ACII Special Tracks Abstracts

This booklet contains all the abstracts associated with the two ACII19 Special Tracks highlighting interdisciplinary research. Because of the various publication formats favored by different disciplines, these special tracks contain a mixture of full papers (published by IEEE) and extended abstracts (contained within this booklet). To see the full list of presentations, please consult the Detailed Program.

Neural and Psychological Models of Affect

Organizers: Luke Chang (Dartmouth College), Giorgio Coricelli (University of Southern California)

Technological and Biological Bodies in Dialogue: Multidisciplinary Perspectives on Multisensory Embodied Emotion and Cognition

Organizers: Ana Tajadura-Jiménez (University Carlos III de Madrid), Stacy Marsella (Glasgow University), Aneesha Singh (University College London), Katherine Isbister (University of California, Santa Cruz), Katerina Fotopoulou (University College London).
Neural and Psychological Models of Affect

**Organizers:** Luke Chang (Dartmouth College), Giorgio Coricelli (University of Southern California)

Computational models of emotion have emerged from the intersection between psychology and other disciplines such as computer science, economics, and neuroscience. These models have attempted to formalize how emotions arise from interacting with the environment and impact subsequent behavioral actions. For example, value associated with specific actions can change based on expectation violations (e.g., reward prediction error), beliefs about counterfactual information (e.g., regret), and beliefs about others beliefs (e.g., guilt). These types of models can be used by neuroscientists to characterize how these processes might be encoded in the brain. More recently, neuroscientists have also attempted to identify how affective information might be represented in the brain in the absence of a formal encoding model by decoding a specific affective state from brain activity using supervised learning techniques.

In the spirit of this rich tradition of interdisciplinary work, the 8th International Conference on Affective Computing & Intelligent Interaction (ACII 2019) invited papers and abstracts to The Neural and Psychological Models of Affect track on research topics focused on understanding how affect is computed in both our minds and brains. Topics of interest include: computational models of affect from a psychological perspective, modeling affect and emotion using learning and decision-making frameworks, and understanding how affect might be encoded and decoded from brain signals measured using neuroimaging techniques (e.g., fMRI, fNIRS, PET, EEG/EEG, ECOG, or MEG). The goal of the neural and psychological models of affect track is to provide an opportunity for continued interaction and cross-fertilization between the ACII community and researchers from the broader psychology and neuroscience communities studying affective science.

**Abstracts**


Identifying distributed representations of emotion schemas in visual images and patterns of human brain activity

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I. INTRODUCTION

Emotions are thought to be responses to canonical situations linked to survival or the well-being of an organism [1]. Although sensory elements of these situations do not fully determine the nature of emotional responses, they should be sufficient to convey the schema or situation that an organism must respond to. However, few computational accounts describe how combinations of stimulus features come to evoke different types of emotional responses, and further, it is not clear that activity in sensory (e.g., visual) cortex contains distinct codes for multiple classes of emotional responding in a rich way [2].

II. METHODS

Here we develop a convolutional neural network that accurately decodes images into 11 distinct emotion categories. We validate the model using over 25,000 images and movies [3] and show that image content is sufficient to predict the category, valence, and arousal [4] of human emotion ratings. In two fMRI studies, we examine how schemas learned by the convolutional neural network are related to human brain activity measured with fMRI, and whether multiple types of emotional situations can be decoded from activity in the visual cortex.

III. RESULTS

We find that patterns of human visual cortex activation encode schemas learned by the model and can be used to decode multiple distinct categories of emotional experience. Comparing decoding performance across multiple brain regions, we find that emotion schemas are best characterized as distributed codes that span multiple visual areas and that largely redundant information about visual schemas is contained in other brain systems.

IV. DISCUSSION

These results indicate that rich, category-specific emotion representations are embedded within the human visual system. We find that emotion schemas emerge through a series of nonlinear transformations of sensory inputs; these transformations may function to ultimately constrain downstream emotional responses to influence behavior and subjective report [5]. More broadly, our findings suggest that psychological and computational descriptions of emotion should explain the sensory qualities that are naturally associated with emotional outcomes, as well as those that are reliably learned through experience and influenced by culture.

ACKNOWLEDGMENT

This work was supported by NIH National Institute of Mental Health R01 MH116026 and R21 MH098149 in addition to NIH National Institute on Drug Abuse T32 DA017637-14.

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A framework for pursuing “real-world” models of affective cognition

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I. ABSTRACT

Technologies rooted in scientifically-grounded theories of social and affective cognition hold significant promise for improving the human condition. The quality of our science will constrain the utility of these technologies. As scientists, we propose that the cognitive principles and models we uncover relate to in situ cognition. A focus on ecological validity aims to bridge between the capacity of the brain to behave in a certain way under specific laboratory conditions and a tendency to react to those same factor manipulations in the unconstrained “real-world”. This bridging work is especially important in social and affective cognition, which are contextual and inferential [1][2][3] as demonstrated by predictive and Bayesian computational modeling [4].

To support the development of “real-world” models of affective cognition, we propose an experimental framework organized by two conceptual approaches: (1) contextualized cognition, and (2) cognition in interaction [3]. The former relates to the concept of representative design [5] from psychology, which closely mirrors ethology from animal research, and emphasizes the importance of contextual cues, often naturalistic, that have the most influence on patterns of behavior and cognition as they occur in the real world.

Regarding interaction, a growing movement recognizes the importance of embodied processes in affective processing [6] (e.g. interoception) as well as our interaction with and perception of other affective agents [7] (i.e., social cognition). As our technologies evolve, it is important to test the impact of different representations of other agents on social and affective cognition. These representations may be modeled along a curve from basic, minimally communicative representations (texts, bots) to richer and more complex representations (virtual reality, face-to-face interaction). Two core themes emerge beyond this context/interaction framework: (1) the importance of individual differences in susceptibility to experimental manipulations, as well as those related to inclusivity (gender, culture, age, abilities, etc.); and (2) the various validities of our experimental paradigms.

We support this framework with three experiments. First, a decision tree predicts defensive responses to threat scenarios that vary along contextual dimensions [8]. Relevant to computational psychiatry [9], individual perturbations in threat processing may relate to disruptions of nodes in such trees. Considering cognition in interaction, we demonstrate that neural processing of gaze from a live person versus a video recording differentiates individuals with autism from neurotypical controls [3].

Finally, a VR version of Cyberball [10], a social ostracism game, allows us to explore our ability to experimentally modulate contextual cues while also mediating a social presence experience amenable to neuroimaging.

ACKNOWLEDGMENT

We would like to thank the USC Chan Division of Occupational Science and Occupational Therapy as well as the USC Provost Office for their support of this research. We would like to thank Aditya Jayashankar and Samantha Noor for their assistance with behavioral testing of the VR task and Daniel Batista for development of the VR Cyberball game. We would also like to thank Ralph Adolphs and members of the Emotion and Social Cognition Laboratory at Caltech at for their involvement in the first two studies as well as supporting early conceptual development of this research framework. Lastly, we would like to sincerely thank the research participants who make this research possible.

