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Assessing Social Behaviour Towards Near-Body Product Users in the Wild: A Review of Methods

M. De Boeck ✉, J. Vleugels, D. Van Rooy and K. Vaes

University of Antwerp, Belgium

✉ muriel.deboeck@uantwerpen.be

Abstract

Prior to wide adoption, a product must find social approval, which is especially true for near-body products as they are considered part of the human body. Based on a theoretical foundation, this study aims to provide an overview of methods to assess natural behaviour towards users of visible near-body products in uncontrolled environments, i.e. in the wild. Approaching the matter from a product design perspective, this article is primarily intended for designers of near-body products who wish to gain insights into the social behaviour of people towards users wearing their design proposals.

Keywords: *social acceptance, research methodologies and methods, near-body products, human-centred design, human behaviour*

1. Introduction

A new world of wearable products is in prospect, but it will only arrive if people consent to wearing them (Bakhshian and Lee, 2020). People bond with products through use and may even come to consider the products as a part of their identity (Belk, 1988; Goffman, 1959; Mittal, 2006). While literature illuminates that these products serve to extend or even empower one's sense of self and mainly focuses on user acceptance of new wearable products (Park *et al.*, 2014), this article addresses social behaviour towards users of these products that are visibly worn or used in close proximity to the human body, i.e. near-body products. Obviously, if such a near-body product is unnoticeable to bystanders, it will not provoke any behavioural reactions. Visibility is therefore an important factor in this respect (Goffman, 1963). In the near future, much more advanced products will become an addition to our bodies. These products will not only expand the limits of our capabilities, but they will also give rise to unfamiliar near-body artefacts that may or may not be socially approved of, e.g. smart glasses (Vaes *et al.*, 2016). Accordingly, this article intends to explore how behavioural reactions towards these near-body products worn visibly by the user can be assessed and provide valuable insights for designers.

2. Aim

The aim of this article is to present an overview of methods for assessing social behavioural reactions towards near-body product users based on theoretical foundation by addressing following research question: "What research methods can be used to assess social behaviour towards near-body product users to provide useful insights for product designers?" Accordingly, the reader is first provided with a theoretical framing regarding nonverbal behaviour types that are essential when studying natural social behaviour and how they can deliver relevant insights to product designers, followed by an overview of research methods found in literature. Methods to assess natural nonverbal behaviour are mostly used in social psychology or urban architecture; our focus however will lie on the field of product design. Methods that have not been used for this specific purpose, but could be useful for the design community, are also addressed within this study. As such, this article is primarily intended for designers of visible near-body products who wish to gain insights in the social behaviour of people towards users of their design proposals or products.

3. Theoretical framing

The choice of a research method to study social behaviour - especially within field research - is not an evident one to make. As field research aims to understand people in their natural environment and tends to analyse what occurs rather than manipulating behaviour within a controlled setting, subjects usually do not know that they are being studied, while participants in a laboratory research do know that they are partaking a research. However, conducting research in an uncontrolled environment is generally more challenging due to lack of control, problems with informed consent and privacy of the participants, which is why researchers investigating human behaviour often prefer laboratory design to the field (Aziz, 2017). Norene Kelly (2016), for example, developed the WEAR scale; a reliable measure of the social acceptability of wearable devices, consisting of statements in which participants have to respond to their level of agreement through Likert scales. Although this is a valid research method to measure social acceptance, many types of biases and much of the subjective interpretation that comes with people self-reporting "facts" can manifest. Basic psychology reveals that people remember and relay things in different ways. As such, most laboratory experiments may represent an artificial setting that may influence the manner in which subjects behave and consequently alter results, which is why many sociologists such as Goffman (1963), Hutchins (1995), and Mehl and Conner (2012) vow to maintain a degree of realism necessary for generalizability. Additionally, with various approaches to behavioural reactions, it is relevant to address the distinction between reflexive and thoughtful reactions (Pryor et al., 2004). Whereas a thoughtful reaction is a powerful single feeling state, a reflexive reaction can occur unconsciously in the first microseconds of thoughts (Baumeister and Bushman, 2014). This implies that when we encounter things or events we have never come across before, we start either liking or disliking it, which in turn manifests itself in our behaviour. Reflexive reactions implicitly reveal one's attitude and social motives that are unlikely to emerge within artificial environments, highlighting the importance of assessing "in the wild". Accordingly, reactions induced during unexpected encounters – thus without subjects being aware that they are being studied to prevent biases and preserve real behaviour – are at the basis of this study (Carpendale, 2008).

