Measuring Electrodermal Activity of Both Individuals With Severe Mental Disabilities and Their Caretakers During Episodes of Challenging Behavior

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Abstract

Here, we present evidence for the feasibility of measuring changes in electrodermal activity in both individuals with severe mental disabilities and their caretakers during challenging (aggressive) behavior. In addition, we will provide guidelines on how to realize these measurements while minimizing distress for individuals with severe mental disabilities. These measurements will both provide insight into the physiology of intense, real life emotions and a better understanding of emotional fluctuations from those who cannot readily express feelings in a verbal manner.

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Introduction

The inspection of health care [1] estimates that in The Netherlands about 20% of the 30.000 people with an intellectual disability (ID) who live in a residential setting show “severe behavioral problems” in which aggression and self-injurious behavior (SIB) are the most predominant. This challenging behavior (CB) is a serious problem in the daily care of people with a mental disability. At present, caretakers try to anticipate CB by relying on their experience on what mix of visual and/ or verbal cues from the client (in a particular context) might be indicative of upcoming aggression. Caretakers often report being surprised by CB. An important marker for upcoming aggression might be found in changes in their physiology (e.g. heart rate (variability), electrodermal activity (EDA)). Of course, changes in these markers are not readily perceived by caretakers. Interestingly, these physiological changes are relatively easy to measure, and these types of measurements are becoming extremely "wearable" and non-intrusive. Because of these developments it is now seems feasible to continuously measure changes in the physiology of clients in (almost) any situation. Caretakers express a great need for a better understanding of the emotional fluctuations of their clients. The ambulatory measurement of EDA now finally gives the opportunity to provide caretakers with additional, objectively measured information regarding the inner states of their clients.

Another important factor is that actions of direct care staff are thought to be antecedents as well as consequences of a large proportion of CB such as aggression [2]. Their actions may increase or decrease the likelihood of future problem behaviors. A low rate of adequate staff responding and even counterproductive responding have been reported [3]. The possibility of the occurrence of CB can be perceived as a stressor in working with clients who have a history of showing CB. This direct stressor can produce a psychological experience, a feeling of frustration or arousal within the caretaker without the actual presence of CB. This heightened level of arousal in the caretaker can further negatively influence the task performance through attention narrowing [4]. Care takers can display the tendency to restrict the range of attention and to ignore surrounding information sources in the context of high (physiological) arousal. Therefore, we measured physiological changes in both clients and caretakers.

Measuring electrodermal activity

For well over 100 years researchers have been measuring electrodermal signals. This has resulted in quite strict standardization regarding both terminology and measuring methods [5]. Typically EDA is recorded as skin conductance (SC, in μSiemens) by applying a direct current (with two silver electrodes) to the skin (exosomatic method). Central to this measure is the electrodermal response (EDR). The EDR constitutes a sharp rise in the SC value, followed by a slower drop in conductance. For example, a sudden loud burst of noise will result an EDR 1-2 seconds later, and this is easily visible in the raw data signal. In general, changes in SC are closely linked to activity of the sympathetic part of the autonomic nervous system (ANS) (i.e. "the fight or flight" system). Therefore, researchers and practitioners have taken EDA measurements as further operationalization for constructs such as attention, stress, anxiety, workload, pain, and arousal.

Developments in electronic devices have made it possible to measure EDA outside the laboratory, in ambulatory fashion. Very recently a shift in measurement location and the application of dry electrodes has further broadened the scope of EDA measurements to true observational field studies [6]. Our sensor, the Affectiva Q sensor, is a wrist worn, wireless sensor (electrodes are placed on the ventral side of the arm) that can easily measure EDA for 24 hours with a sampling frequency of 32 Hz. This measurement location does not adhere to current standards [5]. On the one hand, it has been shown to produce comparable results as the advised locations [7]. On the other hand, the number of sweat glands differ hugely across the body, and it seems to be the case that sensitivity for detecting EDR's can be considered lower at the wrist than at other locations (e.g. the palm of the hand), especially for stimuli that are only weakly arousing [8].

