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Employees with Autism Spectrum Disorders in the Digitized Work Environment – Perspectives for the Future

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Abstract

The aim of this article is to examine the opportunities for employees with Autism Spectrum Disorders (ASD), arising from digital technology (DT) development. The author discusses assistive technology (AT) as a mean of creating a better work environment, making the digitized workplace more friendly for people with ASD. A possible solution of communication problems is replacing the interpersonal communication between employees with electronic (non-direct) forms of communication, such as online communicators or chatbots. Another solution is the implementation of wearable electronic systems, monitoring stress levels and facilitating effective stress control. In the future, the whole digitized workplace could be designed according to a “smart workplace” concept. Sensors recording various human body parameters could be connected to a network with sensors recording physical parameters of the work environment (temperature, humidity, noise, smell, sunlight exposure) and also with controllers of its values, adjusting it dynamically in order to reduce distracting factors. As a result, communication, stress management, and sensory sensitiveness problems could be limited, improving the work comfort of people with ASD, and their colleagues. The pertinence of solutions proposed was also confirmed by the experts interviewed in the field who were asked to assess it in the context of future implementation.

Employees with Autism Spectrum Disorders in the Digitized Work Environment

– Perspectives for the Future

There is no need to justify the importance of digital technology (DT) and the Internet in the contemporary world (Colbert, Yee, & George, 2016). More than half (55.1%) of humankind has access to the Web, with 95% in North America and over 85% in Europe (Internet Worlds Stats, 2018). It is widely used as a communication tool, an unlimited source of information, for entertainment and above all, for work. The Internet and DT very strongly influence both the workforce and the workplace. These digital technologies both create unprecedented possibilities to utilize the unique competencies of people with Autism Spectrum Disorders (ASD), as well as facilitate the development of assistive technology (AT) devices that can enhance the day-to-day functioning of individuals with ASD in the workplace.

The aim of this article is to examine the opportunities for employees with ASD, arising from digital technology development, and to discuss AT as a mean of creating a better work environment, making the digitized workplace more friendly for people with ASD.

The Digital Work Environment

Digital technologies with all their opportunities are shaping the architecture of the workplace, providing new technological possibilities of working and organizing the way we work. Similarly as was defined by Abbott (2007), the term digital technologies is used to describe the wide range of tools and resources that people might access both inside and outside the workplace. Digital technologies may be both hardware-based (computers, mobile devices as phones and tablets); or software-based (web applications, social networking spaces, chat sites). The term also comprises technologies such as virtual reality, Integrated Learning Systems and multimedia (Abbott, 2007). The digitized workplace requires more than just the

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3 use of certain hardware and software but also the need to adjust to other aspects of
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5 organizational practice (Othman & Teh, 2003). The impact of this development is mostly
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7 positive. Employees have almost unlimited access to information, collaborate with colleagues
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9 from all over the world and can deliver products with increasing capabilities at decreasing
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11 costs (Colbert et.al., 2016). Digital technology strongly influence employee behavior in the
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13 scope of, among other things, creativity and employee well-being (Van Knippenberg,
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15 Dahlander, Hass, & George, 2015), collaborative practices and the need for sensory and
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17 emotional engagement in the workplace (Gruber, Leon, George, & Thompson, 2015). It
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19 makes professional work much easier, facilitating the communication process, allowing new
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21 possibilities of virtual teamwork (Gilson, Maynard, Young, Vartiainen, & Hakonen, 2014),
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23 providing some new ideas and tools (e.g. networked mobile crowdsourcing tools; Sasao,
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25 Konomi, Arikawa, & Fujita, 2015). However, there are of course some disadvantages.
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27 Technology can cause information overload (Van Knippenberg et al., 2015) or can even
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29 potentially lead to labor exploitation (Fish, & Srinivasan, 2011). It also has a strong impact on
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31 nonwork life, blurring the boundaries between work and nonwork (Boswell & Olson-
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33 Buchanan, 2007; Butts, Becker, & Boswell, 2015; Ramarajan, & Reid, 2013). Nowadays,
34
35 there is no doubt that technology has a visible impact on organizations, work structure, and
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37 employees' competencies, identity development and patterns of relating (Colbert et al., 2016).
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39 There is a great deal of innovation occurring in human resource (HR) areas (Ulrich &
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41 Dulebohn, 2015), but there is definitely no doubt that the possible range of future innovation
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43 and development related to digital technology is almost unlimited.
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52 **A Workforce with Autism Spectrum Disorders**