Research has shown that social behaviour is profoundly affected by our emotions (Baumeister et al., 2007; DeWall et al., 2016; Mogilner et al., 2012). Moreover, Fiske et al. (2007) stated that people make sense of each other according to two fundamental dimensions that can predict specific emotional prejudices: warmth and competence. Whereas the warmth dimension reflects on people's friendliness, the competence dimension considers their ability. Individuals perceived as warm and competent elicit uniformly positive emotions and behaviour: pride, admiration and attraction. Those perceived as lacking both warmth and competence elicit uniform negativity: contempt, neglect and avoidance. However, most individuals appear high on one dimension and low on the other: high warmth with low competence yields pity or neglect, while low warmth with high competence evokes envy or jealousy (see Figure 1).

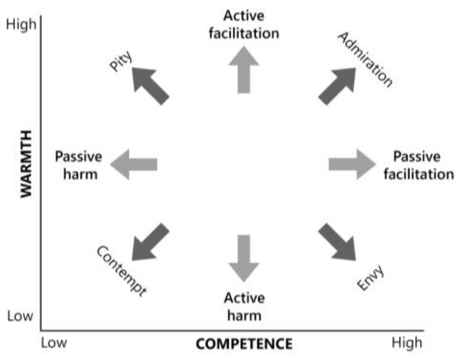

Figure 1. Schematic representation of warmth and competence dimensions (Fiske et al., 2007).

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According to Hans and Hans (2015), the three main aspects of nonverbal communication are kinesics (the use of body language), proxemics (the use of distance), and haptics (the use of touch). Within the purpose of this article, we will only address research methods assessing kinesic and proxemic behaviour, as communication by touch is rather unlikely to occur when encountering someone unfamiliar. More importantly, we hereby discuss how the assessment of kinesic and proxemic behaviour could yield relevant findings for product designers.

3.1. Kinesic behaviour

Kinesic behaviour is body motion communication such as facial expressions, eye movement, gestures and other nonverbal behaviour related to movement of any part of the body (Birdwhistell, 1955). Also eye or oculesic behaviour is considered a subset of kinesic behaviour and includes eye contact or aversion, gaze, blinking, and other eye movements (Andersen, 2016). Birdwhistell (1955) estimated that more than 65 percent of the meaning within a social interaction is carried by kinesic communication and less than 35 percent by words. As social behaviour is profoundly affected by our emotions, facial expressions play a fundamental role in human interaction. Products can elicit emotions through the aesthetics of the product, associated meanings and other aspects. Accordingly, emotions are considered the mechanisms that indicate when an event is favourable or harmful to ones concerns (Desmet, 2003a). Facial expressions can be assessed through observation, but are very difficult to be observed objectively. However, software that can analyse them automatically already exists. Automated systems that detect facial movements corresponding to an action unit (UA) such as FaceReader by Noldus, or open source toolkits such as OpenFace and AFAR, are even applicable in uncontrolled environments, i.e., in the wild (Namba *et al.*, 2021). Although direct observation has been used as a method to assess facial expressions specifically towards products (Nanda *et al.*, 2008), the automated software systems listed here have not been used yet for this specific purpose (that is, towards near-body product users), to our knowledge. Further, assessing kinesic eye behaviour of bystanders towards near-body product users such as moment of detection, staring behaviour or looking over ones shoulder, has been proven valuable for designers. These behavioural actions could indicate bystanders' alertness and may signal that they are at unease in the presence of the product wearer (Vaes et al., 2012). Other methods, for example well-known techniques such as observation and behaviour mapping, allow researchers to gather, analyse and represent more general kinesic data, and to determine how the environment and its attributes - or in our case users of near-body products - may influence certain behaviours. Behaviour mapping is often used within the field of urban design but not yet specifically towards near-body product users (Cosco et al., 2010).

3.2. Proxemic behaviour

As people make sense of each other according to the warmth and competence dimensions, an intimate psychological link exists between positive or negative feelings and approach or avoidance tendencies. We tend to avoid people whom we evaluate negatively and approach people whom we evaluate positively, i.e. proxemic behaviour (Hall, 1963, 1966; Mccall and Singer, 2015). Therefore, proxemic measurement may reveal responses that people do not want to report or cannot consciously access (Dovidio et al., 1997; Mccall et al., 2009). Edward T. Hall (1963) formulated the theory of proxemics, which identifies four zones of interpersonal distance that characterize Western culture that are shown in Figure 2: the intimate space (up to 0.5 m), the personal space (0.5-1.2 m), the social space (1.2-3.7 m), and the public space (3.7-7.6 m). These zones are an indication of people's perception of social presence and are often used to study implicit behaviour. As such, the interpersonal distance indicates people’s willingness to avoid or interact with an individual. Research has shown that measuring interpersonal distance can be used as a method to gain valuable insight for designers (Vaes *et al.*, 2016). By exposing products on users to a large number of bystanders in the wild, the results have been proven valuable for ranking a set of design concepts or products. As there are various different methods to study proxemic behaviour, which will only increase with the rise of new technology, this article intends to include the methods that are relevant within our product-focused purpose.

