Modeling Cue-integration in Emotion Perception
Srishti Goel¹, and Maria Gendron¹
¹Department of Psychology, Yale University

Summary Emotion perception is influenced by various cues including target cues such as facial movements and the situational context. Our understanding of how information from these cues is integrated is limited, however. We propose to examine whether people rationally integrate information from faces and situations to perceive emotions using a Bayesian cue-integration model in a dataset that includes the complexity of social situations experienced by people in daily lives.

Keywords · Emotion · Perception · Cue integration · Computational Modeling · Bayes
Email: srishti.goel@yale.edu

Introduction Extensive research reveals facial movements are important cues that people rely on to make emotion inferences. Yet perceptions of emotions are also strongly impacted by situational context (e.g., Carroll & Russell, 1996; Chen & Whitney, 2019). Emotion perception can be understood as an active process, in which the perceivers rely on culturally learned concept knowledge to integrate cues from the target and the wider context (Barrett et al., 2019). Previous research has focused on the extent to which facial or situational cues dominate in perception, whereas research investigating how information is integrated to perceive emotions is limited.

Aims We aim to investigate how people integrate information from two different cues - facial movements and situational information - to perceive emotions. We will adapt a cue-integration Bayesian computational model from Ong and colleagues (2015) to examine the extent to which human perceivers rationally integrate information from multiple cues to make inferences about other's emotion states.

Methods We will use an archival dataset containing ratings of scenarios, ratings of actors’ portrayals of those scenarios, and ratings of the combinations. The dataset includes 604 stimuli pairs (scenarios and faces). Each participant rated their perception of 13 different emotion categories (disgust, shame, interest, pride, fear, amusement, sadness, contempt, surprise, anger, happiness, awe, embarrassment) on approximately 40 stimuli. Ratings included in the dataset will be used to calculate probabilities of inferring emotions given a scenario, a face and a combination of both. Prior probabilities for emotions will be collected via a separate online sample. Participants (N=40) will be asked to rate the probability of perceiving a given emotion in daily life.

Predicted Results We will calculate model predicted emotion inferences for cue integration using Eq 1, below. The equation for cue-integration was derived by Ong and colleagues (2015):

\[
P(e|s, f) \propto \frac{P(e|s)P(e|f)}{P(e)}
\]

Here, P(e|s,f) is the probability of inferring an emotion given a situation and face, P(e|s) is the probability of inferring an emotion given a situation, P(e|f) is the probability of inferring an emotion given a facial expression and P(e) is the prior probability of emotion. P(e|s,f) is the model predicted probability for cue-integration. Critically, the model assumes that perceivers adopt a lay theory such that facial movements reflect an internal emotional state. We will examine correlations between perceiver inferences based on joint cues (faces and situational contexts) and the model-based predictions. We will also examine correlations with empirically-based inferences from a single cue (faces or situational context). We predict that the Bayesian integration model will correlate better with the empirical joint-cue inferences than the empirically-based single cue inferences. We will test this prediction overall and for each target emotion.

Conclusions This research will further reveal how perceivers integrate information from faces and situations. If perceivers rationally integrate, it suggests they incorporate information about likelihood and cue uncertainty in how they make inferences of emotions. Ultimately, this modeling approach can be leveraged to examine integration of additional cues to examine which cues are prioritized and when. Future directions will also include modeling individual differences in Bayesian cue integration.

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Individual variation in facial expressivity: An evolutionary hypothesis

Bridget M. Waller1, Eithne Kavanagh1 Claire Tierney2, Claire Witham3, Jerome Micheletta4, Anne Burrows5 and Jamie Whitehouse1

1Department of Psychology, Nottingham Trent University, UK; 2Human Anatomy Resource Centre, University of Liverpool, UK; 3Centre for Macaques, Medical Research Council, UK; 4Department of Psychology, University of Portsmouth, UK; 5Department of Physical Therapy, Duquesne University, USA

Summary Individuals differ in facial anatomy (size, structure and number of facial muscles) and how successfully they use facial expression as social tools. Here, we propose a unifying evolutionary hypothesis to explain these phenomena. We suggest that differences in facial expressivity reflect how individuals situate themselves within a social network. In an interdisciplinary study, we will combine psychological, anatomical and cross-species methods to document individual differences in facial expressivity and measure how this is related to social function.

Keywords • facial expression • evolution • primates • FACS • anatomy

Background Human facial expression is unique among species in complexity and subtlety. This ability is likely a key factor in human evolution, connected with the evolution of large brains, large social groups and complex cognition (Dunbar, 1996). However, while there has been a strong focus on the meaning and form of specific facial expressions, such as smiling, we know very little about how and why individuals vary in their capacity to produce (e.g., Waller et al., 2016) and perceive these expressions. Traditional perspectives viewing facial movements as expressions of emotion have driven an implicit assumption that the relevant and evolved aspect of facial expression is its uniformity across individuals and cultures, and that any individual differences could be attributed to random noise rather than being evolutionary significant. We challenge this position by developing a novel hypothesis focussing on the evolution of individual differences in facial expression rather than uniformity. The primary advantage of expressivity must be linked to success in forming and maintaining social bonds with others. However, it is also likely that individual differences in expressivity interact with related abilities in facial control and facial expression processing, in that all three skills are needed in order to build strong and stable social bonds with others.

Aims This large-scale five-year project aims to determine 1) how facial expressivity is underpinned by differences in facial musculature, 2) how these differences may reflect an adaptive strategy in humans, and 3) whether humans are unique in having this specialisation of facial expression.

