Brief Report:

A Contemplative Biofeedback Intervention for Adults with ASD: Feasibility of a Community-Based Treatment

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Abstract

Background: As the number of adults living with ASD continues to grow, a lack of resources and lack of available interventions exacerbate their low quality of life, including low levels of education and employment, and high levels of co-morbid anxiety and depression. Here we build upon existing research showing the effectiveness of contemplative interventions on individuals with ASD, to provide a low-cost biofeedback-enhanced training which can be implemented by non-professional staff, and may help autistic individuals grasp abstract contemplative techniques. We hypothesize that the intervention will decrease participants' anxiety and autism symptoms, and increase their self-awareness, self-determination, and empathy.

Method: Fourteen adults with ASD, residing in assisted living, were provided with 16 weekly half-hour contemplative-biofeedback sessions with non-professional trainers, in which they learned to reduce their arousal levels through combined biofeedback and contemplative techniques, and apply those to everyday life. Quantitative and qualitative data was collected pre- and post-intervention, to determine changes in participants' self-awareness, self-determination, anxiety, autism symptoms, and empathy.

Results: Participants were capable of successfully improving their physiological arousal levels on the biofeedback setup, and we found initial indications for gains in all hypothesized domains on the quantitative measures. Qualitative reports by participants and counselors revealed that participants applied the techniques in many real-life situations, and these had far-ranging effects on their emotional regulation, work and social motivation, and self-determination.

Conclusions: The study provides proof-of-concept for a low-cost, community-based intervention which can ameliorate the lives of adults with ASD.

Keywords: Adults with ASD, biofeedback, contemplative techniques, community-based, self-awareness

Abbreviations: Autism Spectrum Disorder (ASD); Beit Ekstein (BE); Glasgow Anxiety Scale (GAS); Heart Rate (HR); Reading the Mind in the Eyes Test (RMET); Social Responsiveness Scale (SRS); Toronto Alexithymia Scale (TAS).

Introduction

The growing population of children with ASD is quickly aging into adulthood (Howlin & Taylor, 2015). Yet the situation of adults with autism remains poor, with most adults suffering from social isolation and low levels of education and employment; alongside high levels of co-morbid psychiatric conditions, such as depression and anxiety (Magiati, Tay, & Howlin, 2014). The situation is further exacerbated by a lack of resources for adults with ASD in many countries, and a dearth of evidence-based interventions to improve their quality of life (Bishop-Fitzpatrick, Minshew, & Eack, 2013). Recent research suggests that alongside the diagnostic impairments in social and communication skills and repetitive behaviors, individuals with autism also suffer from reduced self-awareness (Uddin, 2011) and high levels of co-morbid anxiety (White et al., 2014). These latter symptoms can have profound consequences for adults with autism, restricting their daily lives and preventing them from achieving their goals and desires (Lawrence, Alleckson, & Bjorklund, 2010).

Self- and body-awareness in autism

Recent research has shown that individuals with autism have difficulties not only in understanding others, but perhaps more primarily in self-understanding (Lind & Bowler, 2008; Uddin, 2011). These difficulties are manifest in reduced emotional self-awareness, or alexithymia (Bird & Cook, 2013), poorer autobiographical narratives (Brezis, 2015), and difficulty with future decision-making (Lind & Bowler, 2010). Such difficulties in self-awareness can have wide-ranging practical consequences for the daily lives of individuals with autism. For instance, an individual who is not aware of his own emotions will have difficulty regulating his emotional responses in everyday situations;

and an individual who does not have a clear sense of his preferences will find it hard to make important decisions about his education and employment. As adults with autism emerge into the wider educational and vocational worlds, they must be given the skills to recognize and advocate for their needs (Lawrence et al., 2010).

