The paper acknowledges that verbal interaction is an important part of teaching a curious agent, and should have been implemented [5].

Keywords for this paper are: artificial curiosity, robots, computational models, intrinsic motivation.

4 OPEN RESEARCH QUESTIONS AND DISCUSSIONS

From past research on affective systems and the psychology of curiosity, there is a lot of information about how curiosity is induced, the different types of curious people, curiosity as a dyad of trust and surprise, but much is to be desired in terms of affective system's ability to predicting curiosity. Furthermore, this may be an issue in the way curious expressions are labelled on data. In the emoReact dataset, curiosity was low on agreement between labeller scale. But it could be argued that larger datasets for curiosity need to be produced.

'Magic for Humans' street tricks may be an excellent dataset for extracting curious behaviours. People participating in the show were undoubtedly curious about what was going to happen, and showed very extreme and genuine curiosity about how the tricks worked. Reality TV shows might be excellent candidates for extracting complex emotions for affective systems.

REFERENCES

[1] Charles Hughes Behnaz Nojavanasghari. 2017. Context-driven Hand Gesture Recognition for Automatic Recognition of Curiosity. *Designing for Curiosity Workshop* (2017).

[2] Menucha Birenbaum, Fadia Nasser-Abu Alhija, Hany Shilton, Helena Kimron, Rovena Rosanski, and Neria Shahor. 2019. A further look at the five-dimensional curiosity construct. *Personality and Individual Differences* 149 (2019), 57–65.

[3] Vincent D Costa, Valery L Tran, Janita Turchi, and Bruno B Averbeck. 2014. Dopamine modulates novelty seeking behavior during decision making. *Behavioral neuroscience* 128, 5 (2014), 556.

[4] Oxford English Dictionary. 1989. Oxford english dictionary. *Simpson, JA & Weiner, ESC* (1989).

[5] Goren Gordon. 2019. Social behaviour as an emergent property of embodied curiosity: a robotics perspective. *Philosophical Transactions of the Royal Society B* 374, 1771 (2019), 20180029.

[6] S Green. 2018. 'Magic for Humans': Justin Willman on His Viral 'Invisible Man' Trick and the Dangers of Fooling Kinds With It. https://www.indiewire.com/2018/09/magic-for-humans-justin-willman-invisible-challenge-1202002805/.

[7] Jamie Jirout and David Klahr. 2012. Children's scientific curiosity: In search of an operational definition of an elusive concept. *Developmental review* 32, 2 (2012), 125–160.

[8] Todd B Kashdan, Melissa C Stiksma, David J Disabato, Patrick E McKnight, John Bekier, Joel Kaji, and Rachel Lazarus. 2018. The five-dimensional curiosity scale: Capturing the bandwidth of curiosity and identifying four unique subgroups of curious people. *Journal of Research in Personality* 73 (2018), 130–149.

[9] Behnaz Nojavanasghari, Tadas Baltrušaitis, Charles E Hughes, and Louis-Philippe Morency. 2016. EmoReact: a multimodal approach and dataset for recognizing emotional responses in children. In *Proceedings of the 18th acm international conference on multimodal interaction*. 137–144.

[10] Ben A Parris, Gustav Kuhn, Guy A Mizon, Abdelmalek Benattayallah, and Tim L Hodgson. 2009. Imaging the impossible: An fMRI study of impossible causal relationships in magic tricks. *Neuroimage* 45, 3 (2009), 1033–1039.

[11] Plutchik Robert. 1980. Emotion: a psychoevolutionary synthesis. *New York7 Harper and Row* (1980).

[12] Tarek Sobh and Khaled Elleithy. 2006. *Advances in Systems, Computing Sciences and Software Engineering*. Springer.

[13] Justin Willman. 2018. magic for humans.