Planned Methods The project will employ three distinct methodological pathways. First, individual variation in production and perception of facial expressions will be measured via laboratory experiments and in relation to social network size and quality (N = 1500). Second, variation in human facial musculature will be documented through cadaveric dissection and muscle fibre analysis (N = 70) and existing MRI databases (N = 600). Third, facial expressivity will be examined in a primate model (rhesus macaques, Macaca mulatta) in both semi-free ranging (N = 50) and captive (N = 100) populations to determine whether patterns are unique to humans. Through integration of these different forms of data, we will test the novel hypothesis that individual differences in facial expressivity are related to the size and quality of an individual’s social network.

Planned Analysis First, we will examine population level variability found in facial musculature and compare it to that found in behavioural expressivity to determine whether there is a likely direct relationship between muscle presence and muscle use. Second, we will compare the individual differences found in humans with those found in macaques and reflect on this in light of evolutionary similarities and differences. Finally, we will consider the link between population variability in facial musculature and individual differences in social network size and quality, to conclude whether human individual differences in facial musculature and expressivity function to maintain social networks, and whether this is unique to humans.

Conclusions This project will provide a novel perspective on the universal nature of facial expression and will integrate individual differences into theories of facial and emotional communication.

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Testing a novel method for measuring subjective affective responses associated with drug craving during fMRI scanning

Stephen J. Wilson

1Department of Psychology, The Pennsylvania State University

Summary The goal of this planned study is to provide initial validation for a novel approach to measuring subjective affect associated with drug craving during fMRI scanning. This method involves recording participants’ facial expressions using an MRI-compatible camera and then extracting a time course of affective responses from these videos. The presentation outlines an fMRI study that will test this approach in adults who smoke cigarettes as they undergo a craving induction. Keywords: Craving, Affect, fMRI, Expression, Brain

Introduction Over the past several years, researchers using fMRI to study drug craving have benefited from several key methodological advances. However, when it comes to assessing craving-related affective actions during scanning, investigators are largely limited to the same self-report measures that have been available since the earliest days of fMRI research. Used in isolation, self-report measures typically lack the sensitivity and precision that are needed to relate momentary affective responses to brain activity in those experiencing craving – an important limitation given the close connection that is thought to exist between craving and affect (Tiffany, 2010). This new study aims to address this barrier by harnessing the unique strengths of facial expression analysis as an objective and sensitive way to measure moment-to-moment changes in affect that are linked to craving during scanning.

Aims The specific aims of the study are: (1) to demonstrate the feasibility of measuring affect by analyzing video recordings of facial movements that are displayed during fMRI; and (2) to demonstrate that moment-to-moment changes in affect are meaningfully associated with ongoing brain activity under conditions designed to produce robust cigarette craving.

Methods Planned Adults who smoke cigarettes (n = 76) will complete an fMRI study following overnight nicotine deprivation. They will be randomly assigned to two smoking expectancy conditions and then placed in the scanner to undergo a previously validated cigarette cue exposure procedure (Wilson et al., 2012). The cue exposure procedure is designed to induce robust cigarette craving, while the smoking expectancy manipulation is designed to shape the affective tone of that craving experience (Sayette et al., 2003). To produce a craving state characterized by strong positive affect, those in the Expect-Smoke group will be told that they will be able to smoke immediately following cue exposure. To produce a craving state characterized by strong negative affect, those in the Expect-Delay group will be told that they must wait for an extended time following cue exposure before being able to smoke. An MRI-compatible camera system will be used to record the facial movements exhibited by both groups during scanning.

Analyses Planned Automated facial expression analysis software will be used to code the facial movements displayed by participants during scanning. Specifically, the software will be used to derive a time course quantifying the valence of participants’ affect throughout the cue exposure period, which will be resampled to the fMRI data acquisition rate and convolved with a double-gamma hemodynamic response function. The resulting vectors will be used as regressors in GLMs to obtain beta weights that reflect the magnitude and direction of the relationship between affective valence and brain activity.

Predicted Findings Those in the Expect-Smoke group will exhibit facial expressions associated with positive affect, and the intensity of this positive affect will positively correlate with activity in reward-related brain areas. Those in the Expect-Delay group will exhibit facial expressions associated with negative affect, and the intensity of this negative affect will positively correlate with activity in brain areas implicated in conflict processing and cognitive control.

Conclusions If shown to be successful, the approach being tested in this study would give researchers who use fMRI to study addictive behavior a powerful new tool to measure craving-related affect during scanning. More broadly, the approach has the potential to be useful for any fMRI studies that focus on affect.

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Solitary and social smile production in congenital blindness

Monica Perusquía–Hernández¹, Felix Dollack¹², Saho Ayabe–Kanamura², and Kenji Suzuki²

¹NTT Communication Science Laboratories, ²University of Tsukuba

Summary Affective processing of facial expressions is often assumed to be predominantly visual. Facial mimicry has been deemed as critical for the understanding of our own emotions and those of others. However, there is evidence that congenitally blind people display both spontaneous and posed facial expressions. This casts doubt on the role of visual facial mimicry in general emotion understanding. Hence, we propose to investigate smile production in the absence of vision. We devised several tasks with the goal of eliciting spontaneous, voluntary, and social smiles. Furthermore, we compare the smiles of the blind to those of an average person. Pilot results showed a similar smiling behaviour. This suggests that visually mimicking the facial expressions of others is not a necessary requirement to develop spontaneous and voluntary facial expression behaviour. Nevertheless, several facial involuntary movements, known as blindisms, might impair other’s recognition of the blind’s facial expressions.