Importantly, most behavioral and neuropsychological studies of self-awareness in ASD have focused on cognitive, conceptual levels of the self (Lind & Bowler, 2008). Yet emergent research is showing that individuals with high-functioning autism have an atypical *bodily* self-awareness (Fiene & Brownlow, 2015). This reduced somatic self-awareness has been hypothesized to lie at the basis of their difficulty in emotional regulation and anxiety (White et al., 2014), their difficulties in empathizing with others (Bird & Viding, 2014; De Jaegher, 2013), and their own self-determination. Based on neuroscientific findings suggesting the strong overlap between self- and other-processing networks (Bird & Viding, 2014; Lombardo et al., 2010), we hypothesize that strengthening ASD adults' bodily self-awareness will lead to a concomitant enhancement of empathic skills.

Contemplative biofeedback intervention for adults with ASD

Several studies have shown that contemplative practices – that focus on increasing body awareness through breathing exercises and mental body scanning - can reduce depression, anxiety and aggression in individuals with ASD (Cachia, Anderson, & Moore, 2016; Hwang & Kearney, 2013; Kiep, Spek, & Hoebe, 2015; Singh et al., 2011). However, the application of these programs at a wider scale remains a challenge, given the reliance on experienced professionals, which may be difficult to

finance; alongside the difficulty of individuals with ASD to grasp the abstract techniques taught in contemplative practice, such as mindfulness-based interventions.

Here we propose to harness the recent advances in biofeedback technology to provide an accessible, contemplative-based treatment that can be easily implemented by minimally-trained staff, and can be readily grasped by individuals with ASD.

Biofeedback interventions, in which participants practice various relaxation techniques while receiving immediate feedback regarding their physiological arousal - e.g., heart rate (HR) and skin conductance - have been used successfully to reduce stress and increase emotional regulation in a wide range of contexts (Schoenberg & David, 2014), including individuals with ASD (McCoy, Zucker, Westlake, & DiGangi, 2014; Sugarman, Garrison, & Williford, 2013; Thompson, Thompson, & Reid, 2010). Here we used a finger-sensor biofeedback setup (Alive™) in which physiological measures were displayed on a laptop, in the form of graphs, movies or video games (Figure 1). This tangible representation of their internal state is particularly beneficial to individuals with ASD who are strongly attuned to visual stimuli (Grandin, 2009), and may thus facilitate contemplative practices. At the same time, the biofeedback setup allows semi-professional caregivers a glimpse onto participants' internal sensations and feelings, enabling more focused therapeutic work towards emotional regulation.

We present preliminary results from a contemplative-based biofeedback intervention conducted in group-home settings of adults with ASD, aimed at increasing participants' self-awareness and self-determination, decreasing their anxiety and autism symptoms and increasing their empathy.

Methods

Recruitment:

Participants were recruited for the study from the Beit-Ekstein (BE) organization, which provides assisted living and job placement for individuals with ASD. The study was approved by the IDC ethical review board and by the Israel Ministry of Social Welfare. Participants were invited to participate in the intervention by the BE and study staff and were told that the biofeedback technique might help them learn more about their emotions, regulate their anxiety, and help them in other aspects of daily life. Participants were required to participate in 16 weekly sessions and were compensated for completing the pre- and post-test sessions. All participants (and caregivers, where required) provided informed consent.

Participants:

Fourteen adults with ASD (12 males) participated in the study. ASD diagnosis was confirmed using the Autism Diagnostic Observation Schedule (Lord et al., 2012), Module 4, performed by a trained psychologist. See Table 1 for participants' background information. All participants completed baseline and post-test measures, before and after the 16-week intervention (none dropped out). Four participants were currently taking psychiatric medication of different types (antidepressants, anti-convulsants, and stimulants), and 5 participants were currently in psychotherapy. Due to the small number of participants, quantitative analyses to examine the effects of concurrent therapy on the study effects could not be performed, but a qualitative examination revealed no significant difference between participants who received or did not receive concurrent therapy on the study results.

Intervention:

Participants received 16 weekly 30-minute private biofeedback sessions from trainers who completed a 3-day biofeedback and contemplative methods training course.

Trainers included: an MA student in clinical psychology (A.L.), a social worker at BE, and a biology major with experience in mindfulness and biofeedback.

