On the bodily expressions of emotion, be aware: More than a century of research! A commentary on Affective Computing by Kristina Höök

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Abstract. This commentary unveils over a century of literature that touches the core of affective computing but appears to be unknown to its community. To enable affective computing to flourish, knowledge on human's physiology, on concepts such as emotions and moods, and on methods and techniques from signal processing and machine learning need to blend together. Two books that appeared approximately 50 years ago were selected, which originate from completely distinct branches of science, but both mark branches of research crucial to affective computing: i) Flanders Dunbar's "Emotions and bodily changes: A survey of literature on psychosomatic interrelationships 1910-1953" (1954) and ii) Satosi Watanabe's "Methodologies of Pattern Recognition" (1969). When the vast and rich body of available relevant scientific literature will be cherished and the lessons learned so long ago will be embraced, affective computing can (finally) make its leap forward and probably will have a bright future!

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1 Introduction

When thinking about this commentary, ideas popped up and emotions emerged. What to comment on? Kia Höök delivered an excellent chapter (Höök, 2012). She mentions three angles to approach emotion in technology from (cf. van den Broek, 2011), namely: affective computing, affective interaction, and technology as experience. In this commentary, I will narrow the focus to affective computing solely. Furthermore, I have also chosen to take a step back and be so bold as to take a methodological perspective with a historical flavor. Why? Well, throughout the years I have discovered more and more literature that touches the core of affective computing but appears to be unknown (e.g., Arnold, 1968; Candland, 1962; Dunbar, 1954). This commentary is founded on two books from a time long before the term affective computing was coined, the 50s and 60s of the previous century. Both books are taken from completely distinct branches of science. Knowledge on science's history can prevent us, both practitioners and scientists, from repeating mistakes. As such, this commentary touches upon the essence of science itself.

Kia Höök provides a concise overview of emotion in technology (Höök, 2012). She embraced affective interaction instead of affective computing. In contrast, in this commentary, I have taken the affective computing standpoint. Moreover, Kia Höök has taken a design perspective, where this commentary touches upon and questions the fundaments of emotions in technology. Lessons had been learned but have already been forgotten (Arnold, 1968; Candland, 1962; Dunbar, 1954). Consequently, affective computing tends to reinvent the wheel, at least to some extent. Yes, this is a bold claim, a very bold claim but I hope that after reading this commentary, you as a reader may share my concerns.

2 Emotions and bodily changes

In 1954, 5 years before her death, Flanders Dunbar delivered the fourth edition of "Emotions and bodily changes: A survey of literature on psychosomatic interrelationships 1910-1953" (Dunbar, 1954). With this impressive volume, she provides an exhaustive and structured review of scientific literature of (roughly) the first half of the previous century on emotions and bodily changes. The volume's title is well chosen and reflects its content nicely. This makes this book undoubtedly valuable for the community of affective computing. However, as far as I know, outside my own work (e.g., Van den Broek, 2011), not a single reference is made to this book in any affective computing article, report, or book. I can only hope that I have missed quite a few ...

Flanders Dunbar starts her book (1954) with: Nearly half a millennium B.C., Socrates came back from army service to report to his Greek countrymen that in one respect the barbarian Thracians were in advance of Greek civilization: They knew that the body could not be cured without the mind. "This," he continued, "is the reason why the cure of many diseases is unknown to the physicians of Hellas, because they are ignorant of the whole." It was Hippocrates, the Father of Medicine, who said: "In order to cure the human body it is necessary to have knowledge of the whole of things." And Paracelsus wrote: "True medicine only arises from the creative knowledge of the last and deepest powers of the whole universe; only he who grasps the innermost nature of man, can cure him in earnest." To us today this seems rather an impossible demand. (p. 3). Where the work of Dunbar illustrates that the origins of affective computing can be traced back to more than a century ago, this quote illustrates that knowledge on the interaction between body and mind was already known more than 25 centuries ago! Let us now identify some core concepts as mentioned in the quote from Dunbar (1954), which are crucial for affective computing.

The old Greek already noted that "the body could not be cured without the mind" (cf. Höök, 2012). So, both are indisputably related and, hence, in principle, the measurement of emotions should be feasible. This is well illustrated by the remark that "the cure of many diseases is unknown to the physicians of Hellas", as the Greek culture was devoted to the body and not to the mind. Recent work confirmed this relation. For example, when chronic stress is experienced, similar physiological responses emerge as were present during the stressful events from which the stress originates. If such physiological responses persist, they can cause pervasive and structural chemical imbalances in people's physiological systems, including their autonomic and central nervous system, their neuroendocrine system, their immune system, and even in their brain (Brosschot, 2010). This brings us to the need for the "knowledge of the whole of things", a holistic view, perhaps closely related to what Kia Höök denotes as Technology as Experience (Höök, 2012).