EDA during challenging behavior

For nine (fixed) couples of clients and caretakers we measured EDA (with the Q sensor) during 24 sessions of approximately two to three hours, which were all recorded on video. EDA measurements were successful in most sessions (many with CB) for both clients and caretakers in clearly showing fluctuations in EDA level and displaying the prototypical EDR's, albeit with far higher amplitudes than what is typically reported in lab studies [5]. This data, and the systematic comparison between physiological changes and behavior, will be reported elsewhere.

Figure 1 shows the data of a client from one session in which both CB (aggressive behavior, 1A) and strongly, positive emotional behavior (while playing music, 1B) were displayed. In the details on the right of this Figure the (superimposed) EDR's are clearly visible. Standard ways of classifying the reactivity of the sympathetic part of the ANS consist of computing the number of EDR's per minute and the mean amplitude of these responses. In addition, the whole level of EDA can rise (i.e. the space under the EDA line), which can be clearly seen on several occasions on the left side of Figure 1. It is important to note that the reactivity of the sympathetic ANS can rise dramatically during both negative and positive emotional episodes. As such the EDA is not particularly sensitive to the valence of an emotion, and caution should be applied when EDA is said to be used to uniquely measure a particular negative experience (such as pain, see [9]).

Guidelines

To measure EDA and heart rate variability (not further discussed here) both the client and the caretaker need to wear a Q sensor wrist band and a Polar chest band and receiver watch. In the interaction with individuals with a severe mental disability (client), who are known to show challenging behavior, every added question or demand to the normal daily routine can be seen as a stressor and therefore can be viewed as an act to cause challenging behavior. For the caretaker this added task can also bring stress to the relationship. Putting on and taking off these materials can be viewed as added tasks that can disrupt the life of the client and the relationship between the client and the caretaker. Below we specify our methods and guidelines to minimize these levels of distress.

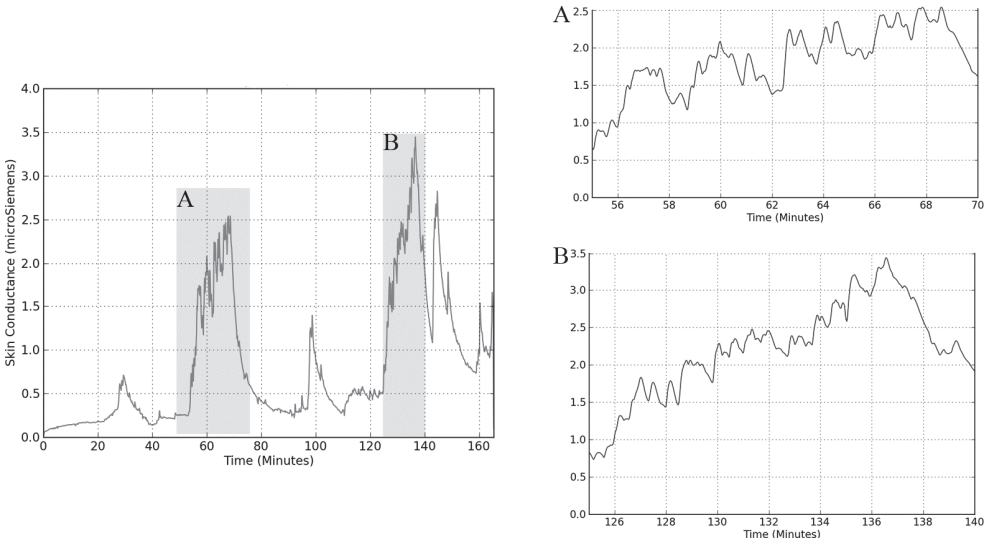

Figure 1. An example of one session in which the client displayed strongly negative challenging behavior (marked with an A in the overview figure and in the detail on the right), and strongly positive behavior associated with making music (marked with a B). Time (in minutes) is on the x-axes, and SC (in µSiemens) is on the y-axis. Data were low-pass filtered (2nd order Butterworth filter with a cut-off frequency of .002 Hz.).