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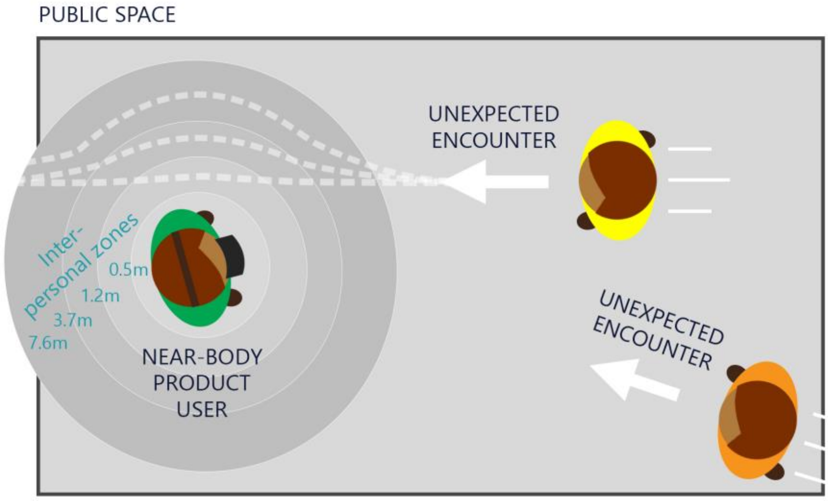

Figure 2. Visualisation of potential proxemic behaviour during an unexpected encounter with a user of a near-body product in a public space

Against this background, research methods that aim to assess kinesic and proxemic behaviour towards near-product users do not provide the designer with an answer to whether products will be socially accepted or rejected. However, these methods have been proven valuable in comparing several conceptual products. Moreover, the results can also be used to justify certain design decisions or to assess which product properties have influenced certain reactions.

4. Method

The following academic databases were used to obtain relevant studies regarding both the theoretical framing and the research methods for assessing the reactions of bystanders towards users of near-body products in the wild: Web of Science, ScienceDirect (Elsevier), and Google Scholar. We searched for methods that were applied in studies of various research domains, but which could also be applicable in a product design context. Because the search for research methods was very wide ranging, we used both a forward snowball search strategy to see where a relevant article was cited, and a backward snowball strategy to see which citations were used in that article (Wohlin, 2014). Accordingly, following set of keywords was composed for the review of methods based on the theoretical framework, which was supplemented with additional keywords (*) during the snowball search: research methods, human/social/kinesic/proxemic behaviour, in the wild, uncontrolled/natural environment, public space, near-body products, wearable products, pedestrians*, monitoring*, tracking*, spatio-temporal behaviour* and facial expression*. To be included, the articles needed to focus on the assessment of social behaviour in an uncontrolled environment, that is, in the wild. However, if the applied research method was irrelevant to our aim and could not be implemented in a study to investigate social behaviour towards users of near-body products, the article was excluded. While conducting the keyword search and the snowball search, the inclusion and exclusion criteria were used to extract a selection of 27 studies presented in an overview (see section 5). The overview is not supposed to be exhaustive as our intention is primarily to give an idea of potential contemporary research methods and because the search area is very broad due to the great diversity of applicable research domains.

5. Overview of applicable methods

The proposed overview of research methods (see Table 1) addresses following basic characteristics respectively: (a) the applied research method and the type of behaviour studied, (b) reference(s) using the stated research method and its field of application, (c) relevant advantage and disadvantages within a research setup, (d) a short description of the method and (e) the required equipment. Subsequently, the research methods and the applied technologies are elaborated on.

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Table 1. Overview of research methods to assess kinesic behaviour (KB), proxemic behaviour (PB) or explicit attitude (EA) in uncontrolled environments