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55 Among the digital workforce, there are also people with ASD. What is important,
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57 ASD comprises not only autism but also two other related disorders: Asperger Syndrome
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59 (AS) and pervasive developmental disorder-not otherwise specified (PDD-NOS; Hendricks,
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3 2010). ASD describes a set of developmental disorders including difficulties in interpersonal
4 communication and social reciprocity with unusual repetitive behavior (American Psychiatric
5 Association, 2013). There are some factors that strongly influence the position of those people
6 in the work environment. People with ASD have problems with social interaction (American
7 Psychiatric Association, 2013) and stress control (Tomczak et al., 2018). They also face some
8 difficulties during the communication process (both verbal and nonverbal communication)
9 and show repetitive and stereotyped patterns of behavior, interests and activities leading to
10 difficulties in development and maintenance of interpersonal relationships (Ikeda, Hinckson,
11 & Krageloh, 2014; Schroeder, Cappadocia, Bebko, Pepler, & Weiss, 2014).

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25 Adults with ASD are underrepresented in the workforce (Anderson et al., 2017;
26 Carter, Austin, & Trainor, 2012; Seaman & Cannella-Malone, 2016). They are disadvantaged
27 regarding employment, including those whose Intelligence Quotient (IQ) is in the range of
28 values for individuals with no cognitive deficits (Howlin & Moss, 2012) and struggle with
29 higher unemployment rate not only in relation to the general population but also in
30 comparison to adults with other disabilities (Ohl et al., 2017; Roux et al. 2013; Wagner,
31 Newman, Cameto, Garza, & Levine et al. 2005). According to some estimations, the
32 unemployment/underemployment rate for individuals on the autism spectrum is greater than
33 90% in the United States (Gerhardt & Lainer, 2011). Employment leads to social, emotional,
34 and mental health benefits (Burke, Andersen, Bowen, Howard, & Allen, 2010) and is
35 fundamental to the well-being of individuals, including those with ASD (Chen, Leader, Sung
36 & Leahy, 2015). The higher unemployment rate in this group has a negative impact not only
37 on their labor situation but also affects their social relationships, community integration and
38 general quality of life (Hendricks, 2010; Hendricks, & Wehman, 2009). Individuals with ASD
39 have the desire and ability to work, but there are still many obstructions that make
40 employment outcomes for this group very disappointing (Hendricks, 2010). One of the
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3 challenges faced by people with ASD is discrimination in the workplace. The discrimination
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5 is a result of stereotypes towards this group (e.g. being impolite, dangerous or rude; Hinshaw
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7 & Stier, 2008; Johnson & Joshi, 2014). The aforementioned research also showed that
8
9 understanding and expectations of people with ASD and employers are different. The
10
11 differences concern the type of workplace support required, job expectations, productivity
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13 requirements and more (Scott, Falkmer, Girdler, & Falkmer, 2015). People with disabilities
14
15 such as ASD, face workplace discrimination not only by the hiring decisions, but also in the
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17 field of performance expectation and performance evaluation (Run Ren, Paetzold, & Colella,
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19 2008). Furthermore, conducted research proved that disability is linked to lower than average
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21 payment, job security, training, and participation in decisions (Schur, Kruse, Blasi, & Blanck,
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23 2009).

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29 Despite this, people with ASD usually have a high interest in Information Technology
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31 (IT) and a broad understanding of the functioning of electronic devices, which can be
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33 considered as their advantage in the contemporary (digitized) workplace (Tomczak et al.,
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35 2018). They are also characterized by sensitivity to details and patterns resulting from
36
37 different cognitive styles (Morris, Begel, & Wiedermann, 2015) and as a result that
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39 characteristic can be successfully utilized in various work positions within computer science
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41 professions, as computer systems administrators, data analysts, software testers, IT systems
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43 administrators, website programmers or database designers. The selected competencies
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45 characteristic for the people with ASD and examples of its possible utilization are listed in
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50 Table 1.