REFERENCES

Endogenous variation in ventromedial prefrontal cortex state dynamics during naturalistic viewing reflects affective experience

How we process ongoing experiences is shaped by our personal history, current needs, and future goals. Consequently, brain regions involved in generating these subjective appraisals, such as the ventromedial prefrontal cortex (vmPFC), often appear to be heterogeneous across individuals even in response to the same external information [1]. Across four studies, we develop a computational framework to characterize the spatiotemporal dynamics of the vmPFC in individual participants while viewing a 45-minute television drama. We find evidence that the spatiotemporal response profiles of the vmPFC were heterogeneous across individuals (N=13), even after performing hyperalignment [2], in which the spatial configuration of voxels for each participant were projected into a common space based on similarity in voxel temporal responses. Interestingly, we found that individual vmPFC spatial patterns appeared to persist for long periods of time and a few of these patterns seemed to recur periodically over the course of the episode. We used hidden markov models to segment patterns of vmPFC activity into discrete latent states separately for each participant [3] and found that a subset of these states appeared to be shared across individuals. Although these states were most often expressed at different moments in time across individuals, scenes that evoked strong affective responses appeared to synchronize these states across participants, which replicated in an independent sample collected on a different scanner (N=35). Finally, we ran two additional behavioral studies to provide further support that these state changes are linked to affective experiences. First, we measured participants facial expressions [4] while they watched the episode (N=20) and found that these states were each associated with scenes reflecting action unit configurations of joy and surprise/concern. Second, we sparsely sampled a separate group of participants subjective feelings while watching the episode (N=188), and used non-negative matrix factorization to recover the missing ratings [5]. Similar to the facial expression behavior, configurations of positive and negative feeling states appeared to temporally co-occur with each of the vmPFC states. Together, we believe these series of analyses provide evidence suggesting that the vmPFC is involved in ascribing affective meaning to our ongoing experiences that arise from unfolding events.

Index Terms—affect, vmPFC, brain, face expression, experience, individual differences

REFERENCES

A neurocomputational model for mood dynamics during decision making

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The happiness of individuals is an important metric for societies, but we know little about how daily life events are aggregated into subjective feelings. Using computational modeling, we have shown that momentary happiness, a proxy for mood, is explained by the history of rewards and expectations during decision making under uncertainty, a result replicated in thousands of individuals using smartphone-based data collection [1] and quantified in relation to major depression [2]. Using functional magnetic resonance imaging, we show that momentary happiness during self-reports is reflected in neural responses in the right anterior insula, where elevated mood is associated with elevated activity. Receipt of extrinsic rewards relates to neural responses in the ventromedial prefrontal cortex (vmPFC). Despite their importance for major life decisions like which career to choose, little is known about how intrinsic rewards (e.g., playing a musical instrument without errors) are represented in the brain, partly because measurement is poorly suited to standard economic approaches like asking how much someone is willing to pay for an item. We tested subjects in a reinforcement learning task incorporating a skilled performance component that did not influence payment. Computational modeling revealed that momentary happiness depended on past extrinsic rewards and also intrinsic rewards related to successful skilled performance. We found that the individuals for whom intrinsic rewards more strongly influence momentary happiness exhibit stronger vmPFC responses for successful skilled performance. Our findings show that the vmPFC represents the subjective value of intrinsic rewards and that computational models of mood dynamics provide a tool that can be used to measure implicit values including the value of a job well done.

Index Terms—affect, vmPFC, brain

REFERENCES


Traditionally, there have been two different ontologies for modeling the user’s affective state: the categorical model and the dimensional model. However, these models have several limitations: for one, the classical Ekman emotion categories have come under substantial critique in psychology [1]. The dimensional model [4] (i.e., the valence-arousal model), on the other hand, while very useful, is a gross simplification of the human experience. Both models also wholly ignore the temporal and contextual aspects of experience: if we want to model a user, we have to take into account the temporal progression of their context.

Thus, we propose a more sophisticated ontology of the human experience that allows artificial intelligence to comprehend the world in a more fine-grained fashion. The ontology combines, on the macro level, the methods from film studies [6] to capture the temporal progression of the surrounding context, as well as micro-phenomenological tools to get a microscopic view in the minute details of the unfolding experience.

Recently developed computational methods allow deconstructing movie structures into smaller events in a multilayered manner [3]. Both automated as well as manual expert annotation methods can be used to describe and categorize narrative events of very different temporal scales, in a multilayered manner.

The method of micro-phenomenology [5] is a new scientific discipline that explores our lived experience very finely and describes it with high precision. It is based on an interview and analysis process that focuses on the structure instead of the content of the experience and aims to discover the phenomenal invariants that generate categories and structure of the experience.

We combine on the macroscopic scale the understanding of temporal dynamics of context from film studies to the precise microanalysis of momentary experience through the method of micro-phenomenology. The effect of the interplay of these two levels is then analyzed using psychophysiology [2] to derive the context-specific neural correlates of the primitive microphenomena.

As the temporal context of, for example, a film can be automatically determined, and once these neural correlates of context-dependent microphenomena are determined, an adaptive system can be build that has a higher resolution view of the user’s subjective experience and can adapt more appropriately.

We hope to start a discussion on how a more comprehensive, more detailed ontology of human experience could be designed that would not just be a conceptual framework but be built with concrete affective computing applications in mind to be easily operationalizable and implementable.

ACKNOWLEDGMENT

Work funded by the EU Mobilitas Pluss Top Researcher Grant MOBTT90 (2017-2022), Estonian Research Council.

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Dense Phenotypic Characterization of a Single Human With Deep Intracranial Recordings over One Year

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Treatment resistant mental health conditions are currently treated using deep brain stimulation, with recent technologies affording the possibility of simultaneous recording from deep brain sites to enable closed-loop neurostimulation systems. Over the past year, we have followed a single individual with severe affective disturbance who was implanted with two deep brain electrodes, one placed in ventral striatum (VS) and a second in dorsomedial prefrontal cortex (DMPFC), two key nodes in the brain’s affective control system. During this period, we also tracked measures of the individual’s affective state using a multimodal array of sensors, including intrinsic phone sensors to capture variation in geolocation features, accelerometer and gyroscope measurements to capture changes in psychomotor behavior [1,2,3], daily surveys to probe for subjective affect, productivity, and related psychological constructs, daily voice diaries to capture changes in vocal stress indicators [4,5], and a series of videos recorded during repeated study visits with the research team every 1-2 weeks.

Over the one year of concurrent neural and behavioral recordings, the individual experienced numerous well-documented changes in affect, from profound depression and immobilization to active engagement in life activities. We tracked signals related to the individual’s affect and self-reported mood as (A) the striatal stimulator was turned on, (B) in a double-blinded trial, the cortical stimulator was turned on, and (C) the trial was eventually unblinded. Here we describe the observed patterns of covariance in affect-related behavioral features, including facial expressivity during dyadic encounters, self-reported affect from smartphone questionnaires, variation in significant locations visited each day, sleep and physical activity, and neural activity fluctuations in VS and DMPFC. This work provides a rich, dynamic clinical phenotype linking temporally-dense neural and psychological manifestations of affect under conditions of severe psychopathology.

Keywords—intracranial recordings, deep phenotyping, brain, face expression, dmPFC, ventral striatum

This work was funded by support from the National Institute of Mental Health UH3NS100548.