Although the previous enumeration of people's physiological systems can give the impression that we are close to a holistic model, it should be noted that this is in sharp contrast with the current level of science. For example, with (chronic) stress, a thorough understanding is still missing. This can be explained by the complexity of human's physiological systems, the continuous interaction of all systems, and their integral dynamic nature. However, Brosschot (2010) considers emotions as if these can be isolated and attributed to bodily processes only. I firmly agree with Höök (2012) that dynamics beyond the body should also be taken into account. Moreover, as Höök (2012) also notes, in relation to computing entities, the interaction consists of much more than emotions; however, the same is true when no computing is involved at all.

3 Methodologies of Statistics and Pattern Recognition

25 centuries ago scientists did not apply modern statistics; however, 1 century ago, scientists did already apply statistics; for example, Fisher invented the ANOVA class of statistical models in 1918. This provided the means to test and generalize findings on emotions and bodily changes and boosted the development of behavioral sciences in general (Dunbar, 1954). Moreover, this work fits into Rosalind W. Picard's definition of affective computing: "... a set of ideas on what I call 'affective computing,' computing that relates to, arises from, or

influences emotions." (Picard, 1995, p. 1) At least it fits when taken as the traditional interpretation of computing (i.e., to determine by mathematical means). However, the added value of affective computing would be its engineering component, in particular, signal processing and pattern recognition (van den Broek, 2011). This would enable machines to sense emotions, reason about them, and perhaps develop them themselves. This would mark a new era of computing.

With the invention of computing machinery, shortly after World War II, a new type of statistics was developed: pattern recognition. In his edited volume "Methodologies of Pattern Recognition" (1969), Satosi Watanabe collected a set of papers that were presented or meant to be presented at the International Conference on Methodologies of Pattern Recognition in 1968. Watanabe started his book with defining pattern recognition: ''To the layman's ear, the term pattern recognition sounds like a very narrow esoteric field of electronic computer applications. But, actually, it is a vast and explicit endeavor at mechanization of the most fundamental human function of perception and concept formation." (p. vii).

Watanabe denotes pattern recognition by computers as the "mechanization of the most fundamental human function of (i) perception and (ii) concept formation." Up to this date human pattern recognition in general is largely unsolved. We do not understand how we, as humans, process affective signals (van den Broek, 2011). Moreover, the perception of signals and, subsequently, patterns is one thing; their interpretation in terms of emotions is something completely different. This issue refers to content validity; that is, (i) the agreement among experts on the domain of emotions; (ii) the degree to which a (low level) percept adequately represents an emotion; and (iii) the degree to which (a set of) percepts adequately represents all aspects of the emotions under investigation.

4 Concept formation in context

The issue of concept formation relates to the process of construct validation, which aims to develop a ground truth (or an ontology or semantic network), constructed around the emotions investigated. Such a framework requires theoretically grounded, observable, operational definitions of all constructs and the relations between them. Such a network aims to provide a verifiable theoretical framework. The lack of such a network is one of the most pregnant problems affective computing is coping with. Kia Höök describes emotions as if we can pinpoint them. Although intuitively this is indeed the case, in practice it proves to be very hard to define emotions (Duffy, 1941; Kleinginna & Kleinginna, 1981).

Par excellence, humans can recognize patterns in noisy environments. Moreover, the ease with which humans adapt to new situations, to new patterns remains striking. Moreover, this is in sharp contrast with the performance of signal processing and pattern recognition algorithms. Often, these perform well in a controlled environment; however, in the "real world" their performance deteriorates (Healey, 2008). This problem refers to the influence of the context on measurements, which is also denoted as ecological validity. Due to a lack of real world research, in general, the ecological validity of research on affective computing is limited and its use often still has to be shown in "real world" practice. However, as Kia Höök illustrates, some nice exceptions to this statement have been presented throughout the last decade.

In 1941, Elizabeth Duffy published her article "An explanation of 'emotional' phenomena without the use of the concept 'emotion"' in which she starts by stating that she considers "... 'emotion', as a scientific concept, is worse than useless. ... 'Emotion' apparently did not represent a separate and distinguishable condition." Although this statement is 60 years old it is still (or, again) up to date, perhaps even more than ever (cf. Kleinginna & Kleinginna, 1981). Almost fifty years later, in 1990, John T. Cacioppo and Louis G. Tassinary expressed a similar concern; however, they more generally addressed the complexity of psychophysiological relations. These "are conceptualized in terms of their specificity (e.g., one-to-one versus many-to-one) and their generality (e.g., situation or person specific versus cross-situational and pancultural)." (Cacioppo & Tassinary, 1990). They proposed a model, which "yields four classes of psychophysiological relations: (a) outcomes, (b) concomitants, (c) markers, and (d) invariants." Although Cacioppo and Tassinary (1990) discuss the influence of context, they do not operationalize it; hence, this discussion's value for affective computing is limited. Nevertheless, articles such as this are food for thought. Regrettably, attempts such as this are rare in the community of affective computing; consequently, the field's research methods are fragile and a solid theoretical framework is missing (Van den Broek, 2011).