Keywords • Blindness • smile • production • EMG • mimicry

Introduction It has been argued that visual input is crucial in the perception, imitation and development of facial expression behaviour. In the Basic Theory of Emotion, certain facial expressions are considered universal and related to the so-called basic emotions. Moreover, facial mimicry seems to play an important role in empathetic understanding and emotional contagion. Evidence from congenitally blind people who smile when happy, or display facial signs of sadness, supports this view that facial expressions evolved to be ‘hardwired’ (Galati, Scherer, & Ricci-Bitti 1997; Matsumoto & Willingham 2009). Blind people might also become aware of their own facial expressions and learn to control them through proprioception (Galati, Miceli, & Sini 2001). Nevertheless, “blindisms”, or uncontrollable facial movements typical of the blind, might render their facial expressions more difficult to be recognised by perceivers unaccustomed to them (Galati et al. 2001). Analysis of the similarity between their smiles and smiles of a healthy person might shed light on the role that facial mimicry can play for people learning to express themselves.

Hypotheses (1) Spontaneous facial expressions between sighted and blind individuals are similar if they are innate expressions. (2) Deliberate facial expressions between sighted and blind differ, as they were learned through different mechanisms. The differences might be seen best in the offset of the smiles, as perceptual studies have suggested that it is the social part of a facial expression (Jack, Garrod, & Schyns 2014). (3) Blind participants can mimic the expressions of an interlocutor similarly to sighted participants, when there is an auditory cue (e.g., laughter).

Methods A 2x2 mixed design is proposed. The within subjects factor is the social and solitary conditions. The between subjects factor is whether the participant is congenitally blind or not. In the solitary condition, spontaneous smiles are elicited using a comedy podcast. In the social condition, spontaneous smiles are elicited when conversing with another person about an emotive (fun) story. Posed smiles are elicited for reference in both conditions using the instructions of a computer (solitary) or a person asking to smile for a picture (social). All facial expressions and interactions are recorded using Electromyography (EMG) and Video cameras. Contrary to us, most of previous studies focus on the morphology of the smiles rather than on their temporal dynamics, and do not consider the facial expression synchronisation between two persons.

Proposed Analysis and Predicted Results Analysis of the spatio-temporal dynamics of the facial expressions will be done using FACS labelling as ground truth. Bayesian modelling and machine learning will be used as automated analyses to match the ground truth. In particular, we are interested in onset, sustain and decay magnitude and speed changes. These can be modelled per experimental condition. Pilot results with one congenitally blind participant showed a similar smiling behaviour to sighted participants across all conditions.

Conclusions We propose to investigate smile production of congenitally blind people who do not have visual input to mimic a facial expression. With this, we aim to shed light on the relationship between facial mimicry and emotional contagion.

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NetFACS: Using network science to understand facial communication systems

Jérôme Micheletta1*, Alexander Mielke2, Bridget M. Waller3, Julie Duboscq4, Claire Pérez1, Alan Rincon1

1Department of Psychology, University of Portsmouth, Portsmouth
2Primate Models for Behavioural Evolution Lab, University of Oxford
3Department of Psychology, Nottingham Trent University
4UMR7206 Eco-Anthropology, CNRS-MNHN, Université de Paris

Summary Understanding facial signals is crucial for understanding the evolution, complexity, and function of the face as a communication system. The Facial Action Coding System enables accurate and objective measurement of facial movements, but we lack tools to analyse these data and efficiently communicate results. Here, we present ‘NetFACS’, a statistical package combining FACS and network analysis to answer questions about facial communication in humans and other animals.

Keywords · Facial Action Coding System · Facial Signals · Network Analysis · Emotion · *Jérôme Micheletta: jerome.micheletta@port.ac.uk

Background Facial signals are important social communication tools in many species, including humans. The face is capable of producing complex, coordinated movements, where the relationship between muscles is important, and it is possible that complexity is reflected in the quantity and quality of these relationships. Facial signals are often coded using the Facial Action Coding System (FACS), which allows for reliable and objective description and quantification of facial signals. Currently, no analytical approach in facial signal research makes full use of the information encoded in FACS datasets. By conceptualising the face as a network of interconnected Action Units (AUs, the smallest unit of facial communication) we can take advantage of the standardised methods developed in the field of network analysis to address a wide variety of questions in a statistically appropriate manner.

Aims We present the potential power of using network analysis to understand, compare and visualise facial signal data. Using an existing dataset, we illustrate some of the functionalities of the NetFACS package for the software R (Mielke et al., 2020).

Methods We used peak frames of 327 FACS coded videos assigned to one of seven posed emotions (anger: 45, contempt: 18, disgust: 59, fear: 25, happy: 69, sadness: 28, surprise: 83) from an existing database (Kanade et al., 2000). We used occurrence and co-occurrence probabilities to build networks of these different emotions. We used resampling methods to determine 1) which AUs occurred more than expected in each emotion, 2) which AUs are conditional on others, 3) whether we can reconstruct the stereotypical facial signals through networks and how graphs in different emotions compare, and 4) whether we can identify clusters of AUs without prior knowledge of the underlying emotion.

Results Using bootstrapping methods, we showed that all seven emotions shared certain AUs, while some AUs were very specific to one emotion (e.g., AU6 and 12 were specific to happy faces). We also found that some emotions are characterised by strong cluster of AUs that had high bi-directional probabilities (e.g., surprise: AU1, 2, 4 and 27) while other emotions are more variable. When building unweighted, undirected networks for each emotion, we showed that they consisted of a core of AUs commonly and strongly linked to each other and corresponding to the known facial signals of emotions (e.g., happy: AU6+12, sad: AU1+4+15+17). We also revealed that even for posed emotions, there was variation in AU composition (e.g., fear: AU1+2+4+5+20 often accompanied by 10, 14, 16, 17 and 26). When ignoring the underlying structure of the dataset (which AUs were used for which emotion) and used a community detection algorithm we could detect three clusters of AUs corresponding to happy, surprise, and a mix of angry, disgust and sad faces.

Conclusions NetFACS offers a way to analyse the wealth of data within and between species, as well as within and between individuals. It creates a vocabulary to describe the information content inherent in the face as a communicative tool. Thus, as a statistical package, NetFACS offers analytical tools for a broad range of researchers studying communication.