REFERENCES


Synchronized emotions during shared experiences increase social connection


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People tend to structure their day in order to coordinate experiences with others. We work during fixed hours so that we can interact with others, share meals together, and participate in group activities. However, it is currently an open question as to how sharing an affective experience with others impacts an individual’s interpersonal relationships, emotional behavior, and appraisal of the experience. The present study investigates how emotional alignment during a shared experience can influence the social bond between individuals, emoting behavior, and their impressions of the experience. We recorded facial expressions of participants (\(N = 86\)) using a custom head-mounted camera [1] while they watched four episodes of a character driven drama television show for a total of four hours either alone or with another participant. After each episode, participants who watched with another participant reported how connected they felt to one another.

We found that participants who watched with another participant displayed more synchronized facial expression behavior than participants who watched alone (average synchrony increase across all episodes \(r = .23, p < .001\)) and that the level of facial expression synchrony predicted the degree to which participants felt connected to one another after each episode (leave-one-group-out cross validation accuracy \(r = .51\)). Not only did participants who watched as dyads synchronize their temporal emoting patterns but they also developed more similar spatial emoting patterns. By projecting each participants’ multivariate facial behaviors to a jointly estimated latent shared response space [2], we compared the inter-subject similarities in their subject-specific transformation matrices to test if dyads developed more similar spatial emoting patterns over time. Indeed, participants who watched the show in dyads showed greater spatial alignment compared to participants who watched alone by the third and fourth episodes (average synchrony increase \(r = .19, p < .05\)). Lastly, we examined the similarities between participants in their impressions of the characters from the show and how this relates to development of social affiliation. Increases in impression similarity was significantly related to increases in average connection ratings in dyads (\(b = .16, t(87) = 2.09, p < .05\)). Combined, these results suggest that shared experiences elicit temporal and spatial alignment of emotional experiences as well as similarities in appraisals that promote social rapport development and that these effects emerge slowly over the course of hours in social interactions.

ACKNOWLEDGMENT

Authors thank Eshin Jolly, Emma Templeton, and Andy Chen for their comments and feedback.

REFERENCES


Using Virtual Reality (VR) in a social interaction experiment. The participant, represented as a virtual human, took part in information sharing and discussion activities with a programmed female virtual character called Anna. We aim at investigating how nonverbal cues in a conversational context influence social closeness between the participants and their virtual co-participants.

Abstract—Real-time face-to-face social conversation involves complex coordination of nonverbal cues such as head movement (nodding), gaze (i.e. eye contact), facial expressions and gestures. In this research, we investigate how coordination in such subtle nonverbal communication can have effects over closeness and trust.

Index Terms—Social coordination, Virtual reality, Mimicry, Synchronization, Nonverbal

I. INTRODUCTION

There is increased research interest in how and why nonverbal social coordination occurs, and an increased need to generate realistic conversation behaviors in artificial characters for virtual reality [1]. In this research, we investigate how coordination in such subtle nonverbal communication can have effects over closeness and trust. Virtual Reality (VR) provides a high level of social presence with conversation patterns that are very similar to face-to-face interaction. Therefore, we employ VR to understand how coordination influences social bonding and strongly perceived similarities in personality. We focus our study on head nodding as social signals, in which the head-mounted display in the VR system allows us to detect the participants nodding during the interaction experiment. In our experiments, participants are represented as virtual humans, and engaged in structured conversations with another programmed virtual character. The conversation consists of 4 trials, alternating turns between the participant and virtual character. Each trial has 45 seconds of monologue during of which sharing information takes place, followed by 35 seconds of dialogue between the participant and the virtual character.

Based on the wavelet analysis results on our high resolution data, we generate an interactive avatar with full facial motion which can engage with a naive participant (Fig. 1). We decided to use a virtual avatar that has a middle shape between stylized and realistic looking avatar. That’s to avoid any effect might cause uncanny reactions [2]. We employ Virtual Reality (VR) to understand how coordination influences social bonding and strongly perceived similarities in personality. In the listening mode, we programmed the virtual character: 1) to mimic the low frequency (0.2-1.1 Hz) head nodding of the participant to varying degrees of accuracy with a delay of 600 ms. 2) to periodically perform anti-synchronous high frequency fast nodding (4.5-6.5 Hz).

The participants evaluate the virtual character's personality, attractiveness, and rate their feelings of similarity, rapport and trust toward the virtual character. Our data reveals that synchrony at low frequency (0.2 1.1 Hz) nodding has positive coherence between the participant and the virtual character, compared to the situations of non-synchrony. This coherence is linked to mimicry behavior, and therefore in range is a plausible signature of the mimicry of the participants head movement by the virtual character. This research potentially confirms that synchrony in conversations is a positive social signal and indicates to greater liking and trust.
Fig. 1. Using wavelet analysis, we found some surprising ways patterns in the way people naturally coordinate with one another. As well as mimicking, we found that people also decoupled their head movements more than we would expect by chance [3].

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Technological and Biological Bodies in Dialogue: Multidisciplinary Perspectives on Multisensory Embodied Emotion and Cognition

Organizers: Ana Tajadura-Jiménez (University Carlos III de Madrid), Stacy Marsella (Glasgow University), Aneesha Singh (University College London), Katherine Isbister (University of California, Santa Cruz), Katerina Fotopoulou (University College London).

The last two decades have seen a paradigm shift in our understanding of human cognition and interaction in relation to the role of one’s own body. The once prevailing assumption that the human mind can be understood by examining exclusively cognitive functions and their neural correlates has received considerable criticism. A diverse and growing community of researchers claim that mental abilities are embedded in the acting, sensing and feeling BODY, and are subject to intricate couplings between organisms and their social and technological environments. In parallel, methodological advances in neuroscience, human-computer interaction (HCI), robotics, virtual reality and wearables allow the investigation of the role of the body in cognition and interaction in unprecedented ways. Increasingly cheap and ubiquitous body sensing and feedback technologies offer up new opportunities and ways to alter or enhance body perception but the aims and focus of these investigations may differ between disciplines. For instance, sensory-driven changes in body perception may be used to enhance user engagement and presence in games, and also to increase body awareness for sports or physical rehabilitation and to address psychological and emotional barriers related to body perception in certain medical conditions, or to explore new artistic avenues.

This new understanding of body perception may also affect many aspects of ubiquitous computing systems worn on the body or supporting ambient interaction among bodies. Simultaneously, HCI research provides an opportunity for evaluating and even furthering our understanding of the mechanisms underlying embodied emotion and cognition. This track aims to bring together researchers from different communities interested in the multidisciplinary topic of multisensory body perception. We will discuss body-centred approaches and frameworks, tools and methods for body sensing and sensory feedback, how to use bodily information and potential issues around, and overall, opportunities for interaction between the communities in relation to the track theme, sharing views on how working together can reshape these communities.

Abstracts


2. Taffou, M., Suied, C., and Viaud-Delmon, I. Emotion induced by auditory roughness modulates multisensory integration in relation with the body.


The effect of Visuomotor Coherence and Appearance on Children’s Embodiment of a Virtual Avatar

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INTRODUCTION

A coherent representation of the bodily self is maintained by the multisensory integration of external and internal bodily signals, in combination with top-down cognitive processing [1, 2]. This mental image alters throughout the lifespan, as sensory stimuli relating to specific body parts are incorporated into pre-existing body representations [3]. Recently, virtual reality (VR) methods have been used to investigate this plastic bodily self, enabling ownership to be taken over a virtual body or body part through the presentation of congruent sensory information. Understanding how children respond to such technologies is of fundamental importance, due to the great potential embodied VR could bring in the future. There is a considerable lack of data on VR embodiment in children despite some suggestions of changes in multisensory integration. We measured children’s responses to a full body illusion in VR, as experienced from first-person perspective, manipulating visuomotor synchronies and avatar appearance.