51 52 53 **Disability as a Workforce Diversity Factor**

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56 Many researchers have taken into consideration workforce diversity as an important
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58 issue and focused on different dimensions of this phenomenon (i.e. age, race, gender, sexual
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3 orientation, culture and disability; Shore et al., 2009). Diversity is necessary for contemporary
4 organizations but does not only bring positive consequences as performance-increasing or
5 creativity improvement and innovation. Heterogeneity in teams can be also a reduction in
6 intra-group cohesiveness , and as a result can lead to misunderstandings and conflicts
7
8 (Roberge & Van Dick, 2010). This can be a serious difficulty, especially for workers with
9
10 ASD, having the social interaction, stress control and communication problems mentioned
11 above. People with disabilities are a growing group among workers, but in comparison to
12 other diversity factors, disability has received relatively little research attention (McLaughlin,
13 Bell, & Stringer, 2004). Most of the articles from that field (analyzing situation of people with
14 disabilities in the workplace) were primarily practitioner-oriented, and the number of
15 academic articles discussing disability considering human resources management (HRM)
16 issues was lower (Markoulli, Lee, Byington, & Felps, 2017).
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31 Theories related to the disability factor in the workplace represent various
32 perspectives, such as: medical, moral, social, and post-modernist. Some of them focus on
33 proposing variability in how people with disabilities deal with their work environment and
34 what their relations with coworkers are (Shore et.al., 2009). For example, Stone & Colella
35 (1996), presented a model of combined factors affecting the treatment of people with
36 disabilities in organizations, as personal characteristics, environmental factors, and
37 organizational characteristics. Other theories involve prejudice, stereotyping, discrimination
38 or stigma, and consider disability as problematic or even negative (Shore et.al, 2009). Of
39 course, different disabilities entail different attributions and stereotypes applying to
40 organizational treatment (Jones & Stone, 1995). For example, Weiner, Perry, & Magnusson
41 (1988) proved that physical stigmas elicited pity and a desire to help but mental-behavioral
42 stigmas elicited anger and a desire to neglect. Furthermore, job applicants with intellectual
43 disabilities were rated lower than individuals with physical disabilities. There was also a bias
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3 against them, especially when the job position was in close proximity to the decision maker
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5 (Premeaux, 2001). On the other hand, there are also theories suggesting the possibility of
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7 lower expectations towards people with disabilities in the workplace and the norm that they
8
9 should not receive negative treatment, even if their performance was poor (Colella, 1996;
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11 Colella et al., 1997).
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15 It is important to note that there are some HR strategies created in order to deal with
16
17 workforce diversity by stimulating a positive change of individuals, groups, and organizations
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19 (Kossek, Lobel, & Brown, 2006), but there are not so many strategies designed for
20
21 overcoming work barriers caused by the disability. Some of them provide various training
22
23 programs for employees, such as diversity training or training for people with disabilities and
24
25 dealing with co-worker resentment for overcoming individual barriers (Jones, 1997). Another
26
27 example of the strategy in order to foster positive effects of disability (in this case considered
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29 together with the age factor) and preventing the negative effects is based on three types of
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31 moderators. These moderators are leadership behavior, including health-focused leadership;
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33 organizational climate, including climate for inclusion and diversity and HR practices,
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35 including diversity-related HR practices and more individual-centered approach of
36
37 idiosyncratic deals (Boehm & Dwertmann, 2015). Some strategies are also designed for
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39 overcoming organizational barriers and based on 1) accommodation, 2) supervisor training, 3)
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41 mentoring/sponsoring programs (Jones, 1997). The most important strategy considering the
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43 problem which this article refers to is accommodation, which can be described as any
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45 reasonable adjustment in the workplace that allows the person to function at full ability
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47 (Americans with Disabilities Act, 1990). The work environment adjustments can be
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49 implemented by modifying equipment and devices and providing facilities usable and
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51 accessible by persons with disabilities (Jones, 1997), with use of assistive (or adaptive)
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53 technology which includes products or equipment that are used to maintain, increase or
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3 improve the functional capabilities of individuals with disabilities (O’Brolcháin & Gordijn,
4 2018). The assistive technology is used in order to maintain or improve an individual’s
5
6 functioning and independence, as well as to facilitate participation and to enhance overall
7
8 well-being (World Health Organization, 2019). So it can be also utilized in the work
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10 environment as well, eventually becoming important element of company’s diversity policy,
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12 making it more inclusive for individuals with ASD.
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18 According to previous research, the majority of the largest US companies have
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20 developed and implemented diversity policies. Fewer than half of them included people with
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22 disabilities in their diversity policy definition of a diverse workforce. A similar number of
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24 companies discussed diversity in a way that neither expressly included nor excluded people
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26 with disabilities from diversity policies. Furthermore, only about one in ten companies can be
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28 named as ”disability absent” as a result of excluding people with disabilities from their
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30 diversity policies, and consequently, from the diverse workplace itself (Ball, Monaco,
31
32 Schmeling, Schartz, & Blanck, 2005). Examples of companies focusing on recruiting
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34 employees with ASD (Wang, 2014), in the U.S. are Towers Watson, E-Y, Microsoft
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36 (Holland, 2016) and in Australia: Weir Minerals, Salesforce, Bankwest, Hewlett Packard
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38 (Jones, 2016). Furthermore, the company SAP implemented the ”Autism at Work” program,
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40 in order to integrate people with ASD into the company’s workforce, with the objective of
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42 making people with ASD 1% of its global workforce by 2020 (Pisano & Austin, 2016).
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44 Finally, Specialisterne, a Danish social innovator company set a ”gold standard” of
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46 neurodiversity, achieving a very high (75%) level of its employees diagnosed with ASD
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48 (Holland, 2016).
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54 55 **Challenges for the Future and Possible Implementations** 56 57 58 59 60