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Comparing formalized theories of co-occurring emotions derived from distinct emotion, network, and dimensional approaches

Jens Lange\textsuperscript{1,}*, and Janis H. Zickfeld\textsuperscript{2}

\textsuperscript{1}Department of Psychology, University of Hamburg
\textsuperscript{2}Department of Management, Aarhus University

Summary Emotions frequently co-occur, yet theories explaining emotion co-occurrence are scarce. We compared four parsimonious, formalized theories derived from distinct emotion, network, and dimensional approaches. Two studies supported the formalized network theory, implying that emotions co-occur because the component networks representing two emotions share components or relate to each other.

Keywords · co-occurring emotions · emotion theories · network theory · network analysis · bootstrapping

Introduction Abundant evidence indicates that emotions frequently co-occur (Trampe et al., 2015), yet theories explaining emotion co-occurrence are scarce. We derived parsimonious, formalized theories from distinct emotion, network, and dimensional approaches (Figure 1). In the distinct emotion theory, the components of two emotions are each caused by independent (absolutely distinct theory) or correlated (correlated distinct theory) latent mechanisms. In the network theory, the components of two emotions form overlapping causal networks (network theory). In the dimensional theory, the components of two emotions are caused by a latent dimension (dimensional theory).

Aims We compared the theories in three steps (Figure 1) based on estimated network models (Epskamp et al., 2018). In Step 1, using bootstrap resampling, the absolutely distinct theory implies no between- but within-emotion connections, the dimensional theory implies similarly strong between- and within-emotion connections, and the correlated distinct as well as network theory imply non-zero between- but stronger within-emotion connections. To differentiate the last two theories in Step 2, using the Partial Correlation Likelihood (PCL) Test (Van Bork et al., 2019), the correlated distinct theory implies more support for a latent variable than a network model and the network theory implies the reverse. Further testing the network theory in Step 3, the clique percolation algorithm (Farkas et al., 2007) should identify overlapping communities.

Methods In Study 1, 410 MTurk workers imagined a situation eliciting both awe and kama muta and in Study 2, 120 Dutch students imagined five situations eliciting both shame and guilt. In both studies, participants rated how intensely they experienced a comprehensive set of components measuring each emotion.

Results In Study 1, the analyses in Step 1 indicated that there were between- \( M = .021, SE = .005, 95\% CI_{BCA} [.016,.039], ps < .001 \), but stronger within-emotion connections, \( \Delta M s = .044 -.059, SE s = .003 -.004, 95\% CI_{BCA} [.035-.048,.049-.067], ps < .001 \). In Step 2, the PCL Test showed a higher likelihood for the network than the latent variable model. In Step 3, the clique percolation algorithm identified overlapping communities. In Study 2, preregistered analyses replicated the pattern.

Conclusions The evidence indicates that the network theory best explains co-occurring emotions. Thus, emotions may co-occur because their networks overlap.

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Figure 1: The four theories and their predictions.
Emotional Granularity is Associated with Daily Experiential Diversity

Yeasle Lee1, Ryan L. Boyd2, and Katie Hoemann1

1Department of Psychology, Katholieke Universiteit Leuven
2Department of Psychology, Lancaster University

Summary
Emotional granularity is thought to reflect differences in concepts accrued through experience. Yet research has not examined the relationship between granularity and the contents of daily life. We used written descriptions of everyday events to estimate the diversity of activities and contexts (i.e., themes) reported by individuals, and found this to be positively associated with granularity.

Keywords • emotion differentiation • concepts • natural language • experience sampling • meaning extraction

Yeasle Lee: yeasle.lee@kuleuven.be

Introduction
Emotional granularity refers to one’s ability to create differentiated and nuanced emotional experiences and is associated with positive health outcomes. Individual differences in granularity are thought to reflect differences in emotion concepts (Barrett, 2017). Emotion concepts are informed by accrued knowledge and experience within sociocultural contexts. Greater variation in experience, then, should play a role in elaborating individuals’ emotion concepts, with impacts for emotional granularity. Yet research has not examined the relationship between granularity and the contents of daily life. Natural language, in particular, provides a window into how individuals conceptualize their everyday experiences.

Aims
We investigated the relationship between individuals’ self-reported emotional experiences and written event descriptions. Specifically, we tested whether emotional granularity was associated with diversity of activities and contexts — here operationalized as the variety and relative abundance of themes recovered from daily diary entries. We predicted that granularity would be positively associated with thematic diversity.

Methods
As part of a larger study (reported in Hoemann et al., 2020), participants (N = 50; 54% female; M = 22.5 years, SD = 4.4 years) completed a 14-day experience sampling protocol. At the end of each day, participants reported on the events they had experienced (M = 8.80, SD = 1.22) by rating each on a set of 18 emotion terms, and by providing detailed (~200 words) descriptions for three events of their choice. Following the meaning extraction method (Chung & Pennebaker, 2008), we identified the 200 most frequent content words in these descriptions and computed a binary co-occurrence matrix of these words for each event. We extracted the 15 most prevalent themes (i.e., groups of co-occurring words) using a principal component analysis. We then scored each event for the themes present and computed a Gini coefficient for the diversity of themes represented by each participant’s data (Benson et al., 2018). Using the emotion ratings, we computed granularity for each participant as the inverse of the average intraclass correlation for negative and positive emotions (Tugade et al., 2004).

Results
Consistent with our prediction, emotional granularity was positively associated with thematic diversity (r = .50, p < .001). Significant associations were found between emotional granularity and the mean positive and negative affect reported by participants during experience sampling (b = .17, SE = .07, t(54) = 2.65, p ≤ .006). Sensitivity analyses confirmed that the effect was robust to the removal of potential outliers and held across multiple analytical parameter values (e.g., number of themes extracted).