METHODS

We tested children aged 8 to 12 years (N = 32), using a median split to define two groups: younger (<10.5 years) and older (>10.5 years). Responses were measured using both questionnaires related to factors of body experience (Table 1) and skin conductance response (SCR) to a virtual threat. We manipulated visuomotor synchrony by presenting movements of the virtual avatar at the same time as the initiated movement (synchronous condition) and with a delay of 0.5 or 1.0 seconds (asynchronous conditions). We presented two avatar types: one similar in appearance to the children (human condition) and one which differed significantly (skeleton condition). Manipulations were all performed as within-subject and the condition layout is presented in Table 2.

RESULTS

Overall, children experienced a sense of ownership over the avatars in each of the conditions, measured both subjectively by the self-report questionnaire and objectively with the physiological responses. Although the SCRs were present in each condition, they were not significantly affected by experimental manipulations. Because this was an exploratory study with a unique sample population using children, results should be considered with caution. However, taking into consideration that high variation is often observed between individuals in body ownership experiments [4], we were still able to find some interesting insights into how children between the ages of 8 and 12 years embody a virtual avatar.

Results showed that ownership ratings of the virtual avatars were significantly higher in the older age group (Fig.1a) and the human condition (Fig.1b). The sense of agency was significantly stronger in the synchronous condition, than in both asynchronous conditions, similar to what is observed in adults (Fig.1c) [5]. The sense of strangeness was dependent on an age and synchrony interaction, such that when visuomotor information was mismatched, older children gave higher ratings than the younger children (Fig.1d). Additional trend effects suggested that in the older age group, the reported sense of strangeness and ownership were more dependent on synchronous movements, suggesting that children over the age of 10.5 years may demonstrate stronger multisensory processing mechanisms.

CONCLUSION

These findings fit in with previous studies suggesting that the ability to integrate stimuli from different senses is not an inherent feature from birth, but develops throughout childhood [6]. This was the first study of its kind to induce a movement-based body illusion with full body tracking with inverse kinematics in children and provides interesting insights into understanding the bottom-up visuomotor and top-down cognitive factors necessary to induce embodiment over a virtual avatar.
Children generally responded positively to the experience of embodying a moving virtual avatar. This may open up avenues to utilize virtual embodiment paradigms in future applications with children.

ACKNOWLEDGEMENTS

A special thank you to the Kleineweltendecker group, Developmental Psychology at the University of Zurich, for providing me with the resources to conduct these experiments with children and utilize the extensive database to recruit child participants. An incredible thanks to Marte Roel for the technical expertise to assist with implementing the full body tracking technology using inverse kinematics. Finally, many thanks to the Cognitive Neuropsychology group at the University of Zurich, for the guidance, experimental setup and assistance with pilot testing.

REFERENCES

Emotion induced by auditory roughness modulates multisensory integration in relation with the body

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ABSTRACT

It has been evidenced that alarming sounds such as human screams comprise an acoustic attribute (amplitude modulation in the 30–150Hz range), which corresponds to the perception of roughness. Roughness seems to be linked to a more intense induction of fear, behavioral gains and a higher activation in cerebral areas involved in fear and danger processing [1]. These observations, however, were made with voice sounds, i.e. particular and meaningful sounds, and the importance of the semantic content for the emotional value conferred to the sounds remains unclear.

In the present study, we hypothesized that if roughness can modulate the emotional effects of simple and meaningless sounds, it should impact the integration of multisensory stimuli related to the coding of the space around body. Indeed, the space immediately surrounding the body is an interface with the external world [2]. Multisensory integration processes are thought to convey the behavioral relevance of events in relation to the body and thus to play a role in the protection of the body [3].

We used a modified version of Canzoneri et al. paradigm [4] to study audio-tactile integration in healthy participants. Participants had to detect a tactile stimulation delivered on their hand while a meaningless simple sound was approaching them from the rear hemifield. The meaningless sound was either a simple harmonic sound (f0=500Hz) or a rough sound (the same harmonic sound amplitude-modulated at 70Hz). The sounds were processed through binaural rendering so that the virtual sound sources were looming towards participants from the left hemispace of their rear hemifield.

We found that rough sounds interact with tactile processing from farther distances than non-rough sounds, suggesting that auditory-tactile integration is sensitive to auditory roughness. This finding suggests that roughness, even expressed in a very simple way (simple harmonic sounds and not human screams or natural sounds), modifies the behavioral relevance of auditory events in relation to the body. This confirms our hypothesis: auditory roughness, even apart from semantic content, could be an auditory attribute efficiently conveying a signal of danger to the central nervous system.

ACKNOWLEDGMENTS

This work was supported by the French Ministry of Armed Forces (grant number HUM-1-0814). We thank Olivier Warusfel and Thibaut Carpentier for their help on the elaboration of spatialized dynamic auditory stimuli through binaural rendering. We thank Loris Billaud who contributed to the experimentation.

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‘Embreathment’ illusion shows influence of breathing on embodiment

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Recent theories posit that physiological signals contribute to corporeal awareness - the basic feeling that one has a body (body ownership) which acts according to one’s will (body agency) and occupies a specific position (body location) [1]. However, these signals are notoriously difficult to manipulate. Using immersive virtual reality in a group of healthy volunteers (N = 32), we found that an ecological mapping of real respiratory patterns onto a virtual body (avatar) led to illusory changes of corporeal awareness (see video). This new bodily illusion, called ‘embreathment’, revealed that breathing uniquely influences corporeal awareness over and above other bodily cues. In particular, breathing turned out to be almost as important as visual appearance for inducing body ownership, and more important than any other cue for body agency (Fig. 1).

We also assessed if the strength of these effects was moderated by individual levels of interoceptive sensibility and accuracy, predicting that a weaker sense of the physiological condition of the body would yield a more plastic representation of the body and thus induce a stronger illusion of ownership and agency over the avatar. The results confirmed the hypothesis (Fig. 2). Overall, we show that respiratory, visual and spatial signals exert an interoception-mediated, specific, and weighted influence on the fundamental feeling that one is an embodied agent. Given that respiration is a primary conduit for expressing and perceiving emotions [2], future studies may also rely on the embreathment illusion to map emotional states onto virtual environments.

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This work was supported by a European Research Council (ERC) Advanced Grant 2017, Embodied honesty in real world and digital interactions (eHONESTY) (to S.M.A.), an Avvio alla Ricerca 2017 research grant from Sapienza (to A.M.) and the BIAL Foundation grant n. 218/2016 (to G.T). We wish to thank M. Mametti for his helpful and timely advice on virtual reality issues, M. S. Panasiti for her insightful remarks on data analysis and interpretation, and M. Scandola for his valuable comments on linear mixed-effects models.
I. ABSTRACT

Social communication, including the exchange of emotional states and social feedback (e.g. ‘Likes’, ‘Emojis’ and ‘Emoticons’) is increasingly digitally mediated, as in social media and other platforms. Most of the technologies supporting such communication are visual and ignore sensations such as touch. Yet touch is the preferred, and the only reliable, non-verbal channel of communication for prosocial emotions (love, admiration; Hertenstein, Holmes, McCullough, & Heltner, 2009; Hertenstein, Keltner, App, Bulleit & Jaskolka, 2006), and social intentions such as social support (Gallace & Spence, 2010; von Mohr, Kirsch & Fotopoulou, 2017). As a primary nonverbal communication channel, touch may trigger pleasant or unpleasant experiences. Slow, caress-like touch has been found to activate a dedicated, neurophysiological system, namely the C-tactile (CT) system and is positively correlated with perceived pleasantness, while faster or firmer types of touch do not activate this system and are perceived as emotionally neutral (Kirsch et al., 2018).