Sessions proceeded at an individualized pace, introducing a variety of contemplative and relaxation techniques. In the first 8-10 sessions, the intervention focused on teaching and practicing relaxation and regulation techniques. The first meeting focused on psycho-education, familiarizing participants with the biofeedback software (Alive™) environment (Figure 1) and its rationale. Participants were briefly taught about the sympathetic and para-sympathetic systems and their importance for stress-management, and taught about the potential of self-awareness to enhance this balance. The following sessions focused on training in different breathing techniques (extension of inhalation, abdominal breathing and HRV breathing), and bodily relaxation techniques such as body scanning. While the participants practiced these techniques, they viewed their HRV and/or skin conductance responses in the form of graphs or animations, and were able to track their own progress. After each exercise, the trainer helped the participant link the changes viewed in the biofeedback display with the bodily sensations, thoughts and emotions that arose. E.g., “What did you feel in your body when a stressful thought came to mind? How was this displayed on the graphs? What made you feel more relaxed? How do you feel in your body when you become relaxed?”. Training proceeded at an individualized pace, with the goal of identifying at

least two relaxation techniques which the participant can use smoothly and comfortably, and which can be easily used in their daily lives.

In the second part of the intervention (sessions 10-16), sessions aimed to develop the participants' meta-awareness, helping them identify stressful moments in their everyday lives in order to use the techniques pre-emptively. Each session began with a short discussion on how the participant has felt in the past week, whether there were any stressful events, and whether the participants had used the contemplative techniques independently. The session then proceeded with guided biofeedback training in the Alive™ environment, wherein the trainer gently challenged the participant to recall a stressful event, observe the physiological changes which ensued, and then use the relaxation techniques to balance the arousal state. Each session then ended with a short discussion on what had happened during the training, any challenges that arose, and how the techniques could be used in everyday life.

Measures and analysis

1. Physiological data were recorded continuously during sessions, and the following measures were used for analysis:
 - a) Average change in HR (i.e., HR in the last 15sec of the session – HR in the first 15 sec of the session), over sessions. Negative values indicate a greater relaxation over time, within each session.
 - b) Change in HR throughout the treatment (i.e., average HR in the entire last session, approximately 30 minutes - average HR in the first session, approximately 30 minutes).

- c) HRV coherence was computed as the power in the LF (Low Frequencies) band (0.04 to 0.15 Hz) of the HR signal divided by the overall power. Average change in HRV signal coherence, over sessions (i.e., coherence in the last 15sec of the session minus the coherence in the first 15 sec of the session) served as a dependent variable. Positive values denote an increase in coherence during sessions.

To determine the *rate* of change in each participant, we computed the slope of the regression line for HR and coherence over the 16 sessions. To determine whether these physiological values were related to our outcome measures, we further computed correlations with the variables below.

2. Pre-post measures of change were assessed using a combination of quantitative and qualitative methods, integrating both the participants' and caregivers' reports. Caregiver reports were collected from counselors, who spent an average of 3.75 hours ($SD=1.19$) with the participants a week, have known the participants for an average of 7.5 months ($SD=3.7$), and whom were kept blind to individuals' participation in training. The following measures were collected:

- a) IQ was measured using the Vocabulary and Matrices sub-scales of the WAIS (Wechsler, 1998), at baseline only. We present age-normed scores for these sub-scales.
- b) Autism Symptoms were measured using both the adult self- and caregiver-report versions of the Social Responsiveness Scale (SRS; Constantino, 2012).

- c) Anxiety was measured using the Glasgow Anxiety Scale (GAS; Mindham & Espie, 2003), a self-report measure adapted for individuals with intellectual disability.
- d) Alexithymia was assessed using the Toronto Alexithymia Scale (TAS; Bagby, Parker, & Taylor, 1994).
- e) Self-determination was measured using the Arc's Self-Determination Scale (Wehmeyer, 1995).
- f) Cognitive Empathy was measured using the Reading the Mind in the Eyes Test (RMET; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001).
- g) Response to Challenging Situations was assessed in a semi-structured interview, co-developed by the researchers and BE staff, in which participants described what they would do in 5 different challenging situations based on real-life situations from the group home (Supplementary Materials). A coder blind to Time coded their responses for their degree of adaptiveness.