Conclusions
Individuals who report more differentiated emotions also refer to a more varied and balanced set of activities and contexts in their daily lives. Although we cannot infer the direction of causality, this finding suggests a strong link between the content of everyday experiences and how they are conceptualized. As such, this finding not only identifies a potential source of individual differences in emotion, but sheds light onto concepts’ role in constructing experience.

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Evidence for phylogenetic continuity in nonverbal vocalisations

Roza G. Kamiloğlu¹*, Cantay Çalışkan², and Disa A. Sauter¹

¹Department of Psychology, University of Amsterdam
²Department of Data Science, Denison University

Summary Vocalisations like laughs and screams occur across a range of species. Here, we examine acoustic similarity between human and chimpanzee vocalisations produced in matched behavioural contexts, using comparisons of Euclidian distances based on acoustic features and unsupervised clustering methods. The results show that vocalisations produced in several contexts (e.g., being attacked by a conspecific, discovering a large food source) were acoustically similar across humans and chimpanzee vocalisations.

Keywords · Behavioural context · Comparative/animal behaviour · Evolution · Unsupervised clustering · Vocalisations

Introduction Nearly 150 years ago, Darwin (1872/1965) proposed that emotional vocalisations are phylogenetically continuous across different mammalian groups. Research has tested this idea using perceptual judgments, that is, examining human listeners’ recognition of arousal levels, valence, and behavioural contexts from vocalisations produced by other species (e.g., Filippi et al, 2017; Kamiloğlu, Slocombe, Haun, & Sauter, 2020). Here, we directly compare the acoustic structure of human nonverbal vocalisations and vocalisations of one of our closest living relatives, chimpanzees (Pan troglodytes), using vocalisations produced in matched behavioural contexts.

Aims Vocalisations that were produced in the same behavioural contexts were predicted to be acoustically more similar to each other across the two species in comparison with vocalisations produced in other contexts.

Methods The stimuli were human nonverbal vocalisations and chimpanzee vocalisations produced in eight behavioural contexts: being attacked by a conspecific, being refused access to food, being separated from mother, copulating/having sex, discovering a large food source, discovering a threat, eating strongly preferred food, and threatening a conspecific. For each behavioural context, 20 human vocalisations were collected from online sources. The chimpanzee vocalisations were 117 recordings collected in wild and captive settings. We extracted 88 acoustic features from each vocalisation using eGeMAPS (Eyen et al., 2016).

Results We first examined the degree of acoustic similarity between human and chimpanzee vocalisations per context, using pairwise comparisons of Euclidian distances between the acoustic features of vocalisations produced in each context. We then used unsupervised clustering methods to test the differentiability of behavioural contexts based on acoustic features across the two species.

The results show that vocalisations produced when individuals were attacked by a conspecific, discovered a large food source, and discovered a threat were acoustically similar across humans and chimpanzees (see Figure 1). In fact, the two species were indistinguishable for the vocalisations produced in these contexts.

Figure 1: Distance matrix for Euclidian distances between the acoustic features of vocalisations produced in eight behavioural contexts (smaller numbers denote greater similarity)

Conclusions The findings of this study provide evidence for phylogenetic continuity in vocalisations produced in several behavioural contexts. Our study highlights the acoustic similarity of heterospecific vocalisations, and point to the deep evolutionary roots of primate affective vocalisations.

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Affective Decoding of Face Signals in the Brain is Dynamically Distinct

Meng Liu1, Nicola van Rijsbergen2, Robin A.A. Ince3, Oliver G.B. Garrod3, Rachael E. Jack1,3, and Philippe G. Schyns1,3

1School of Psychology, University of Glasgow, UK
2Department of Psychology, Edge Hill University, UK
3Institute of Neuroscience and Psychology, University of Glasgow, UK

Summary Dynamic facial movements are readily used to communicate affect. Understanding how the brain decodes these signals into affective messages remains unknown. Here, we measured brain responses (magnetoencephalogram, MEG) to dynamic facial movements while participants resolved perceptual tasks (valence/arousal ratings). Using an information-theoretic analysis, we characterized the diagnostic stimulus features and task-relevant brain activities. We show that, between similar peaks at 270ms and 750 ms (temporal lobes) in the two tasks, judgements of valence elicited distinct peaks at 387ms (parietal lobes). Our results suggest distinct dynamic processing for these key affective judgments.

Keywords - Facial expressions · Affective · MEG · Meng Liu: m.liu.3@research.gla.ac.uk

Introduction Facial expressions are frequently used to communicate affective messages. Given the importance of accurately decoding for social functioning, understanding how the brain decodes facial expressions is a source of intense scrutiny. However, as complex signals, identifying how specific facial movements (i.e., Action Units; AU), drive these judgments and associated brain responses is challenging.

Aims We use a novel information-theoretic approach2 to examine how the brain decodes and represents individual elements of facial expressions and transforms them into affective judgments.

Methods We presented each participant (5 white Western, 3 females, mean age = 25) with a series of 4000-6000 facial animations, each comprised of a single dynamic Action Unit (see Fig. 1A for AU list) activated at one of four intensities (25% - 100%) across a duration of 1.25s and displayed on a same identity. Each participant rated the facial animations on arousal (‘low’, ‘neutral’, ‘high’) or valence (‘negative’, ‘neutral’, ‘positive’) in separate blocked tasks.

Results We first examined the stimulus-behavior relationship. Fig. 1A shows the results for each AU, intensity level, and task separately. Warmer colors indicate higher ratings (see color bar on right). While arousal ratings increased with higher AU intensities, valence remained relatively consistent. Next, to identify task-relevant brain activities, we measured the Mutual Information (MI) between behavior responses and the corresponding brain activities. Fig. 1B shows the results after permutation-test (p<0.05). Color-coded lines (each representing brain regions of interest; see legend at top) show the MI values across time. Red colored brains show the whole brain activities at each time point of interest (see colorbar top right). We found that tasks of valence and arousal evoked similar peaks at 270ms and 750 ms in the temporal lobes. In contrast, judgments of valence elicited an additional peak at 387ms on parietal lobes. Our results suggest that affective judgments from facial signals use distinct dynamic processing mechanisms.

