VOICE Initiative: Biomedical Research

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Introduction

Project Description: Today, non-verbal children are believed to have minimal intelligence and cognitive abilities. We are aiming to prove this to be false. The Voice Project initiative aims to reverse biases in academia and show that communication is still possible without words or signs. Our current work consists of integrating computer software with biomedical engineering and neurology to explore non-verbal and non-symbolic communication through brain monitoring applications.

Research

Foundational Emotions: Fear, Sadness, Joy/Happiness

1. Heart Rate (HR)

Fear: Heart rate tends to increase with fear due to the activation of the sympathetic nervous system (the fight-or-flight response). The increase in heart rate is part of the body's preparation to face a perceived threat.

- Range: 90-120 bpm (can possibly be higher in intense fear situations)

Sadness: Heart rate may decrease in response to sadness. The parasympathetic nervous system (which calms the body) might be more active during this emotional state, leading to slower heart rate and reduced arousal.

- Range: 60-80 bpm

Joy: Joy or happiness often leads to an increase in heart rate, though the increase might be less intense than with fear. Positive emotions tend to activate the sympathetic nervous system, but in a more moderate way than fear.

- Range: 80-100 bpm

2. Blood Pressure

Fear: Blood pressure typically rises with fear due to the body's stress response. This happens as the body prepares for action—either fight or flight—by sending more blood to muscles and vital organs.

Range: Systolic 120-140 mmHg, Diastolic 80-90 mmHg

Sadness: Blood pressure might either remain steady or slightly decrease with sadness. A prolonged emotional state of sadness can lead to lower overall arousal, including a reduction in blood pressure.

Range: Systolic 100-120 mmHg, Diastolic 60-80 mmHg

Joy: Blood pressure can increase with joy, particularly if the emotional

state is intense or accompanied by physical activity (e.g., laughing or jumping around). However, the increase is typically less pronounced than with fear.
Range: Systolic 110-130 mmHg, Diastolic 70-85 mmHg

3. Skin Conductance (Galvanic Skin Response or GSR)
Fear: Skin conductance (which measures sweating) increases during fear. Fearful emotions trigger the release of adrenaline, which activates sweat glands, leading to higher skin conductance.
Sadness: Skin conductance can decrease during sadness. When experiencing sadness, there's often less physiological arousal and lower sweating.
Joy: Joy may also increase skin conductance, but generally not as much as fear. Positive emotions can lead to mild increases in sweat production, but the response is less intense compared to fear.

4. Respiration Rate
Fear: Breathing rate typically increases with fear. Rapid, shallow breathing is a common response as the body prepares for quick action.
Range: 18-30 breaths per minute
Sadness: Sadness can be associated with slower and deeper breathing, as it is often linked to a more subdued and low-energy state.
Range: 12-18 breaths per minute
Joy: Joy is often marked by faster, shallow breaths, especially if the person is laughing or excited. However, in a calmer state of joy, breathing might be normal or even deeper than usual.
Range: 15-22 breaths per minute

5. Pupil Dilation
Fear: Fear triggers dilation of the pupils (mydriasis). This response is part of the fight-or-flight mechanism, increasing visual sensitivity to detect threats in the environment.
Sadness: Pupil dilation is generally less pronounced with sadness, although there might be some dilation due to emotional distress or fatigue.
Joy: Pupil dilation can occur with joy or excitement, though it is often less noticeable than with fear. Positive emotions can lead to increased alertness, which can cause minor dilation.

6. Facial Expressions
While not strictly physiological markers, facial expressions are closely tied

to emotion and can give additional context to the physiological signals. For example:
Fear: Widened eyes, raised eyebrows, and a mouth that might be open.
Sadness: Downturned lips, furrowed brows, and eyes that might be teary or appear "droopy."
Joy: Smiling, with the mouth forming a wide grin and the eyes potentially squinting or showing "crow's feet."

7. Body Temperature
Fear: Often, body temperature might decrease in response to fear (cold hands or feet), due to the redirection of blood flow to essential organs and muscles.
Sadness: Sadness may lead to a slight decrease in body temperature, especially if it leads to lethargy or feelings of coldness.
Joy: Positive emotions like joy can sometimes cause a slight increase in body temperature, particularly if the joy is linked to physical activity or excitement (e.g., laughing, running around).

8. Cortisol Levels
Fear: Cortisol, the stress hormone, increases during fear as part of the body's preparation for danger.
Range: Approximately 15-25 mcg/dL (can vary widely, depending on the intensity and duration of fear)
Sadness: Cortisol levels may also rise during sadness, particularly if the sadness is prolonged or linked to stress.
Range: Approximately 10-15 mcg/dL (slightly elevated from baseline in some cases)
Joy: Cortisol tends to be lower during positive emotions like joy. Joy and laughter can reduce stress and lower cortisol levels.
Range: Approximately 5-10 mcg/dL (slightly lower than baseline)

9. Muscle Tension
Fear: Increased muscle tension is common with fear, especially in the face, neck, shoulders, and hands. This is related to the fight-or-flight response.
Sadness: Muscle tension tends to decrease with sadness, as the body may feel fatigued or weakened.
Joy: Joy can lead to muscle relaxation and less tension. Laughter and other joyful expressions often involve a relaxation of facial and body muscles.