Here, we present two experimental studies with healthy volunteers (N = 35) testing the idea of tactile emoticons, i.e. the use of particular types of touch to optimally express emotion during digital communication (e.g. Amour Pour 2014; Gao, Bianchi-Berthouze, & Meng, 2012). Technological advances have researched the effectiveness of devices in facilitating communication when physical interaction is not possible. For example, participants have been requested to use wearable devices (e.g. tactile sleeves, or wrist-worn watches) and communicate certain emotions in a virtual reality environment (Huisman, Frederiks, van Erp, & Heylen, 2016; Joi et al., 2016). Findings have shown benefits for partners in long-distance relationships and other similar advantages in other settings. However, to our knowledge, no study has explored the role of different tactile modalities, delivered by a device, or manually to the communication of sensory and social emotions, such as warmth and social support, respectively. Here, we present two studies with this aim.

The first study pilots and validates a touch device that can communicate emotions between interacting partners by the combination of three different tactile sensations. Specifically, a pair of custom-built mittens was used to receive and send sensations of temperature (ranging from cold to hot), pressure (ranging from low to high), and vibration (ranging from low to high) between two partners. The second study examines the role of specific types (manual, brush mediated) touch in digital, Twitter-like, communications, involving both negative and positive emotions, as well as individual and social messages.

Our results reveal the kind and number of emotions that can and cannot reliably communicate affect via our touch device and related challenges and individual differences, while we discuss how this device differs from other tactile communication devices (Study 1). Our results from Study 2 expand on the effect of a neurophysiologically-defined type of affective touch (namely CT-optimal) in the perception and memory of social support during social media communications. We discuss the implications of these findings for the further development of tactile emoticons and affective, social communication.

Keywords—tactile emoticon, touch, affect, digital communication, social media

ACKNOWLEDGEMENT

This work was supported by the European Research Council (ERC) Starting Grant ERC-2012-STG GA313755 (to A.F.).
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Anomalous Bodily Experiences Related to Body Image Concerns: Evaluation of the Potential Effects of Sound Feedback on Body Perception, Emotional State and Gait

I. ABSTRACT

A. Background

Body image concerns (BIC), defined as excessive worries and dissatisfaction for one’s own body appearance, are on rise in our societies [1][2]. They have been linked to distorted mental body-representations [3], such as in the case of eating disorders (EDs). BIC can have dramatic consequences for social, motor and emotional functioning [3-7]. Current EDs treatments focus on various aspects of the disorders, ranging from nutrition, to medications and psychological support. However, these current approaches often fall short on one key facet of the EDs, namely body image distortions, known to affect the onset, maintenance and relapses of EDs [8]. Recent research provided support to distorted mental body-representations [3], suggesting the possibility to use such body-representations through technologies that enable the integration of bodily sound-feedback. This proof-of-principle study aims to establish the potential value of using sound-feedback for enhancing body-perceptions and related emotional state in relation to BIC.

B. Aim

We aim to investigate the possibility to manipulate body-representations through technologies that enable the integration of bodily sound-feedback. This proof-of-principle study aims to establish the potential value of using sound-feedback for enhancing body-perceptions and related emotional state in relation to BIC.

C. Methodology

58 female participants (mean age ± s.d.: 21.8 ± 3.2 years; age range: 18–32 years) were pre-screened using the Eating Disorders Examination Questionnaire [21][22] and classified in 3 groups: 21 Low-BIC, 19 Medium-BIC, 18 High-BIC [23-26]. They walked wearing a prototype that alters their body sound through specially designed sensory-feedback [10-16], in particular, on recent findings that real-time sonification of people's movement leads to increased self-efficacy in everyday activity [17], and more importantly that alteration of the sounds produced by walking can alter the perceived body size and related gait, and result in more positive emotional states in healthy people and people with chronic pain [18-20].

D. Results & Discussion

Sound condition interacted with BIC group across all measures. The altered sounds changed how “Medium-BIC” participants visualized their body and their feelings of body weight, upright position and emotional arousal, consistent with previous results in healthy subjects [18][20]. “Low-BIC” participants showed no effects on these measures. For gait, our implicit measure, “High-BIC” participants showed an inverse pattern than the other two groups who showed a pattern similar to previous studies. Finally, “Low-BIC” and “Medium-BIC” participants felt equal agency of the sounds across conditions, but “High-BIC” participants felt less agency of the altered sounds, suggesting different processing of body-feedback in this group. These results are in line with the idea that people with EDs present distorted perception of bodily signals [28], which might have dramatic consequences for their body representation [29]. We will discuss these findings and future opportunities for designing BIC-specific, technologies, diagnostic tools and therapies.
ACKNOWLEDGMENT

This work was supported by Ministerio de Economía, Industria y Competitividad of Spain Grants RYC-2014–15421 and PSI2016-79004-R (“MAGIC SHOES”; AEI/FEDER, UE) [to AT] and “European Research Council Starting Investigator Award” [ERC-2012-STGGA313755] [to AF]. LC thanks the Erasmus+ training programme and JL thanks doctoral training grant BES-2017-080471. We thank Joe Newbold for his technical help during data collection.

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The role of Bodily Self Consciousness in Morality and (dis)honest behaviors

ABSTRACT

Bodily self-consciousness (BSC) mainly consists of the sense of owning one’s own body, i.e., the Sense of Ownership (OW) [1], and of being in control of one’s own actions, i.e., the Sense of Agency (AG) [2]. The way in which BSC signals can influence morality and the tendency to deceive is still unclear, with studies suggesting that attention towards body signals can make us more sensitive to our needs and thus dishonest [3, 4], and others suggesting that BSC signals would make us feel more in control of our actions and then more honest [5].

Here, we tested (in 658 participants) whether self-report measures of BSC differently relate to Moral Identity (measured by a questionnaire) and Moral Behavior (measured as participants’ tendency to cheat in a task where they could gain more money by lying). Our results show that the relationship between OW and internalized morality is moderated by sensitivity to Monetary Reward with less sensitive participants showing higher internalized morality; higher AG seems to increase Internalized Morality by boosting the effect of Sense of Power and diminishing that of Moral Disengagement. Interestingly, analysis of Moral Behavior shows that the effect of OW on dishonesty is higher in those who are not very sensitive to Monetary Reward.

Our data show an interesting dissociation between Moral Identity and Behavior: when high OW is associated to low sensitivity to Monetary Reward, people feel more moral but behave less honestly. This suggests that being aware of the fact that we are not tempted by rewards enhances our moral self-image but impairs Moral Behavior. This is in line with moral credit models which posit that we use moral behavior to balance our moral self: when moral identity is high, we allow ourselves to misbehave (moral self-licensing) [6-9] and when low, we enhance honest behaviors (moral cleansing) [9-10].