Conclusions Here, we examined how dynamic affective facial signals are represented and decoded in the brain. We show that the decoding of affective face signals for affective judgments is characterized by distinct brain activations over time, suggesting the involvement of distinct neutral mechanisms. Our results take a further step towards understanding how the brain decodes complex dynamic facial expressions.

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Is Mother-Infant Face-to-Face Responsivity Affective?

Yeojin Amy Ahn1*, Itir Onal Ertugrul2, Sy-Min Chow3, Jeffrey F. Cohn4, Daniel S. Messinger1

1Department of Psychology, University of Miami
2Department of Cognitive Science and Artificial Intelligence, Tilburg University
3Department of Human Development and Family Studies, Pennsylvania State University
4Department of Psychology, University of Pittsburgh

Summary We examined infant and mother face-to-face responsivity to primarily non-affective (mouth opening) and affective (Duchenne smiling) facial actions using computer vision. Frame-by-frame continuous measurement yielded evidence for reciprocal responsivity for both mouth opening and Duchenne smiling. Thus infants and mothers are responsive both to one another’s non-affective and affective facial actions.

Keywords • Child development • facial expressions • social interactions • dyadic interaction • computational modelling

Introduction Mother and infant responsivity during early interaction is central to social and emotional development (Landry et al., 2006). While mother deliberately imitates infant’s expressions with the intent to intensify the expression of her infant (Wormann et al., 2012), infant’s imitation of maternal expression may be a form of motor mimicry (Holodynski & Friedlmeier, 2006). It is not clear whether moment-to-moment responsivity to the partner’s facial expressions are primarily affective or primarily non-affective. We reasoned that responsivity to Duchenne smiling was more likely to involve affective communication, while responsivity to mouth opening might be non-affective and involve only motoric imitation. Automated facial affect recognition is a burgeoning area of computer vision research but the few applications to infant face-to-face interaction to date have used relatively small samples.

Aims To ascertain the significance of infant→mother and mother→infant responsivity with respect to mouth opening and Duchenne smiling during early interaction. That is, does increased mouth opening and/or smiling lead to increases by the partner?

Methods Sixty-one 4-month-olds and their mothers completed two minutes of face-to-face interaction. Separate mother and infant synchronized video-recordings were submitted to automated facial affect recognition (AFAR; Ertugrul et al., 2019; Ertugrul et al., 2020). The AFAR computer vision software uses a fast cascade regression framework tracked and normalized facial images from which the degree of mouth opening was calculated. Images were input to a convolutional neural network that output the probability of the facial Action Unit associated with Duchenne smiling (AU6 and AU12). Generalized additive models provided residual variables by detrending the time series of log-transformed probabilities of Duchenne smile (AU6 x AU12) and mouth opening. The residuals were used in the analyses.

Results We fit multilevel vector auto-regressive (VAR) models to determine the lead-lag relationships between mothers and infants’ Duchenne smiling and mouth opening during face-to-face interaction. Controlling for both infant and mother auto-regression, there were significant positive bidirectional cross-regression associations between mothers and infants for both mouth opening ($\beta_{M\rightarrow I} = 0.166, \text{SE} = .0007, p < .0001$; $\beta_{I\rightarrow M} = .172, \text{SE} = .0007, p < .0001$) and Duchenne smiling ($\beta_{M\rightarrow I} = .0046, \text{SE} = .0011, p = .0002$; $\beta_{I\rightarrow M} = .0038, \text{SE} = .0006, p < .0001$).

Conclusions Frame-by-frame, continuous objective measurement of facial expressions was applied to the largest infant-mother face-to-face interaction sample to date. Infants and mothers both increased their mouth opening in response to partner mouth opening, and increased the probability of Duchenne smiling in response to an increase in partner’s Duchenne smiling. Interactive influence vis-à-vis smiling is typically interpreted as evidence for the communication of positive affect. However, objective measurement indicates similar interactive dynamics occurring with respect to mouth opening. Mouth opening may index arousal but does not have a specific affective meaning. Thus, motor mimicry or similar non-affective processes may have a role in early face-to-face interaction.

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Designing Emotional Expressions for a Reading Companion Robot

Fangyun Zhao¹,³, Nathan White³, Bengisu Cagiltay³, Paula Niedenthal¹, Joseph Michaelis², and Bilge Mutlu³

¹Department of Psychology, University of Wisconsin-Madison, USA
²Department of Learning Sciences and Computer Science, University of Illinois at Chicago, USA
³Department of Computer Science, University of Wisconsin-Madison, USA

Summary Advancements in affective science and robotics have allowed researchers to consider how robots can express emotions appropriately in human-robot interaction. Borrowing previous work from theories of nonverbal expressions of emotion, we designed 24 distinct emotional expressions for a reading companion robot—Misty II. We validated the expressions with and without social context using crowdsourcing methods. The current work aims to provide a publicly available set of emotional expressions for robots to advance research on emotional responsiveness in human-robot interaction.