Ethical Concerns in Data Collection (from those who are unable to give consent)

For individuals who can't provide direct consent, there are a few methods that might help make sure the process is ethical, respectful, all while obtaining effective data collection:

-Proxy Consent: In cases where individuals cannot consent themselves, a legal guardian or family member can provide proxy consent on their behalf. This is often used for vulnerable populations and requires that proxies act in the best interests of the individual.

-Assent Process: Though they may not provide formal consent, nonverbal individuals can sometimes show signs of assent or dissent through nonverbal cues. This might include gestures, eye movements, or physiological signs (e.g., relaxation versus signs of distress). Observing these cues can help determine if they are comfortable participating.

-Institutional Oversight: Working under the guidance of an Institutional Review Board (IRB) or an ethics committee can help ensure that the methods used respect the individual's autonomy and minimize risks. These boards are experienced in overseeing studies involving vulnerable populations.

-Anonymized and Minimal Data: Collecting only essential data and anonymizing it as much as possible can help minimize privacy concerns. Ensuring data security, especially with physiological data, is crucial.

-Continuous Monitoring and Withdrawal: If possible, monitor for signs of distress during the data collection process. This allows the study to be adjusted or paused if signs indicate the participant is uncomfortable.

" The ethical mandates underlying the conduct of research using human subjects are derived from several sources, including:

- the ancient and traditional duty of physicians to benefit their patients, or at least do them no harm;1

- the Kantian philosophical view of human beings as "ends in themselves," never to be used merely as means to ends, or for the advantage of others;2

- the political and legal concept of autonomy or self-determination that requires consent to any bodily intrusion;3 and

- the requirements of good scientific method in designing and conducting experiments, including: minimization of risk.4 These ethical concepts are often translated into three basic principles that provide a framework for the moral conduct of human subjects research:

- The principle of "autonomy," or personal self-governance, "by adequate un-

derstanding while remaining free from controlling interference by others and from personal limitations that prevent choice" (Faden et al., 1986, p. 8). In order for a research subject to make an autonomous choice, the autonomy of the subject must be respected which includes providing sufficient information for the subject to make an autonomous and informed decision.
- The principle of "beneficence," which is concerned with the intent and capacity of science and medicine to avoid harm and provide benefit; in the case of research, this requires careful weighing of potential harms against potential benefits.
- The principle of "justice," or treatment according to what is fair, due, or owed, which includes avoiding unfairly burdening subjects or communities of subjects in relation to benefits. "

Source: National Research Council (US) Committee on Evaluation of 1950s Air Force Human Health Testing in Alaska Using Radioactive Iodine-131. The Arctic Aeromedical Laboratory's Thyroid Function Study: A Radiological Risk and Ethical Analysis. Washington (DC): National Academies Press (US); 1996. 3, The Ethics of Human Subjects Research. Available from: https://www.ncbi.nlm.nih.gov/books/NBK232523/

Codes of ethics and regulations for ethical clinical research include:

- Nuremberg Code (1947): It is a set of 10 principles that govern human experimentation:
- Voluntary Consent: the participants in this research have to be voluntary; participants must be fully informed about the nature, duration, and purpose of the experiment.
- Benefit to Society: the experiment's goal needs to be to produce results that benefit society that cannot be done through other means. Based on Prior Knowledge: the experiment should be grounded in prior animal experimentation and existing scientific knowledge to justify its validity.
- Avoidance of Unnecessary Harm: all unnecessary physical and mental suffering and injury must be avoided.
- No Risk of Death or Disabling Injury: no experiment should be conducted if there is a reason to believe it can cause death or disabling injury, except possibly where the researchers also serve as subjects.
- Risk-Benefit Balance: the risk must not exceed the potential humanitarian importance of the problem the experiment seeks to solve.

- Adequate Preparations: proper preparations and facilities should be available to protect participants from harm.
- Qualified Researchers: only scientifically qualified individuals should conduct experiments.
- Right to Withdraw: participants must have the freedom to withdraw from the experiment at any time.
- Obligation to Terminate: researchers must terminate the experiment if they observe that it is likely to result in harm or injury to the participant.

*** In addition to physiological data, can incorporate other types of inputs to create a more holistic interpretation of an individual's emotional state. (some are the controls of the experiment)**

- Environmental Context: Recording contextual factors like the physical environment, noise level, and who is present can add important context. For instance, loud environments might increase stress responses, while familiar caregivers could have a calming effect. This data could be gathered through passive sensing, such as detecting sound levels or noting the time of day.
- Routine and Activity Patterns: Tracking daily routines, activities, and sleep patterns may reveal emotional cues. For instance, disruptions in sleep or deviations from regular routines might correspond with certain emotional states, like anxiety or discomfort.
- Medical History Data and Trends (sensor aspect @ Jimin): Comparing current physiological and behavioral data with historical data from the same individual can improve accuracy. For example, if the individual shows a particular physiological response consistently during certain activities, it may reveal patterns of enjoyment or distress.
- Sensory Preferences or Sensitivities (sensor aspect @ Jimin): For some individuals, specific sensory inputs—like light, sound, or touch—can affect their emotional state. Tracking the presence of such inputs (e.g., detecting a light level or sound frequency) may help correlate environmental stimuli with emotional responses.