Research method	Reference and context	Pros and cons regarding usability	Short description	Equipment
Behaviour mapping through observation (KB)	(Dharmawan and Rachmaniyah, 2019; Mu *et al.*, 2021), urban design	+ Extensive variety of situations - Time consuming - Costly due to man-hours	Behaviour mapping identifies behaviour in a particular setting and time (qualitative and descriptive research).	/ (Observational sheets and site plans)
Quantity of social interaction through observation (KB)	(Huang, 2006), urban design	+ Some variety of situations - Time consuming - Costly due to man-hours	The observation involves counting social interactions, which includes nodding, talking, waving, and friendly physical contact.	/ (Observational sheets)
Observation of facial expressions (KB)	(Jansson and Norberg, 1995), psychology	+ Profound analysis - Time consuming - Costly due to man-hours	Two methods of interpreting facial expressions were compared: the unstructured naturalistic method (UNM) and the Facial Action Coding System (FACS) method	Video camera(s)
In-depth multimodal observations (KB)	(Stefani and Mondada, 2018), social psychology	+ Revisable recordings - Time consuming - Costly due to man-hours	Studies different phases of encounters: their identification, recognition, and categorization of the imminent co-participants, their approach, greetings, etc.	Video camera(s)
Staring behaviour: looking over the shoulder (KB)	(Vaes et al., 2012), product design	+ Straightforward, easy to process - Not very meaningful results	The method implies counting how many time passers-by looked again.	Video camera(s)
Automatic facial expression recognition (KB)	(Liu et al., 2021), social psychology	+ High level of accuracy (87%) to classify emotional expression - Subject must face the camera and only a small angle of rotation is allowed - Costly equipment	FaceReader software is designed to measure six emotional facial expressions (happiness, surprise, fear, sadness, anger and disgust) quickly and easily through: (1) detecting the face, (2) 3D modelling of the face and (3) classifying facial expressions.	FaceReader software and video camera(s) (also other but less advanced software is available)
Facial expressions and movements of facial muscles (KB)	(Soares and Santos, 2021), social psychology	+ High level of accuracy (88%) to classify emotional expression - Limited freedom of movement	The Intel RealSense camera extracts facial movements of individual facial muscles as well as detecting up to 78 facial landmarks using the depth information.	Any depth camera(s) (in this case using RealSense)
3D localization (PB)	(Leroy et al., 2014), social psychology	+ Accurate, natural, and unobtrusive measurement + Camera can be moved freely - Accuracy reduces significantly beyond 4 m	The RGB-Depth cameras create large 3D observation scene coupled with possibilities of users and skeleton tracking to extract non-verbal cues linked to proxemics behaviours.	Any depth camera(s) (in this case using Kinect sensors (or Asus Xtion sensors + OpenNI library)

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Laser scanning (PB)	(Nakamura et al., 2012), engineering	+ High accuracy of a few centimetres - Costly equipment	The laser scanner(s) visualize(s) crowd flow (moving people) in public places.	Laser scanner(s) (in this case SICK laser scanner)
Dyadic distance experiment (PB)	(Vaes et al., 2016), product design	+ No privacy issues - Limited (one-dimensional) data	The ultrasonic sensor measures the distance between the wearer and passers-by.	Ultrasonic sensor(s)
Interpersonal distance through observation (PB)	(Vaes et al., 2012), product design	+ Straightforward - Relatively time consuming (not automated)	Using visual scale references on the overhead camera images, the distance between the wearer and the passers-by can be measured.	Overhead video camera(s)
Capacitive floor sensing system (PB)	(Sousa et al., 2013), engineering	+High resolution + Commercially available - Costly equipment	The proximity sensitive floor system determines the direction and velocity of human movements. The sensor floor is built up of triangular modules that operate independently.	Capacitive proximity sensors (in this case using SensFloor)
Pressure sensing floor system (PB)	(Al-naimi and Wong, 2017), engineering	+ Tracking a person with an error no more than 11.76 cm - Considerable work to set up	The smart floor detects and tracks people accurately using pressure sensors.	Pressure sensitive floors
Optical gait measuring (PB)	(Boolani et al., 2021), Physical therapy	+ Assembled in a few minutes + Modular system - Very advanced for our purpose - Costly equipment	The optical system consists of a transmitting and a receiving bar. The bars can track people walking between them, as they contain LEDs that communicate on an infrared frequency.	Optical gait measuring system (in this case OptoGait)
Bluetooth proximity detection (PB)	(Yoshimura et al., 2014), Museum planning	+ No privacy issues - Measures relative (and thus not exact) distance(s) - Bluetooth needs to be activated on mobile devices	Bluetooth sensors (each with a defined detection area) register check-in and check-out time to measure interest. A visitor's trajectory can be constructed through a unique identifier.	Bluetooth proximity sensors (Bluetooth beacons)
Post survey and/or interview (EA)	(Mu et al., 2021), urban design	+ Detailed information - Time consuming - Costly due to man-hours	Questionnaires and interviews can be used to analyse and compare the key influencing factors of various parks.	Prepared questionnaire and/or interview questions

In this first section, methods and corresponding technologies to assess **kinesic behaviour** are addressed (see Table 1; denoted by KB in the first column). One of the most common conventional method of analysing kinesic behaviour is (direct) observation, whether or not complemented by video recording or photographs. Observations can provide an extensive variety of results as, depending on the objectives, both quantitative and qualitative data can be collected. As the setup has few restrictions, observations can provide a great variety of situations and environments that subjects experience in their natural habitat. Nonetheless, personal bias and lack of competence of the observer may hamper the validity and reliability of observation. Further, numerous studies have investigated the assessment of facial expressions conveying the emotional state of an individual. These studies discuss valid measurements of universally recognized facial expressions using (a) an objective coding system (e.g. the Facial Action Coding System (FACS)), or (b) observer judgements of facial expressions described in everyday terms (e.g. "smiling") or in terms of emotions (e.g. "sadness") (Desmet, 2003b).