Further reports on the intervention were collected at various intervals:

- a) Weekly sessions report: At the end of each session, the participants and the trainers completed a brief report about their experience (Supplementary Materials).
- b) Post-treatment questionnaire: During the last session, participants completed a questionnaire regarding their view of the intervention; and counselors reported on any observed changes (Supplementary Materials).

- c) A focus group was held with the counselors to assess the changes they perceived in participants.

Responses were analyzed both qualitatively and quantitatively, using one-sample *t*-tests, comparing the responses to the items' mean, where appropriate.

Results

1. Participants learned to modulate their arousal through the intervention, and showed gains in hypothesized domains

Participants' HR coherence increased, on average, during each session ($M=6.92$, $SD=8.3$); and their HR decreased, on average, during each session ($M=-.592$ bpm, $SD=.865$), indicating greater relaxation. Their HR decreased through the time of the intervention by an average of 8.38bpm ($M_0=85.7$; $M_1=77.4$; $t(12)=2.86$, $p=.014$).

Participants' changes in measures before and after the intervention are reported in Table 2. In line with our hypotheses, participants showed a reduction in ASD symptoms (SRS Self- and Caregiver report), a decrease in anxiety (GAS), an increase in self-determination (ARC), an increase in adaptive behaviors to challenging situations, and an increase in empathy (RMET). They did not show a decrease in alexithymia (TAS).

We further found a correlation between a decrease in anxiety symptoms (GAS pre-post) and the rate of increase in coherence ($\rho=-.694$, $p=.008$; Figure 2).

2. Participants reported enjoying and benefiting from the intervention

During weekly session reports, participants reported using the techniques an average of 2.1 times a week ($SD=.77$); and on average, their ratings were felt significantly more positive ($M=4.0$, $SD=.78$) than the scale mean ($t(13)=4.86$, $p<.001$).

At the end of the intervention, participants reported enjoying the intervention ($M=3.3$, $SD=.75$; $t(13)=4.22$, $p=.001$) and thought that it helped them ($M=3.15$, $SD=.89$; $t(13)=2.68$, $p=.018$). A great majority of the participants (93%) indicated they would like to continue the intervention either now (31%) or possibly in the future (62%). And a great majority (85%) of participants noted that they will continue to use the techniques either a lot (31%) or occasionally (54%).

Trainers' weekly ratings revealed that participants were highly cooperative ($M=8.5$, $SD=1.1$; $t(12)=10.67$, $p<.001$); that they enjoyed the sessions ($M=7.9$, $SD=1.3$; $t(12)=8.10$, $p<.001$); that they showed mastery of the techniques ($M=7.8$, $SD=1.0$; $t(12)=9.88$, $p<.001$); and that they were focused during the sessions ($M=8.0$, $SD=1.4$; $t(12)=7.97$, $p<.001$).

3. Participants and counselors reported multiple impacts on participants' everyday lives

Participants reported that the trainings helped them "become calmer" and more "relaxed", and they were capable of using the techniques in everyday life. Examples: "I used [the relaxation technique] when my boss pressured me and it helped me calm down." "I can turn to people and tell them what I want without becoming anxious". Others reported broader effects, relating their greater awareness of their own bodily states with better response to external situations: "It gave me a sense of relaxation, like

water flowing through my body.” “I am more relaxed now, I can listen and focus, I can be at ease.” “I learned how to be with myself, so it helps me a lot”.

Counselors reported that participants attended more social events ($M=0.3$ more events per week); and that their level of independence increased ($M=0.29$ point increase on a 4-point scale); though these were not statistically significant. They further reported gains in emotional regulation and self-determination:

“Earlier Ruthi [pseudonym] was very reclusive... Now she is much more open, when something bothers her she complains immediately or asks for help”

“Yifat’s work situation has improved, she started going to the gym and to a social group and she has a new [romantic] partner after she ended an ‘imaginary’ relationship.”