To further investigate the impact of Body Ownership over (dish)honesty in social situations, we used Virtual Reality (VR) to modulate participants’ OW of a virtual body while interacting with another person and having the opportunity to lie for a monetary reward. Our preliminary results (N = 28) suggest that people behave less honestly when their virtual hand appears disconnected from the virtual body, but this effect does not seem to be modulated by reward.

REFERENCES

In this presentation, we tackle the challenge of assessing the phenomenon of lived experience methodologically by applying the perspectives of two distinct empirical approaches, those of 1) phenomenology and 2) cognitive neuroscience. The aim of the proposed approach is to reveal the role of embodiment in cognition in a way that captures both its phenomenal qualities and physiological data.

Until recently, studying lived experience from an empirical stance hasn’t been utilized considering subjective, introspective reports as non-reliable, non-reproducible, and non-verifiable because of the very singular nature of experience [4], [2]. Lived experience is indeed characterised by its embodied and pre-reflective dimensions that are not immediately accessible to reflection, introspection, and verbal report. Examination of experience as a disciplined phenomenological method was introduced through neurophenomenology [9], a research programme that includes phenomenology for cognitive science. On one hand, the neurophenomenological programme follows the enactive approach to the embodied mind, as proposed by Varela, Rosch, and Thompson [8], this is, the agents sensory-motor dynamic coupling with the environment. On the other, drawing from dynamical systems theory, the approach addresses the mind-body explanatory gap between subjective experience and brain, body and behaviour. In pragmatic terms, the method requires integrating third-person methods of cognitive science with first-person methods of phenomenology in such a way that neither approach has the primacy.

The aim of the empirical stance on phenomenology, also dubbed empirical phenomenology, is to obtain rigorous, generalizable and verifiable phenomenal data [6], [10] about lived experience. Importantly, systematic gathering of empirical data in this way is not equated with quantitative methods of natural sciences.

The future challenge in proposed multidisciplinary data obtaining and analysis is to find a level of observation at which convergence is possible on both phenomenal (phenodynamics) and neural (neuro-dynamics) sides [5]. The method called micro-phenomenology [3] allows a very fine-grained descriptions of experience on a sub-second level [5] that can be correlated with neurological data. The approach requires a trained mediator (second-person approach) to make these dimensions explicit by means of interview and analysis methods of first-person reports [7], [1].

Finally, we will discuss the method in the light of a case from the field of interactive media systems, and consider its contribution with respect to other areas of cognitive science that investigate embodied cognition.

ACKNOWLEDGMENT

Work funded by the EU Mobilitas Pluss Top Researcher Grant MOBTT90 (2017 - 2022), Estonian Research Council.

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Multisensory wearable device to measure effect of human interaction on stress level

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Abstract—Human interaction is known to affect the autonomic nervous system, which regulates physiological stress responses. We investigated the effect of human interaction on stress-arousal responses using a wearable device in pairs of volunteers attending a music festival. We show that listening to each other’s heartbeat reduced the heartrate and increased the skin temperature of both lovers and friends. These results could be used to increase relaxation through technology driven human interaction.

Keywords—multisensory wearable device, stress response, human interaction, skin conductance

I. INTRODUCTION

Human interaction is an important basis of relationships and thereby society. Different forms of human interaction, such as eye contact, human touch, or just the presence of another person in the room are known to affect the autonomic nervous system [1]–[3]. Physiological stress responses are also regulated by the autonomic nervous system.

Recent developments in wearable devices provide the opportunity to measure physiological signals in ambulatory setting and process them real-time to provide feedback. We investigated the effect of human interaction between lovers and friends on stress-arousal responses. Physiological data was collected using a wearable device on the wrist.

II. METHOD

Physiological data of 120 pairs was collected at the 2018 Lowlands festival in the Netherlands, using a multisensory wearable wrist device, to measure skin conductance (SC), skin temperature (ST) and heartrate (HR). HR was converted real-time to a heartbeat sound using a tablet with custom-made software, fig. 1.

After a period of rest (15 min), each pair went through 3 measurement conditions in randomized order: (1) eye contact EC, (2) holding hands HH, (3) listening to each other’s heartbeat (LH).

Mean HR during LH was lower compared to EC and HH (p<0.001), fig. 2. In addition, ST median was higher during LH compared to the other interaction conditions (p<0.01). All interaction conditions showed lower mean HR and higher ST median, when compared to rest (p<0.0001 and p<0.0001, respectively). There was no significant effect on SC phasic. These results indicate that human interaction, especially listening to each other’s heartbeat, lowers stress indicators. We did not observe a difference in the effect of human interaction due to the relationship type between participants.

IV. CONCLUSION

Taken together this study indicates that human interaction changes the autonomic nervous response, by lowering HR and increasing ST. Realtime feedback of each other’s heartbeat using a multisensory wearable device had the largest impact on stress related features, compared to other interactions. This provides
opportunities for technology driven human interaction and relaxation techniques.

ACKNOWLEDGEMENT

Thanks to M. Stevens and W. Huyghe for creating the heartbeat sound, to J. Bax-Witteveen for organizing attendance to the festival, to E. Hermeling for the idea, S. Patki for support with the Chill+, G. Schiavone for advice with the analysis and to the whole team for support in data collection.

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Exploring gesture-sound coupling for motor-recovery

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I. INTRODUCTION

Acquired brain lesions after stroke or traumatic brain injury (TBI) induce sensory, cognitive, and motor dysfunctions, representing major cause of autonomy loss in daily life activities [1-3].

Due to the interdependence of cognitive process and motricity, disorders affecting one of this area may limit recovery in the other. Reciprocally, progress in one area may also promote recovery in the other one [4].

The development of interactive technological tools, taking into account such recovery processes, i.e; allowing for sensory and attentional substitution supporting cognitive and motor activities, offer new perspectives for assisting rehabilitation. In particular, potential benefits of using augmented feedback for upper limb motor recovery after stroke has been suggest in literature reviews [5,6].

Among different modalities, auditory feedback, in particular rhythmic auditory stimulus, have been found to be potentially beneficial to arm function recovery [7-13]. Furthermore, the development of real time sonification devices are currently investigated with encouraging results [14-18]. Such an approach seems to be more efficient than simple rhythmic auditory stimulus because of the continuous feedback, allowing users to dispose continuous information about their action being taken [19].

We believe that, due to the potentially strong receptivity to sounds and music, far from being neutral information, sonification devices could be emotionally invested by the users, which could positively affects the accomplishment of gestures. To our knowledge, no study has yet been proposed in the case of stroke recovery, to explore and compare various types of sound feedback and coupling modalities. Towards this aim, we conducted a study to investigate how various sounds and the gesture-sound interactions are perceived by patients and healthy participants and to what extent can modify upper-limb gestures.

II. METHODS

A. Participative Design

We elaborated the study protocol with a clinicians-engineers-users participative design, aiming to build a device responding to patients’ needs and specificity of hospital context.