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Due to the emergence of new technology, more and more studies investigate measurements of facial expressions using (c) high-end equipment, for example FaceReader software by Noldus (Dols and Russell, 2017). The latter category also comprises tools that enable automated analysis, which show promise for the future as innovative technologies emerge. Depth cameras for instance already offer a wide range of opportunities when assessing social behaviour, including recognition of emotional facial expressions, hand-gestures and human activities (Zhang, 2014). Overall, our body can communicate an array of additional expressions, such as bright eyes, slightly raised eyebrows, a tighter mouth or even a slight head nod, which do not often find their way into the literature, as they are very challenging to analyse.

This second section addresses research methods and corresponding technologies to assess **proxemic behaviour**, i.e. approach or avoidance (see Table 1; denoted by PB in the first column). As proxemics represents people's willingness to avoid or interact with an individual, measurements of interpersonal distance can be useful for comparing several conceptual products. There are various different ways to investigate proxemic behaviour, which will only increase with the emergence of new technology. Millonig et al. (2009) studied methods and experiences for monitoring pedestrian behaviour and provided an overview of most commonly used methods regarding specific aspects of human motion behaviour and the determinants influencing spatial activities. Also Hanzl and Ledwon (2017) compared various methods of analyses of pedestrian behaviour in outdoor spaces from the standpoint of its usefulness for the requirements of urban design. In both these studies, the focus relied on analyses of pedestrian behaviour (e.g. motion patterns, interaction modelling and evacuation dynamics) from an urban design perspective. However, many methods mentioned are broadly applicable and can be implemented within our scope. As numerous technologies can be used to record measurements of interpersonal distance, we discuss the ones relevant within our scope, respectively: depth cameras and distance sensors, sensing floors and Bluetooth modules. Depth (or 3D) cameras enable the perception of depth in images to replicate three dimensions. Examples are the Intel RealSense camera, the Asus Xtion camera, the Microsoft Kinect camera, etc. In addition to these three-dimensional devices, there are also one- and two-dimensional sensors that allow capturing distance measurements, such as ultrasonic, infrared, depth and laser sensors. Depending on the implementation, these optical devices can be used for distance tracking in either one direction (stationary) or a constrained field of view (scanning). Next, sensing floor systems are less frequently addressed in the literature, but relevant within our scope as they enable footstep detection and thus interpersonal distance. These flooring systems are most suitable for indoor applications and use either capacitive proximity sensors (reacting to physical proximity) or floor pressure sensors (reacting to the external pressure). Further, Bluetooth modules are able to detect nearby personal devices such as smartphones or smartwatches that emit Bluetooth identification signals (Kotanen *et al.*, 2003). As a precondition, detection is only possible if Bluetooth visibility is activated, and the number of people with activated Bluetooth on their mobile devices is often rather limited (Yoshimura *et al.*, 2014). Moreover, its signal strength is not a good distance indicator as it is affected too much by environment conditions, making it unsuitable for measuring exact distance. On the other hand, Bluetooth does allow proximity determination and some Bluetooth beacons even enable ranging (e.g. far, near or immediate distance) to determine the relative distance (Kouhne and Sieck, 2014). And concerning privacy issues, participants are unidentifiable by design and can fully control the possibility of being tracked (Millonig *et al.*, 2009). Next to personal devices, also dedicated devices emitting and receiving Bluetooth for tracking are available and currently most often used for social distancing to prevent the spread of COVID-19, such as the Maggy device (Maggy, 2021). However, in order to measure interpersonal distance, passers-by would also have to carry such a device, which would make them aware that they are being studied. For this reason, we excluded these dedicated devices, whether they use Bluetooth, radio-frequency identification (RFID) or ultra-wideband (UWB), from our study. Wireless Local Area Network (WLAN) and Global Positioning System (GPS), which are often reflected in the literature when it comes to pedestrian mobility studies, were also excluded from our study, as they are not suitable for the analysis of accurate interpersonal distance. WLAN can be used in indoor environments and, for example, to estimate which room one is in, but not to determine how close people are to each other. GPS, in comparison, has a relatively low precision (about up to three

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metres) and is only suitable for outdoor environments because it requires unobstructed satellite signals.