Keywords · Robot Design · Non-verbal Behaviors · Affective Computing · Emotional Expressions · Fangyun Zhao: olivia.zhao@wisc.edu

Introduction Emotional expressions manifest themselves in multiple ways, such as endocrine, facial expressions, facial colorations, gestures, voice tones and speech. Emotional expressions not only reflect people’s internal states, they also convey meaningful signals to facilitate social interactions. These components of emotional expressions could be potentially applied to designs in robots. To facilitate relationships and personal connections between robots and humans, robots must send effective social signals to the human partner. Indeed, many works in Human-Robot Interaction (HRI) have explored the effectiveness of emotional expressions in one modality (e.g. color and eye movements). Few have attempted to explore multi-modal emotional expression design in robots. We propose that enabling robots with expressive nonverbal behaviors can facilitate social interaction in HRI. Borrowing literature from human emotional expressions, we designed and validated twenty-four distinct emotional expressions (Figure 1), with the integration of facial expressions, eye gaze, head and body movements, and color changes, for a reading companion robot—Misty II.

Aims The goal of the current work is to develop a set of emotional expressions for robots to support future research on the effects of emotional responsiveness in Human-Robot Interaction. The set of emotional expressions will be publicly available on Open Science Framework (https://osf.io/fjtuc/).

Methods Using the emotion labels defined by Plutchik (1980), we designed twenty-four dynamic emotional expressions for Misty II that incorporated color change, facial movements, body movements, gestures and head orientations.

Results Confusion matrices and F-measures were constructed to confirm the validity. We found that the design of anger expression performed the best in the first study, while joy and surprise yielded the best results with social context in the second study.

Conclusions In the current study, we introduce a novel set of twenty-four emotional expression design for a reading companion robot—Misty II. We intend for the design to be a unique contribution, and a step towards designing emotionally intelligent robots.

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Wearing N95, Surgical and Cloth Masks Compromises the Communication of Emotion

Andrew T. Langbehn1,*, Dasha A. Yermola2, Fangyun Zhao3, and Paula M. Niedenthal*2
1Department of Psychology, University of Tennessee - Knoxville
2Department of Psychology, University of Wisconsin - Madison
3Wisconsin Institute of Discovery, University of Wisconsin - Madison

Summary Across two studies masked faces were rated by 222 Mturk workers to communicate less of the intended emotion than visible faces. This was particularly true for expressions that utilize more lower-face musculature. Masked anger, disgust, surprise, and happiness expressions were perceived to have more non-target emotions; however, participants did not perceive more non-target signals in masked affiliative, dominance, and reward smiles. Masks disrupted perceptions of expression that predominantly utilize lower facial musculature to a greater degree than those that are predominantly display on the upper part of the face.

Keywords · COVID-19 · facial expressions · facial perceptions · face masks · communication
*Andrew T. Langbehn: A-langbe1@utk.edu

Introduction Perceiving emotions in facial expressions relies on at least three processes (Wood, Rychlowska, Korb, & Niedenthal, 2016) that can be hampered by masks. First, visual information from faces can be matched to mental representations of expressions that have been encountered in the past. Second, emotion recognition can rely on proprioceptive feedback from the perceiver’s face (Wood et al. 2016). Finally, people rely on contextual information to interpret emotion expressions (Hassin, Aviezer, & Bentin, 2013). A recent study investigated the recognition of facial expressions covered by face masks (Carbon, 2020). In that study, static images of faces expressing happiness, sadness, anger, and disgust emotions covered with masks were misclassified more often than fully visible faces.

Aims The goal of the present research was to investigate whether wearing face masks, which have become common during the COVID-19 pandemic, affects accurate facial expression recognition. We hypothesized that participants would see less of the target emotion in masked versus unmasked faces. We further hypothesized that this effect would be greater for emotions that utilize more lower face musculature as compared to expressions comprised of more upper face signals.

Methods In study one, 162 Mturk workers saw videos of human faces displaying expressions of happiness, disgust, anger, and surprise that were fully visible or covered by N95, surgical, or cloth masks and rated the extent to which the expressions conveyed each of the four emotions. In study two, 60 Mturk workers saw the same actors displaying three types of smiles (reward, affiliative, dominance) and rated the degree to which the person was expressing positivity, reassurance, and superiority.

Results In Study 1, using a factorial mixed-model ANOVA we found that dynamic, masked happy, disgust, anger and surprise expressions were perceived as conveying less happiness t(161) = 12.11, p < .001, disgust t(161) = 10.99, p < .001, anger t(161) = 10.06, p < .001, and surprise t(161) = 5.84, p < .001, respectively, than fully visible faces. There was a 2-way interaction between facial action predominance and face presentation F(1, 158) = 7.17, p = .008. indicating that perceptions of lower face target emotions were compromised to a greater degree than perceiving upper face target emotions.

In Study 2, smile ratings were submitted to a factorial mixed-model ANOVA. The interpretation of dynamic smiles of reward, affiliation and dominance were compromised when the smiles were covered by face masks. This was observed in particular for the smiles of reward t(59) = 3.16, p = .003. and dominance t(59) = 3.54, p < .001. Ratings of affiliation smiles as specifically communicating reassurance were only marginally lower t(59) = 1.92, p = .060 in masked compared to visible conditions.

Conclusions Masked faces were found to communicate less of the intended emotion than fully visible faces. People may need to increase other non-verbal emotion expressivity to make up for this deficit and facilitate interpersonal communication.

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Increases in Emotional Responding Predict Greater Visual Avoidance during a
Disgust-Eliciting Task
Marcela C. Otero and Robert W. Levenson

1 Sierra Pacific Mental Illness Research, Education, and Clinical Center (MIRECC), Veteran Affairs (VA) Palo Alto Health Care System, Palo Alto, CA
2 Department of Psychiatry and Behavioral Science, Stanford University School of Medicine, Stanford, CA
3 Department of Psychology, University of California, Berkeley, Berkeley, CA

Summary
Visual avoidance (VA) is movement of the head and body that limits exposure to aversive stimuli. We examined how VA relates to physiological activity and disgust facial behavior in neurologically intact and impaired adults. Greater increase in skin conductance before VA onset predicted greater overall VA in controls, but not in patients. Finding suggests VA may be a normative behavioral response to increased disgust that is impacted by neurodegenerative disease.