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3 Today, there is no doubt that digital technology development can stimulate positive
4 outcomes such as communication process facilitation or virtual teamwork, but one of the main
5 challenges for the future will also be utilizing it in order to facilitate or even enable the
6 individuals with disabilities to take up work. This problem will probably gain significance in
7 the near future because the number of children diagnosed with ASD has been increasing
8 significantly over the last twenty years (Moloney, 2010). Some predictions assume that 1 in
9 every 59 children aged 8 years in the United States may be suffering from this disorder (Baio,
10 Wiggins, & Christensen, 2018), therefore in the next years estimations show a significant
11 increase in the number of young people with ASD transitioning to adulthood (Hensel, 2017).
12 Some of them will surely try to enter the labor market, so there is a strong necessity of
13 providing tailored solutions in order to expand employment opportunities for them. This
14 situation can be considered not only as a matter of threat or danger but also as an opportunity
15 both for employees and employers. Better integration of adults with ASD into the workforce
16 will lead to more efficient use of the talents and abilities of this population for employers
17 (Hensel, 2017).
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38 **Overview of existing Assistive Technology in the workplace for individuals with ASD**

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41 For many years, research has been focused mostly on young children, school-age
42 children (Hurlbutt & Chalmers, 2004) or on young adults in their 20s and 30s, so the majority
43 of support systems and intervention programs available focus on early intervention for
44 individuals on the autism spectrum (Neely & Hunter, 2014; Stevenson & Correa, 2018). As a
45 result, a system of electronic sensors network to measure physiological parameters associated
46 with emotional state changes for fostering behavioral therapy of children with ASD was
47 developed (Jędrzejewska-Szczerska, Karpienko, & Landowska, 2015; Landowska,
48 Karpienko, Wróbel, & Jędrzejewska-Szczerska, 2014) and also other solutions supporting
49 children with ASD in the classroom (Fage et al., 2018, Roldán-Álvarez, Gomez, Márquez-
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3 Fernández, Martín, & Montoro, 2016) or during typical routines (Alabbas & Miller, 2019).
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5 People with ASD in mid-to-late adulthood were neglected as a research subject (Edwards,
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7 Watkins, Lotfizadeh, & Poling, 2012; Howlin & Moss, 2012), especially considering the labor
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9 activity perspective and there is almost no research examining the position of tech workers
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11 with ASD (Morris, Begel, & Wiedermann, 2015). As a result, there are only a few tools
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13 addressed to adults with ASD, such as an iPhone application used for teaching targeted social-
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15 vocational skills (Burke et. al., 2010) or DT-mediated intervention composed of web
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17 interface, mobile application and LED lighting system for living skills enhancement (Pérez-
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19 Fuster, Sevilla, & Herrera, 2019). There were also some training programs using technology
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21 including an employment support training program for young adults with ASD, using selected
22
23 iPad applications in order to help them with organization, scheduling and social interaction
24
25 (Hill, Belcher, Brigman, Renner, & Stephens, 2013). Internet-based and virtual reality-based
26
27 training programs for social skills relevant for job searching and job interviews (Smith et al.,
28
29 2014; Strickland, Coles, & Southern, 2013) and other work-related behavior trainings using
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31 video modeling and audio cuing (Allen, Burke, Howard, Wallace, & Bowen, 2012; Kellems
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33 & Morningstar, 2012; Van Laarhoven et al., 2012). Nowadays, utilized technical devices as a
34
35 primary medium of intervention limit to such examples as: personal data assistants (PDA's),
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37 tablets, iPhones, iPods, pagers, laptops, computer-assisted instructions (CAI), DVD's, radio
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39 and headsets (McDonald & Machalicek, 2013; Walsh, Holloway, McCoy, & Lydon, 2017).
40
41 However, potentially, the opportunities for adult people with mental disorders created by such
42
43 technological solutions are still very promising. All forms of electronic communication
44
45 provide new potential possibilities for people with ASD, such as gaining or expanding the
46
47 level of education through mobile learning (Ismaili & Ouazzani Ibrahim, 2016). These
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49 solutions should not only be limited to providing a possibility of "wired-working" in the place