This third section discusses methods to assess **explicit attitude** post the experiment (see Table 1; denoted by EA in the first column). Whereas implicit attitudes occur unconsciously and reflexively, explicit attitudes are based on conscious judgment and can be measured directly by self-report (Overgaard, 2019). Although methods to assess explicit attitude were not the focus of this study as they make the subjects possibly suppress biases and report subjective interpretations, we only discuss methods applicable after the unexpected encounter to maintain a degree of realism.

6. Discussion

The factors affecting the social behavioural reactions towards users of near-body devices are poorly understood, yet they can have a strong influence on whether a new wearable succeeds or fails. As reflexive reactions that reveal one's unbiased attitude and social motives are unlikely to emerge within artificial environments, this study focuses on assessing social product acceptance in entirely uncontrolled settings without subjects being aware that they are being studied, or as we refer to it; in the wild. Accordingly, based on a provided theoretical foundation, this study aims to present an overview of research methods for assessing social behavioural reactions towards users of visible near-body product users in the wild. Approaching the matter from a product design perspective, this article is primarily intended for designers of near-body products who wish to gain insights into the social behaviour of people towards users wearing their design proposals.

The overview presented in this article primarily addresses assessment methods of kinesic and proxemic behaviour, which are essential nonverbal behaviour types when studying implicit social behaviour in the wild. These methods will not provide the designer with an answer to whether products will be socially accepted or rejected. However, they can be valuable for designers when comparing different conceptual products. The results can for example also be used to justify certain design decisions or to assess which product properties have influenced certain reactions. Overall, with the ubiquity and emergence of innovative technology that can result in new research studies, the overview is probably not - or in any case will not remain - exhaustive.

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ORCID-ID of Muriel De Boeck: 0000-0002-7457-1768.

References

Al-naimi, I. and Wong, C.B. (2017), “Indoor Human Detection and Tracking Using Advanced Smart floor”, ICICS 2017, IEEE.

Andersen, P.A. (2016), “Eye Behavior”, The Int. Encyclopedia of Interpersonal Communication, pp. 1–7, doi: 10.1002/9781118540190.wbeic0152.

Aziz, H. (2017), “Comparison between Field Research and Controlled Laboratory Research”, Archives of Clinical and Biomedical Research, Vol. 01 No. 02, pp. 101–104, doi: 10.26502/acbr.50170011.

Bakhshian, S. and Lee, Y. (2020), “Influence of Social Acceptability and Product Attributes on Consumers’ Attitude and Intention of Using Smart Apparel”, ITAA Proceedings, pp. 4–7, doi: DOI: 10.31274/itaa.11849.

Baumeister, R. and Bushman, B. (2014), Social Psychology and Human Nature, Belmont, Boston USA.

Baumeister, R.F., Vohs, K.D., Nathan DeWall, C. and Liqing Zhang. (2007), “How Emotion Shapes Behavior: Feedback, Anticipation, and Reflection, Rather Than Direct Causation”, Personality and Social Psychology Review, Vol. 11 No. 2, pp. 167–203, doi: 10.1177/1088868307301033.

Belk, R.W. (1988), “Possessions and the Extended Self”, Journal of Consumer Research, Vol. 15 No. September.

Birdwhistell, R. (1955), “Background to kinesics”, ETC: A Review of General Semantics, Vol. 13 No. 1, pp. 10–18.

Boolani, A., Sur, S., Yang, D., Avolio, A., Goodwin, A., Mondal, S., Fulk, G., et al. (2021), “Six Minutes of Physical Activity Improves Mood in Older Adults: A Pilot Study”, Journal of Geriatric Physical Therapy, Vol. 44 No. 1, pp. 18–24, doi: 10.1519/JPT.0000000000000233.

Carpendale, S. (2008), “Evaluating information visualizations”, Information Visualization, Springer-Verlag, Berlin Heidelberg, pp. 19–45, doi: 10.1007/978-3-540-70956-5.