5 Discussion

To ensure sufficient advancement, it has been proposed to develop computing entities that respond on their user(s) physiological response(s), without the use of any interpretation of them in terms of emotions or cognitive processes (Tractinsky, 2004). This approach has been shown to be feasible for several areas of application. However, this approach also undermines the position of affective computing itself as a field of research. It suggests that emotion research has to mature further before affective computing can be brought to practice. This would be an honest conclusion but a crude one for the field of affective computing. It implies that affective computing should take a few steps back before making its leap forward. A good starting point for this process would be the hot topics on emotion research that Gross (2010, p. 215) summarized in his article "The future's so bright, I gotta wear shades" (see also van den Broek, 2011).

Taken together, Kia Höök should be acknowledged for her concise overview of emotion in technology. In her chapter she takes the affective interaction standpoint (Höök, 2012). In contrast, with this commentary, I have taken an affective computing standpoint. Moreover, Kia Höök has taken a design perspective, where this commentary touches upon the fundaments of emotions in technology. I pose that if anything, affective computing has to learn more about its roots (e.g., Arnold, 1968; Candland, 1962; Dunbar, 1954); then, affective computing can and probably will have a bright future!

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References

Arnold, M. B. (1968). *The nature of emotion: Selected readings.* Harmondsworth, Middlesex, England: Penguin Books Ltd.

Brosschot, J. F. (2010). Markers of chronic stress: Prolonged physiological activation and (un)conscious perseverative cognition. *Neuroscience & Biobehavioral Reviews*, *35*(1), 46–50.

Cacioppo, J. T., & Tassinary, L. G. (1990). Inferring psychological significance from physiological signals. *American Psychologist*, *45*(1), 16–28.

Candland, D. K. (1962). *Emotion: Bodily change – An enduring problem in psychology, selected readings.* Princeton, NJ, USA: D. van Nostrand Company, Inc.

Duffy, E. (1941). An explanation of "emotional" phenomena without the use of the concept "emotion". *Journal of General Psychology*, *25*, 283–293.

Dunbar, H. F. (1954). *Emotions and bodily changes: A survey of literature on psychosomatic interrelationships 1910–1953* (Fourth ed.). New York, NY, USA: Columbia University Press.

Fisher, R. A. (1918). The correlation between relatives on the supposition of Mendelian inheritance. *Transactions of the Royal Society of Edinburgh*, *52*(2), 399–433.

Gross, J. J. (2010). The future's so bright, I gotta wear shades. *Emotion Review*, *2*(3), 212–216.

Healey, J. A. (2008). Sensing affective experience. In J. H. D. M. Westerink, M. Ouwerkerk, T. overbeek, W. F. Pasveer, & B. de Ruyter (Eds.), *Probing experience: From assessment of user emotions and behaviour to development of products* (Vol. 8, pp. 91–100). Dordrecht, The Netherlands: Springer Science + Business Media B.V.

Höök, K. (2012). Affective computing: Affective computing, affective interaction and technology as experience. In M. Soegaard (Ed.), *The interaction-design.org encyclopedia of human-computer interaction.* Aarhus C., Denmark: The Interaction-Design.org Foundation.

Kleinginna, P. R., & Kleinginna, A. M. (1981). A categorized list of emotion definitions, with a suggestion for a consensual definition. *Motivation and Emotion*, *5*(4), 345–379.

Picard, R. W. (1995). *Affective computing* (Technical Report No. 321). Cambridge, MA, USA: M.I.T. Media Laboratory Perceptual Computing Section.

Tractinsky, N. (2004). Tools over solutions? comments on interacting with computers special issue on affective computing. *Interacting with Computers*, *16*(4), 751–757.

van den Broek, E. L. (2011). *Affective Signal Processing (ASP): Unraveling the mystery of emotions*. Unpublished doctoral dissertation, Human Media Interaction (HMI), Faculty of Electrical Engineering, Mathematics, and Computer Science, University of Twente, Enschede, The Netherlands.

Watanabe, S. (1969). *Methodologies of pattern recognition*. New York, NY, USA: Academic Press, Inc.