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51 of residence but most of all should create an opportunity for people with ASD to take a job
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3 successfully and then facilitate their work performance. The use of technology on increasing
4 employment outcomes of individuals with ASD is considered as one of the key
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6 recommendations for further research (Walsh, Holloway, McCoy, & Lydon, 2017; Wehman
7
8 et. al., 2014). The subject has not been widely taken as a research problem, so the author of
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10 this article has noted the potential benefits of using IT to facilitate joining the workforce and
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12 increasing the employment level among adults with ASD.
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18 Stereotypically, as mentioned before, ASD employees are considered less attractive
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20 and potentially problematic. Providing some accommodation and changes in the workplace
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22 layout as well as reorganizing the communication modes is very desired and beneficial but
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24 certainly is not sufficient (Morris et.al, 2015). There is a need to provide some specific
25
26 solutions tailored to ASD employees: 1) Wider usage of electronic mediated forms of
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28 communicating fostering interpersonal communication and based on non-direct and non-
29
30 verbal contact. 2) Promoting solutions focusing on stress monitoring and as a result,
31
32 facilitating stress control, exposure of feelings and emotions for improving work efficiency,
33
34 better group integration, and team building. 3) Reduction of oppressive and distracting
35
36 factors, like temperature, humidity, noise, smell, sunlight exposure by ambient environment
37
38 parameters control based on "smart workplace concept". Below, there are a few proposals of
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40 possible specific AT tools implementations, tailored for people with ASD in the work activity
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42 context (Table 2).
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48 **Communication Process Facilitation**

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51 Autism is a disorder which causes various problems in the communication of feelings,
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53 making social interactions and integration of sensual impressions. People with ASD are not
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55 able to understand abstract contents or have strong limitations in this field. They face
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57 problems with interpreting thoughts, feelings, and body language understanding. On the other
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3 hand, their spoken language can also be difficult to understand. Facial expressions,
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5 movement, and gestures rarely follow the words and the tone of the voice do not reflect
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7 feelings. Additionally, lack of eye contact with the interlocutor makes social interaction more
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9 difficult or even impossible. As a result, all that was mentioned above make effective social
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11 communication impossible for those people. It seems that the ideal solution of this problem is
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13 replacing the interpersonal communication between employees with electronic forms of
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15 communication, like e-mail, online communicators, discussion chats, chatbots, discussion
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17 forums or other IT solutions dedicated to management and communication of employees. This
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19 non-direct form of communication is much easier for people with ASD because it doesn't
20
21 require eye contact and body language interpreting. The importance of this issue will probably
22
23 increase because of a general dissemination of technologically mediated communication
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25 among neurotypical employees, which results in difficulties in recognizing nonverbal emotion
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27 cues or even potentially lead to a possibility of declining levels of empathy (Colbert et.al.,
28
29 2016). What is important, this will affect both neurodiverse and neurotypical employees, but
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31 it seems there is a unique chance for people with ASD. Wider usage of textual communication
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33 can impact the work life of these people very strongly but it is surely not enough.
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40 **Stress Monitoring for Stress Management**