“Alon has been able to keep a job in high-tech for 3 months now for the first time in his life... and is saving in order to live independently.”

Finally, the group home manager reported that participants who received the intervention were later more open to other forms of therapy.

Discussion

Our study provides proof-of-concept for the feasibility of a contemplative-biofeedback intervention for adults with ASD in a community setting. We demonstrated that participants learned to regulate their arousal, through increased coherence and reduced HR over the sessions, and that they enjoyed and benefited from the intervention.

Furthermore, as hypothesized, participants showed initial indications for an increase in self-determination, empathy, and adaptive behaviors to challenging situations, and decreases in anxiety and ASD symptoms. Moreover, we found that participants who increased more quickly in their degree of coherence on the biofeedback program also showed greater decreases in anxiety symptoms, suggesting that the physiological techniques mediated their gain in psychological well-being.

The fact that participants' self-report measures did not show statistically significant changes before and after the intervention may in part be explained by the fact that as an intervention aimed at increasing self-awareness, some participants may have become *more* aware of their own difficulties with anxiety and self-determination, and thus reported more difficulties at post-test than at pre-test. For this reason, we further probed the participants' counselors for their view on the participants' change.

Participants and counselors provided ample examples for the intervention's impact on participants' daily lives, from helping them feel calmer and more focused, to using the techniques in specific situations. Surprisingly, in the short span of the intervention, some of the participants made even greater leaps: e.g., finding and keeping meaningful work, entering a new romantic relationship, and moving towards greater independence. These impacts were echoed by the BE staff, who plan to expand the treatment to multiple group homes, enabling tenants and counselors to use it on a daily basis.

Our small sample size limited our ability to conduct rigorous statistical analyses.

However, our quantitative and qualitative results do point to the effectiveness of the intervention, and future research should put the intervention to a randomized-controlled test, controlling for concurrent interventions. Furthermore, it is possible that larger

effects would have been obtained using a more intensive intervention, rather than just once a week. As the technology of biofeedback training becomes ever more accessible and low-cost, future studies should consider providing participants with biofeedback apps and sensors for personal devices, and training them to practice the biofeedback techniques, individually or with a trainer, on a daily basis, to determine the optimal dosage of the intervention. Finally, to counter the limitation of assessing changes in self-awareness via self-report, which may disproportionately reflect the participants' own growing awareness of their difficulties, future studies should continue to explore objective measures of change in self-awareness.

In sum, this study joins a growing body of literature demonstrating that contemplative-based interventions can decrease anxiety, and increase social responsiveness and well-being in individuals with ASD (Cachia et al., 2016; Singh, Lancioni, & Manikam, 2011; Spek, Ham, & Nyklíček, 2013), while demonstrating that the intervention can have a meaningful impact even when conducted with minimally-trained staff in a community setting. Given the many daily challenges of adults with ASD alongside the dearth of interventions and limited resources, this low-cost, community-based intervention provides much promise for ameliorating the lives of individuals with ASD.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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Figures

Figure 1: The biofeedback setup, in which (a) a participant is connected to finger sensors of heart-rate and galvanic skin response, and can view his or her measures on a laptop computer or tablet, in the form of (b) either graphs or dynamic movies.

Figure 2: Correlation between participants' ratings of anxiety symptoms, pre-post treatment, and their rate of change in coherence (i.e., the slope of the regression line of change in coherence, over time, denoting each participant's rate of change in the amount of coherence they increased by each session). These results suggest that participants who succeeded in increasing their coherence on the biofeedback apparatus more quickly throughout the 16-week training, also showed a greater decrease in their levels of anxiety symptoms.

Tables

Characteristic	Mean (SD), Range /Percent
Age	29.71(8.44), 19-48
Gender	
Male	86%
Female	14%
Living Situation	
Semi-independent apartments	36%
Group home setting	64%
VIQ	12.64(3.272), 8-19
PIQ	10.86 (3.592), 5-17

Table 1: Participants' demographic variables.