B. Participants

We included in the study patients corresponding to the following inclusion criteria:

--- Be older than 18 years, have suffered from an acquired brain lesion (stroke or a traumatic brain injury), being hospitalized on the rehabilitation department of Pitié-Salpêtrière hospital, have upper-limb motor sequelae allowing to initiate an elbow extension, have a good comprehension of the French language and signed an informed consent to participate.

We have not included in the study patients who presented at least one of following non-inclusion criteria:

--- Other neurological pathology or medical complication in progress, antecedent of epileptic seizure, wearing a pacemaker, cognitive impairment preventing the study comprehension, hearing impairment prior to brain injury involving the use of hearing aids, or refusal to participate.

To compare data with a control group we have also included healthy subjects who meet the criteria of the study.

C. Protocol

The experimental design is composed of four steps:

1) An interview to evaluate the personal sound and music environment, based on the French Psychomusical Appraisal (education, practical, and musical tastes) [20].

2) The assessment of musical perception with the Montreal Battery of Evaluation of Amusia [21].

3) The sonification of an elbow extension task (Fig.1). We asked participants to perform a series of reaching movement for each arm
affected arms in patients, and on dominant and non-dominant arms in healthy subjects) alternating the use of different types of sonification described below. A condition with no auditory feedback was also performed at the beginning, between each sonification type, and at the end.

Biomechanical parameters of the movement are collected with three Inertial Measurements Units sensors placed on each upper limb. Each IMU transmits through Wi-Fi a stream of data at 200 Hz, and contains 3D accelerometers, gyroscope and magnetometers. Real-time movement analysis, sound-movement coupling and sound synthesis are performed using a Max/MSP software we developed (IRCAM). We tested different types of auditory feedbacks, each of them using a different strategy for the sound-movement mapping [22]. The first two types of movement-sound mapping are based on direct relationships between the reaching distance and either the pitch of a continuous tone (named as “Pitch”), or the tempo of a regular beat pattern (“Tempo”). The second two types of auditory feedback is music-oriented: the users control the tempo of musical pieces by the arm movement (“Discrete Melody” versus “Continuous Melody”). The third type of auditory feedback associates to the arm position to specific environmental sounds (“Environmental Sounds”).

4) A semi-directive interview to collect subject’s feeling was conducted. We asked participants to sort by order of preference the auditory feedback, and to choose in order 5 terms to describe their feeling in a 18 qualifier list, based on an balanced valence/arousal diagram.

Fig 1. GESTURE-SOUND INTERACTIVE SYSTEM

III. PRELIMINARY RESULTS

At this stage of the ongoing experiments, a complete qualitative and quantitate dataset were obtained for 14 patients and 14 healthy subjects. The analysis of the quantitative movement data are currently in progress and seems to suggest that the movement velocity are affected by the movement-sound coupling.

Regarding the perception of the sound-couplings, (Table I.) comparable results were found between the patients and the healthy subjects, with a clear preference for environmental sound and the continuous melody. We can also observe that the “Pitch” and “Tempo” conditions, which represent the most used modalities of coupling in published investigations, are the least appreciated. While they can be considered as simple and intuitive couplings, because of the direct relation between the extension of the arm and a clearly perceivable sound frequency or tempo shift, they nevertheless are considered as less motivating by the participants.

These elements support the idea that the auditory-feedback cannot be considered as a neutral information source and a particular attention must be according in the choice of coupling. Finally, we also note that the words chosen to describe the experiments are also comparable between patients and healthy subjects (Table II.) with the three positive qualifiers “stimulating”, “playful” and “intuitive” selected, which confirms the interest of this approach.

TABLE I. SOUND-COUPLING PREFERENCES

<table>
<thead>
<tr>
<th>Patients</th>
<th>Healthy Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Sound</td>
<td>Environmental Sound</td>
</tr>
<tr>
<td>Continuous Melody</td>
<td>Continuous Melody</td>
</tr>
<tr>
<td>Discrete Melody</td>
<td>Discrete Melody</td>
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<tr>
<td>Tempo</td>
<td>Pitch</td>
</tr>
<tr>
<td>Pitch</td>
<td>Tempo</td>
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</tbody>
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TABLE II. QUALIFICATION OF THE EXPERIMENT

<table>
<thead>
<tr>
<th>Patients</th>
<th>Healthy Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulating</td>
<td>Playful</td>
</tr>
<tr>
<td>Playful</td>
<td>Amusing</td>
</tr>
<tr>
<td>Intuitive</td>
<td>Captivating</td>
</tr>
<tr>
<td>Surprising</td>
<td>Stimulating</td>
</tr>
<tr>
<td>Pleasant</td>
<td>Intuitive</td>
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ACKNOWLEDGMENT

This research was supported by IUIS Sorbonne Université, and Laboratory of Excellence SMART (ANR-11-LABX-65, ANR-11-IDEX-0004-02). We thank the team of occupational therapists of the rehabilitation department of Pitie-Salpetriere Hospital, Maël Segalen sound engineer student, and Baptiste Caramiaux Research Scientist, for their contributions.


Affect Regulation Using Technology: Lessons Learned by Taking a Multidisciplinary Perspective

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Abstract—We share two challenges that emerged in our work to build, design, and evaluate vibrotactile technology to facilitate affect regulation. These challenges concern, respectively, the timing of interventions and the role of technology in initiating them. First, we challenge the Just-in-Time Adaptive Intervention (JITAI) framework in HCI for affect regulation, specifically the use of technology to identify when an intervention becomes necessary. Second, we discuss the issue of user agency when initiating an affect regulation intervention, and argue that the user should ideally be the one to initiate an intervention instead of the technology.

Index Terms—emotion regulation, haptics, biofeedback, vibrotactile, breathing pacer, Just-in-time-adaptive interventions

I. INTRODUCTION

Regulating high-arousal negative affective states (which includes negative emotions and moods, as well as stress responses) is a well-known challenge. Experiencing high-arousal affect reduces cognitive abilities [1], but cognition is often required to resolve a stressful situation. In these situations, people may turn to maladaptive affect regulation strategies such as surface acting, expressive suppression, or distraction [2]. Such maladaptive strategies, however, can exacerbate the situation or lead to health costs in the long run [3]–[6]. There is significant interest in developing technology to help people regulate high-arousal negative affective states in everyday life [7]–[12].

We use the framework proposed by Miri et al. [13], [14] to consider the different ways technology can be used to facilitate affect regulation. This framework is based on the extended model of emotion regulation which proposes the following steps in affect regulation: identifying the need for affect regulation, selecting an affect regulation strategy, implementing the strategy, and monitoring how well the implementation is going [15]. In the absence of technological support, all four steps are done by the individual. Affect regulation technologies distribute the execution of these steps between a device and a user; depending on what steps a device is involved in, the interaction between the user and the device differs. According to the type of user-technology interaction, the framework clusters affect regulation technology into three types: cueing, involvement, and feedback. Cueing technology aids at either the identification or the selection stage, directing the user towards a strategy. Involvement technology guides a user through implementation of a strategy, either explicitly (with effort) or implicitly (automatically). Feedback technology uses biofeedback to monitor the success of an implementation. We find the above framework useful because devices of the same type share a similar set of design issues; we encourage creators to make comparisons between the design choices for different types of devices.

The device our team built administers personalized vibrations with which participants synchronize their breathing to lower arousal. Our device is therefore an instance of an involvement intervention which facilitates explicit affect regulation. Our decision to focus on involvement was partly influenced by the challenges we discovered that apply to cueing and feedback devices. In this paper, we would like to share two challenges that apply to cueing interventions for the consideration of future creators.