Cosco, N.G., Moore, R.C. and Islam, M.Z. (2010), “Behavior Mapping: A Method for Linking Preschool Physical Activity and Outdoor Design”, Journal of the American College of Sports Medicine, pp. 513–519, doi: 10.1249/MSS.0b013e3181cea27a.
Desmet, P. (2003a), “From disgust to desire: how products elicit emotions”, Design and Emotion, No. May, pp. 8–12, doi: 10.1201/9780203608173-c2.
Desmet, P. (2003b), “Measuring emotion: development and application of an instrument to measure emotional responses to products”, Funology. Human-Computer Interaction Series, Springer, Dordrecht, pp. 111–123, doi: https://doi.org/10.1007/1-4020-2967-5_12.
DeWall, C.N., Baumeister, R.F., Chester, D.S. and Bushman, B.J. (2016), “How often does currently felt emotion predict social behavior and judgment? A meta-analytic test of two theories”, Emotion Review, Vol. 8 No. 2, pp. 136–143, doi: 10.1177/1754073915572690.
Dharmawan, V. and Rachmaniyah, N. (2019), “Spatial behavior pattern of visitors in City Park Case study: Flora and Bungkul Park, Indonesia”, ICEAT 2019, Vol. 821, doi: 10.1088/1757-899X/821/1/012006.
Dols, J.M.F. and Russell, J.A. (2017), The Science of Facial Expression, Oxford University Press.
Dovidio, J.F., Kawakami, K., Johnson, C., Johnson, B. and Howard, A. (1997), “On the Nature of Prejudice: Automatic and Controlled Processes”, Journal of Experimental Social Psychology, Vol. 540 No. 33, pp. 510–540.
Fiske, S.T., Cuddy, A.J.C. and Glick, P. (2007), “Universal dimensions of social cognition: warmth and competence”, Trends in Cognitive Sciences, Vol. 11 No. 2, pp. 77–83, doi: 10.1016/j.tics.2006.11.005.
Goffman, E. (1959), “Presentation of self in everyday life”, American Journal of Sociology.
Goffman, E. (1963), Behavior in Public Places, The Free Press, New York, USA.
Hall, E.T. (1963), “A system for the notation of proxemic behaviour”, American Anthropologist, Vol. 65 No. 5, pp. 1003–1026.
Hall, E.T. (1966), The Hidden Dimension, Anchor Books.
Hans, A. and Hans, E. (2015), “Kinesics, Haptics and Proxemics: Aspects of Non -Verbal Communication”, IOSR Journal Of Humanities And Social Science Ver. IV, Vol. 20 No. 2, pp. 47–52, doi: 10.9790/0837-20244752.
Hanzl, M. and Ledwon, S. (2017), “Analyses of human behaviour in public spaces”, ISOCARP, Portland, Oregon, USA.
Huang, S.C.L. (2006), “A study of outdoor interactional spaces in high-rise housing”, Landscape and Urban Planning, Vol. 78 No. 3, pp. 193–204, doi: 10.1016/j.landurbplan.2005.07.008.
Hutchins, E. (1995), Cognition in the Wild, MIT Press, Cambridge, Massachusetts.
Jansson, L. and Norberg, A. (1995), “Facial Expressions of Patients With Dementia: A Comparison of Two Methods of Interpretation”, International Psychogeriatrics, Vol. 7 No. 4, pp. 527–534, doi: 10.1017/S1041610295002262.
Kelly, N. (2016), The WEAR Scale: Developing a Measure of the Social Acceptability of a Wearable Device, Iowa State University, doi: 10.1145/2851581.2892331.
Kotanen, A., Hännikäinen, M., Leppäkoski, H. and Hämäläinen, T.D. (2003), “Experiments on Local Positioning with Bluetooth”, ITCC 2003, IEEE, pp. 2–8.
Kouhne, M. and Sieck, J. (2014), “Location-Based Services with iBeacon Technology”, AIMS 2014, pp. 315–321, doi: 10.1109/AIMS.2014.58.
Leroy, J., Rocca, F. and Gosselin, B. (2014), “Proxemics Measurement During Social Anxiety Disorder Therapy Using a RGBD Sensors Network”, Bio-Imaging and Visualization for Patient-Customized Simulations., Springer Cham, pp. 89–101, doi: 10.1007/978-3-319-03590-1_8.
Liu, Y., Wang, Z. and Yu, G. (2021), “The Effectiveness of Facial Expression Recognition in Detecting Emotional Responses to Sound Interventions in Older Adults With Dementia”, Frontiers in Psychology, Vol. 12 No. August, pp. 1–16, doi: 10.3389/fpsyg.2021.707809.
Maggy. (2021), “Maggy as your Social distancing device”, available at: https://www.maggylife.eu/ (accessed 18 September 2021).
Mccall, C., Blascovich, J., Young, A. and Persky, S. (2009), “Proxemic behaviors as predictors of aggression towards Black (but not White) males in an immersive virtual environment”, Social Influence, Vol. 4 No. 2, pp. 138–154, doi: 10.1080/15534510802517418.
Mccall, C. and Singer, T. (2015), “Facing Off with Unfair Others: Introducing Proxemic Imaging as an Implicit Measure of Approach and Avoidance during Social Interaction”, PLoS ONE, Vol. 10 No. 2, pp. 1–14, doi: 10.1371/journal.pone.0117532.
Mehl, M.R. and Conner, T.S. (2012), Handbook of Research Methods for Studying Daily Life, New York, NY: Guilford.
Millonig, A., Ray, M. and Bauer, D. (2009), “Pedestrian behaviour monitoring: methods and experiences”, Behaviour Monitoring and Interpretation, doi: 10.3233/978-1-60750-048-3-11.