Measurement Scale	Mean (SD) – Time 0	Mean (SD) – Time 1	Cohen's D
Social Responsiveness Scale (ASD symptoms) – Self Report	59.9 (8.4)	58.2 (9.4)	-0.20
Social Responsiveness Scale – Caregiver Report	67.0 (7.0)	63.3 (5.9)	-0.53
Toronto Alexithymia Scale	46.1 (10.8)	47.6 (13.0)	0.14
Glasgow Anxiety Scale	19.4 (6.8)	18.8 (4.5)	-0.09
Reading the Mind in the Eyes Test	22.5 (4.9)	22.8 (5.8)	0.05
ARC Self-Determination Scale	69.5 (8.1)	71.7 (10.6)	0.27
Challenging Situations – adaptive behavior rating	1.0 (0.4)	1.1 (0.2)	0.13

Table 2: Change in measures prior (Time 0) and post-intervention (Time 1).

Supplementary materials

1. Weekly sessions report
2. Post-treatment participants' questionnaire
3. Post-treatment counselors' questionnaire
4. Challenging Situations

1. *Weekly sessions report* (To be completed by the trainer, in conjunction with the participant, before and after each session):

Questions for the participant:

At the start of the training:

- a. How do you feel today? (Emotional slider)
- b. Did you have any exceptional events this week? (Open-ended)

At the end of the training session:

- a. How did you feel during the training session (Emotional slider)
- b. How many times did you use the techniques this week?

Questions for the trainer

- a. Did the participant arrive on time to the meeting? (Yes/No)
- b. How much do you feel the participant cooperated in the session? (10-point slider)
- c. How much do you feel the participant enjoyed the session? (10-point slider)
- d. How well did the participant master the techniques introduced? (10-point slider)
- e. How focused was the participant during the session? (10-point slider)
- f. How comfortable were you during the session? (10-point slider)
- g. Further notes (Open-ended).

2. *Post-treatment participant questionnaire*

1. How much did you enjoy the treatment sessions? (1- I did not enjoy them at all;
2- I did not enjoy them; 3 – I enjoyed them; 4- I enjoyed them very much)
2. Would you like to continue the biofeedback sessions? (1- Not at all; 2- Maybe in
the future; 3- Yes, I'd be happy to continue)
3. Do you think the biofeedback sessions helped you? (1- Not at all; 2- A bit; 3-
Moderately; 4- Very much)
4. To what extent will you use the techniques you've learned? (1- Not at all; 2-
Sometimes; 3- Often)
5. In what ways do you think the biofeedback sessions have helped you? (Open
ended)
6. What were the good things about the training? (Open ended)
7. In what ways do you think the training could be improved? (Open ended)

3. *Post-treatment counselors' questionnaire*

- a) How many people live with the participant?
- b) How many social events does the participant attend per week?
- c) What is his/her daily independence level?
 - 1. Completely independent
 - 2. Needs some help
 - 3. Needs a lot of help
 - 4. Cannot function without my help
- d) How would you rate his/her relationship with their roommates?
 - 1. Great
 - 2. Very good
 - 3. Good
 - 4. Not good
- e) How would you rate the participant's relation to you?
 - 1. Great
 - 2. Very good
 - 3. Good
 - 4. Not good
- f) How many hours a week do you see the participant, on average?

4. Challenging Situations (completed by participants pre- and post-intervention)

“I will read off some situations that happen to people like you. Some of them may have happened to you, and some may not. I want to hear from you what you would do in such a situation.”

After reading each phrase, the interviewer begins by asking, “has something like this happened to you in the last 4 months/ since our last interview?” If yes, “What did you do?” If no, “What would you do if this happened to you?”

- a) Someone took from the personal food I bought for myself.
- b) I injured my foot while I was in the apartment
- c) A social activity or extra-curricular activity has been canceled.
- d) My roommate played really loud music
- e) My roommates laughed at me in the apartment