Measurement materials are presented and removed by the caretaker. In this way the client does not need to build a new demanding relationship with unknown researchers. Caretakers are individually trained by the researchers in executing a measurement material applying (MMA) protocol during a two hour training session. In this training session the MMA protocol is personalized for the specific client-caretaker couple. For each caretaker an individual MMA protocol instruction card was made.

Central to the MMA protocol is maximizing the feeling of influence on the situation for the client. By making the situation predictable (in announcement and repeatability) and maximizing the level of participation the client can follow, recognize and understand the actions needed to put on and take off the measurement materials. Personalization is accomplished in two ways.

1. *Announcing the start and finish of the task to the client at his own determined level of communication*. For every client the level of communication is determined on the basis of the ComVoor [10]. A client can function on sensation, representation or presentation level. On the level of sensation, predictability is hard to accomplish. At best, recognition and familiarity by can be reached by repetition. Time is taken to let the client get used to the feeling of actual materials on their skin. Executing the MMA protocol in a consistent manner is needed and practiced by the caretaker in the training. At the level of representation, predictability in a short window of time can be reached. The client is presented with the blue box or the picture of the blue box in which the materials are stored just before putting on or taking off. With every time the blue box is introduced, the actual introduction of the measurement materials will be a bit later in time. Through this principle of backward chaining the client can form a link between presentation of the blue box and the action of putting on or taking off the measurement materials. At the level of presentation the picture of the blue box is part of the timeline that is shown to predict the upcoming day or part of the day. Covering the picture with a red cross indicates the end of the measurements.

2. *Determining the clients optimal level of participation in applying the materials*. We added caretaker help from least to most. “Least to most help” is defined as a continuum from verbal instruction, modeling (“showing how” on yourself or a demonstration doll), applying materials together, to making the client aware of total takeover by the caretaker. The caretaker is instructed to wait five seconds before adding the next level of help.

After each session the caretaker was interviewed by the researches to determine the level of participation and the level of intrusiveness of the materials employed. The level of participation by the clients was surprisingly high. In five cases verbal instruction was combined with modeling and physical assistance at the start of the research. In four cases the caretaker totally took over. During the course of the research for all but one client the level of participation increased.

During the training additional attention was paid to the several ways clients with a severe mental disability could show resistance [11]. For each client possible behaviors that could indicate resistance were determined. If a possible form of resistance was noted the researcher organized a multi-disciplinary meeting in which the behavior was evaluated by his/ her physician, legal representative and treatment coordinator. Depending on this multi-level interpretation of the behavior, participation in the research was continued or not. During the 24 x 9 session this 'resistance protocol' was only set in motion once. The behavior was interpreted as not specifically related to resisting to wearing the measurements materials. Participation in the research was continued.

Conclusions

EDA measurements are now possible under the most challenging circumstances. Here, we show how it is possible to measure EDA during CB of severely mentally disabled people and their caretakers. One of the future possibilities of an application based on this information is to assist caretakers in the recognition of CB by means of a technological aid that is based on online variations of the clients physiology. This signal could perhaps simply help caretakers to direct focused attention to this client and establish whether action is required to prevent escalation and thereby increase the safety and health of both the client and the caretaker. In addition, caretakers could also be informed about changes in their own physiology and possibly shortly refrain from interaction with the client, or actively engage in relaxation techniques, when their arousal seems to high. These measurements will both provide insight into the physiology of intense, real life emotions (see also [12] for similar attempts with a psychiatric patient) and the outlook of getting a better understanding of emotional fluctuations of those who cannot readily express feelings in a verbal manner [6].

Ethical statement

This study was approved by the local Medical Ethical Committee, MST hospital, Enschede (METC no. P11-27 NL 37314.044.11, approved on 06-09-2011). This study was also registered in the Netherlands Trial Register (Trial Code 3043).

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