Mittal, B. (2006), “I, me, and mine - how products become consumers’ extended selves”, Journal of Consumer Behaviour, Vol. 5 No. November, pp. 550–562, doi: 10.1002/cb.

Mogilner, C., Aaker, J. and Kamvar, S.D. (2012), “How happiness affects choice”, Journal of Consumer Research, Vol. 39 No. 2, pp. 429–443, doi: 10.1086/663774.

Mu, B., Liu, C., Mu, T., Xu, X., Tian, G., Zhang, Y. and Kim, G. (2021), “Spatiotemporal fluctuations in urban park spatial vitality determined by on-site observation and behavior mapping: A case study of three parks in Zhengzhou City, China”, Urban Forestry and Urban Greening, Vol. 64 No. January, doi: 10.1016/j.ufug.2021.127246.

Nakamura, K., Zhao, H., Shao, X. and Shibasaki, R. (2012), “Human sensing in crowd using laser scanners”, Laser Scanner Technology, No. May 2014, doi: 10.5772/33276.

Namba, S., Sato, W., Osumi, M. and Shimokawa, K. (2021), “Assessing automated facial action unit detection systems for analyzing cross-domain facial expression databases”, Sensors, Vol. 21 No. 12, doi: 10.3390/s21124222.

Nanda, P., Bos, J., Kramer, K.L., Hay, C. and Ignacz, J. (2008), “Effect of smartphone aesthetic design on users’ emotional reaction: an empirical study”, TQM Journal, Vol. 20 No. 4, pp. 348–355, doi: 10.1108/17542730810881339.

Overgaard, K.D. (2019), Student’s Explicit and Implicit Attitudes Regarding Breastfeeding in Public: Analyzed Through FaceReaderTM Technology, Montclair State University.

Park, J., Morris, K., Stannard, C. and Hamilton, W. (2014), “Design for many, design for me: Universal design for apparel products”, Design Journal, Vol. 17 No. 2, pp. 267–290, doi: 10.2752/175630614X13915240576103.

Pryor, J.B., Reeder, G.D., Yeadon, C. and Hesson-McInnis, M. (2004), “A dual-process model of reactions to perceived stigma”, Journal of Personality and Social Psychology, Vol. 87 No. 4, pp. 436–452, doi: 10.1037/0022-3514.87.4.436.

Soares, F. and Santos, C.P. (2021), “Fostering Emotion Recognition in Children with Autism Spectrum Disorder”, Multimodal Technol. Interact., Vol. 5 No. 57, doi: 10.3390/mti5100057.

Sousa, M., Techmer, A., Steinhage, A., Lauterbach, C. and Lukowicz, P. (2013), “Human tracking and identification using a sensitive floor and wearable accelerometers”, PerCom 2013, IEEE, pp. 166–171, doi: 10.1109/PerCom.2013.6526728.

Stefani, E. De and Mondada, L. (2018), “Encounters in public space: how acquainted versus unacquainted persons establish social and spatial arrangements”, Research on Language and Social Interaction, Routledge, Vol. 51 No. 3, pp. 248–270, doi: 10.1080/08351813.2018.1485230.

Vaes, K., Jan Stappers, P. and Standaert, A. (2016), “Measuring Product - Related Stigma in Design”, DRS2016: Future-Focused Thinking, Vol. 8 No. June, doi: 10.21606/drs.2016.444.

Vaes, K., Standaert, A. and Jan, P. (2012), “Masked Aversion - Walking and Staring Behavior towards Stigmatizing Products”, pp. 1–4, doi: 10.13140/2.1.3542.2722.

Wohlin, C. (2014), “Guidelines for snowballing in systematic literature studies and a replication in software engineering”, ACM 2014, doi: 10.1145/2601248.2601268.

Yoshimura, Y., Sobolevsky, S., Ratti, C., Girardin, F., Carrascal, J.P., Blat, J. and Sinatra, R. (2014), “An analysis of visitors’ behavior in the louvre museum: A study using bluetooth data”, Environment and Planning B: Planning and Design, Vol. 41 No. 6, pp. 1113–1131, doi: 10.1068/b130047p.

Zhang, Z. (2014), “Microsoft Kinect Sensor and Its Effect”, Computer Society, No. June, doi: 10.1109/MMUL.2012.24.