II. TWO CHALLENGES

A. Just-in-Time Adaptive Interventions

An influential idea in the field of Human-Computer Interaction (HCI) is that of Just-in-Time Adaptive Interventions (JITAI). As their name suggests, JITAI are interventions that through mobile technology can be delivered when and where needed [16]. The efficacy of JITAI depends strongly on the sensing component which decides the type and the timing of the intervention. Examples of inputs to the sensing component might include: situational context, self-reported measures, geographical location, social setting, and user mood and behavior. Although useful in many circumstances, we claim that JITAI may not be appropriate for affect regulation, particularly when input to the sensing component involves
subjective experience, expressive behavior, or peripheral physiological responses (such as heart rate or breathing). When one or more of these inputs is used in sensing emotion, JITAIAs are in danger of sensing the need for intervention too late.

Timing is crucial to the effectiveness of attempts to regulate affect. The process model of emotion regulation defines five types of strategies one can use to change one’s emotion. The following strategies are listed in order of when in the emotion generation process they are believed to operate: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. As one moves further along the emotion generation process, autonomic nervous system arousal increases and the negative emotion manifests itself more strongly in terms of subjective experience, expressive behavior, and peripheral physiological responses, making it easier to detect using technology. At the same time, the process model suggests that strategies which intervene at earlier stages of emotion generation tend to require less effort and be more effective than strategies which intervene later. In other words, situation selection and situation modification require the least effort; attentional deployment requires more effort; cognitive change requires even more, and response modulation is the most effortful [17].

From the process model of emotion regulation, it is evident that JITAIAs which use subjective experience, expressive behavior, or peripheral physiological responses as part of their sensing input will be unable to facilitate affect regulation in a meaningful way. While detection that uses these inputs is more effective later in the emotion generation process, emotion regulation is more effective earlier in the process. Therefore, by the time the sensing component arrives at its conclusion based on emotional expression or behavior, the detected emotion will already have surfaced and be more difficult to regulate. It would be best, instead, for an intervention to begin early, ideally before a high-arousal negative emotion is even generated. In most cases, this would be most effectively performed by the individual and not by sensing technology. We allow, however, the possibility that JITAIAs which do not base their sensing on emotional expression or behavior may yet be effective at detecting the necessity of intervention in time. For instance, in the case of someone who reliably gets anxious when visiting a certain location, data about their environment would be sufficient to suggest the need for intervention.

B. User Agency

Even if effective technology could be built that sensed the need for affect regulation, should it be used to do so? From an HCI perspective, it is tempting to seek to incorporate technology to support people wherever possible, from identifying and selecting a regulation strategy to implementing and monitoring it. Yet to hand over the role of initiating interventions to technology removes the agency of determining when affect regulation is desired. We know that in many cases, an individual is able to predict their emotions and initiate an intervention early on. There will always be cases where unexpected situations arise, and in such cases when a person cannot predict their emotion, involvement technology may become particularly valuable in helping them to regulate successfully. But we ultimately believe that at no time should an individual feel controlled by their technology.

Indeed, we believe that in the same way that emotions do not simply happen to us, interventions should not simply happen to us, either. Giving the reins to technology to decide when an intervention is merited has the potential to damage individuals’ beliefs about control of their emotions. Instead, we seek for our work to promote self-awareness, self-efficacy, and the belief that managing emotions is possible.

We urge creators of cueing technology to make the preservation of users’ agency in initiating an intervention a central part of their design. Note that while we hold the above to be true in the present day, it is possible that in the future explainable AI will be able to provide predictions that are understandable and generalizable by humans. If this were the case, the user could learn from the technology how to make similar predictions themselves. As long as we still await the development of explainable AI, we believe in allowing the user to initiate affect regulation interventions themselves.

III. Future Work Direction

We would like to propose a direction for future work in affect regulation technology in light of the above two challenges. As previously discussed, attempting to detect emotion using emotional expression or behavior as input results in interventions that arrive too late to be effective. We see potential in a device which uses environmental (as opposed to emotional) input to learn when emotion regulation is desired. Although such a device would not have data on a user’s emotional expression or behavior, it would combine environmental input with reinforcement from the user, so that over time it would learn to predict what types of situations lead the user to desire regulation. The device could have a prior probability of intervention being necessary in different situations, and update that probability by asking the user how they felt after the situation had passed. This design would avoid the problem posed by the JITAI devices and enable cueing technology to deliver timely interventions after sufficient learning.

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Abstract: While the number of people with mild depression and mental illness is increasing, it is an issue that there is little support for them. In this study, we propose a method and indicator for emotion estimation based on the biometric signals with sensors to quantitatively evaluate emotion during treatment. Based on sensor values and a psychological model, we propose a method that calculates the biometric signals to evaluate the level of stabilization of emotion, and using color effect research results, presenting appropriate colors for humans to stabilize their emotion. As a result of experiments, we have obtained the first results that show the effectiveness of our approach.

Keywords: Heart rate, LF/HF, electroencephalogram, color therapy, stabilization of emotion, support for assessment, support for counseling

1. INTRODUCTION

According to a survey of patients with mental illness by the Ministry of Health, Labor and Welfare, there was an increase of approximately 1.88 million patients with mental illness from 1999 to 2014 [1]. Among the people with mental illness, the proportion of “Emotional disorders including depression” is the highest, accounting for 28% of the total. Considering these facts, supporting the treatment of emotional disorders is very important. In this study, we firstly considered how emotions were quantitatively evaluated since the lack of evaluation could be the cause of insufficient explanations given to people seeking treatment for their depressive state.

2. PROPOSAL

As emotion recognition, we propose an approach from an affective computing area, based on human body measurements such as EEG (Electroencephalogram) and pulse rate analysis [2]. Because the facial expression would be carried by the somatic nervous system, which is the part of the nervous system responsible for voluntary body movements, it can be arbitrarily changed if the people would like to hide it. On the other hand, biometric signals are controlled by the autonomic nerve which is the involuntary nervous system, so cannot be arbitrarily controlled.

We consider emotion estimation method with biometric signals would be effective for people for whom it is difficult to understand their emotional state of depression, and it is also possible to apply the quantitative evaluation of their emotion. Based on the idea, we propose a method and an index to estimate emotions quantitatively using biometric signals as explained above. This method classifies emotions based on detecting brainwaves and pulse signals. Also in this study, as a counseling step, we will use color therapy that attempts to stabilize emotions by presenting colors that are appropriate for the emotions stabilization calculated and classified by the proposed support system (Fig 1).

Based on the idea, we consider the two steps in medical treatment used by psychiatrists, assessment and counseling. The experiments were conducted with experimental collaborators in a studio where it is possible to change the illumination color. The preliminary result of experiments indicates that the effectiveness of our approach. Collaborators’ emotions were measured in a studio, then it was shown that emotions were stabilized by changing the lighting colors as proposed by the stabilization method.

3. CONCLUSION AND FUTURE WORKS

As a result of experiments, we have obtained the first results that show the effectiveness of our approach. Collaborators’ emotions were measured in a studio, then it was shown that emotions were stabilized by changing the lighting colors as proposed by the stabilization method.

REFERENCES