Keywords
Disgust · Behavioral coding · Neurodegenerative disease · Psychophysiology · Aging

Introduction
VA is a basic response tendency of disgust. It is also commonly observed in attention-based emotion regulation. Despite its prominence, no prior work has examined if VA effects peripheral physiology and emotional facial behavior (two major indices of disgust responding), and under what conditions VA occurs. VA is reduced in patients with behavioral variant frontotemporal dementia (bvFTD), an early-onset neurodegenerative disease characterized by progressive changes in behavior and emotional responses. Studying VA in neurodegenerative disease may offer the unique opportunity to examine this basic phenomenon in brain-based disorders with well-defined behavioral symptomatology and well-characterized neural circuitry, potentially yielding insights into the conditions in which VA occurs and how VA affects emotional responding.

Aim
To examine the association between VA behavior and changes in emotional responding before and after VA onset. We hypothesized that greater overall VA behavior across a disgust-eliciting task would be associated with (1) greater increases in emotional responding before VA onset and (2) greater decreases in emotional responding after VA onset. We also explored whether diagnostic group moderated these effects.

Methods
Sample included 169 participants (67 with bvFTD, 67 with Alzheimer’s Disease [AD], and 35 healthy age-matched controls) (M_age = 65 years). 6 VA behaviors (e.g., head turns, gaze aversion, eye closures) were coded for intensity and frequency while participants viewed a disgusting film. Disgust responding was measured using skin conductance level (SCL), interbeat interval (IBI), and behavioral coding of disgust facial expression. Dementia severity was assessed using the Clinical Dementia Rating Scale.

Results
Bivariate correlations were run on total VA scores and the slopes of IBI, SCL, and disgust facial behavior before and after VA onset. Rates of change for IBI, SCL, and disgust facial behavior were computed using second-by-second data taken from the 15 seconds immediately preceding (pre-VA) and following (post-VA) VA onset. Hierarchical regressions were used to examine the moderation effect of group membership. Age, gender, and dementia severity scores were entered as covariates. Results indicated that increasing SCL before VA onset was associated with greater VA across the entire task, r = 0.16, p < .05. This effect was moderated by group membership, ΔR² = 0.12, ΔF (2, 127) = 10.09, p < 0.001, β = -1.02, t (136) = -4.47, p < 0.001, with greater increases in SCL before VA onset associated with greater total VA in controls, β = 0.97, t (136) = 4.61, p < 0.001, but not patient groups. No associations were found between rates of change in disgust responding after VA onset and total VA behavior.

Conclusions
Current findings extend our basic knowledge of VA by providing evidence for the context in which VA occurs (i.e., increasing sympathetic nervous system activation as indexed by SCL), suggesting that VA may represent an intent to down-regulate negative emotion via behavioral responding. Neurodegenerative disease may negatively impact this normative behavioral response to disgust.

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Evaluating emotion from biological motion: The role of social competence

Elizabeth B. daSilva, Bushra Jameel, Mark Jaime
Indiana University-Purdue University Columbus

Summary: This study examined factors of social competence that influence perceptions of arousal and valence from biological motion created from body movements expressing anger, fear, and happiness. Biological motion representing fear was rated significantly higher in arousal compared to happiness and anger. Moreover, participants with lower social competence rated fearful biological motion as more arousing compared to those with higher social competence. Our preliminary findings suggest that biological motion is sufficient to specify valence and arousal, and that individual perceptions of valence and arousal vary as a function of social competence.

Key words: biological motion, social competence, autism traits, arousal, valence

Introduction: Body movements can reveal nuanced information about emotion. According to the circumplex model\(^1\), emotions have two dissociable aspects of information: valence, which refers to how negative or positive an emotion is, and arousal, which is how energizing or activating an emotion is. This model predicts that emotions such as fear are typically perceived as high-arousal, negative emotions. It is not known, however, whether valence and arousal can be perceived from biological motion and what role individual differences play in its perception.

Aims: The goal of this study was to explore relations between perceptions of valence and arousal from affective biological motion and social competence. Based on the circumplex model, we hypothesized that raters higher in social competence would make valence and arousal judgments that are more ‘emotion-congruent’ (i.e., fear as a high-arousal, negative emotion).

Methods: Fifteen participants performed body movements of anger, fear, and happiness while recorded with the Microsoft Kinect\(^2\). Movements were then converted into biological motion stimuli\(^3\) using the Kinect-based biological motion capture (KBC) toolbox. An additional 67 participants made ratings of arousal and valence of the stimuli using a 7-point Likert scale. Social competence of each rater was assessed with the Reading the Mind in the Eyes Test (RMET)\(^4\) and the Autism Quotient (AQ)\(^5\)—measures of social cognition and autism-spectrum traits, respectively.

Results: Overall, fearful stimuli were rated as significantly more arousing than anger and happiness, \(F(2,32)=19.22, p < 0.001, \eta^2=0.23\). Anger and fear were rated as more negative compared to happiness, and anger as more negative than fear (all \(rs < -2.21, ps < 0.05\); see Figure 1). A median split was applied to AQ scores; raters who scored high on the AQ (reflecting lower social competence) rated fearful stimuli as more arousing compared to raters with low AQ scores, \(t(66)= 2.30, p=0.03\) (see Figure 1). For half of the actors, there were significant negative correlations between arousal and valence ratings for fear and anger (\(rs > -0.27, ps < 0.05\)).

Figure 1. Arousal and valence scores by emotional biological movement and AQ group (low vs. high).

Conclusion: To our knowledge, we are not aware of any studies that have examined perceptions of valence and arousal from biological movements. Moreover, the fact that participants’ perceptions varied as a function of social competence, particularly for fearful stimuli, raises interesting questions about whether the level of social competence mediates or modifies normative emotion processing.

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