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44 Another important issue considering supporting solutions for employees with ASD is
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46 efficient stress level monitoring and as a result, facilitating stress control what can positively
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48 influence interpersonal relations with associates. A stressful situation in the workplace can be
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50 indicated by a change in physical factors, as it was proposed by Han et al. (2017). There are
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52 many wearable and non-wearable sensing devices for stress recognition developed for the
53
54 general population. Most wearable devices use chest belt sensors or wrist band sensors
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56 measuring various human body physiological parameters - skin resistance, pulse or
57
58 temperature, and are usually connected with smartphones by a dedicated application. There
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3 are also devices tailored for a specific group (e.g. for people suffering from epilepsy). These
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5 are popular Empatica products, such as "E4"(Empatica, 2019a), or its developed version
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7 "Embrace2" (Empatica, 2019b), which are wristbands with sensors in order to predict
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9 epilepsy attacks. There are also smartphone applications for stress recognition and stress
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11 management using built-in smartphone sensors only. Unfortunately, most of these
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13 applications follow only the common approach of asking and providing a textual description
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15 on the ways of dealing with negative consequences of stress, and few of them provide the
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17 additional possibility of tracking the behavior related to negative affect of stress (Muaremi,
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19 Arnrich, & Tröster, 2013).
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25 All of the solutions presented above haven't been developed specifically for people
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27 with ASD so they don't cover all the needs and don't fulfill all the expectations. Stress
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29 detection for employees with ASD can be executed by similar parameters as listed above: skin
30
31 resistance, pulse, temperature (Jędrzejewska-Szczerska, Karpienko, & Landowska, 2015) but
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33 definitely should be notified in a real time by a dedicated smartphone application for more
34
35 accurate stress recognition and as a result making controlling it more efficient. To make the
36
37 device as discreet as possible, as well as comfortable for the user, the best place of locating
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39 the sensors is the wrist (Tomczak et al., 2018), and the shape and size of the wrist-worn
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41 device can be similar to the smartwatch/wristwatch. The system should also allow to generate
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43 reports of stressful situations occurrence.
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48 **Oppressive and Distracting Factors Reduction**

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51 We can even move a few more steps forward in our futuristic considerations and
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53 discuss combining the stress level measurement with a set of sensors networked to controllers
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55 dynamically customizing ambient environment parameters in order to reduce the effect of
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57 sensory sensitiveness that people with ASD have to deal with. We could imagine that readings
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3 from the wearable sensors which ASD employees are using could be connected with a
4 network of sensors recording various of other physical parameters (such as temperature,
5 humidity, noise, smell or sunlight exposure) in the office environment and also with the
6 controllers of its values. As a result, on a pattern of “smart home” (Chan, Esteve, Escriba, &
7 Campo, 2008; Stefanov & Bien, 2004), a ”smart workplace” (Kbar & Aly, 2014) or ”smart
8 office” (Alberdi, Aztiria, Basarab, & Cook, 2018) could be developed , making the work
9 environment more inclusive and more accessible for people with ASD (Wille & Sajous-
10 Brady, 2018). The distracting or oppressive factors like ambient temperature, noise or sunlight
11 exposure level influencing the increase of stress level among people with ASD could be
12 eliminated immediately, improving the work comfort of such people.
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27 **The experts’ assessment**

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30 Given the importance of AT for individuals with ASD work performance and to
31 deepen the analysis, a qualitative study was conducted (Silverman 2016; Creswell, 2012). Due
32 to the qualitative perspective of research, no preliminary hypotheses were set. The solutions
33 proposed above were presented to the experts in the examined field who were asked to assess
34 its pertinence in the context of future implementation. The opinions were gathered from
35 individuals whose day-to-day tasks include work and cooperation with people with
36 neurodiversity. The experts were selected as the respondents deliberately because of their
37 broad field experience and proficiency in identifying the needs and limitations of individuals
38 with ASD. Interviews were conducted in April and May 2019 with a group of 11 people (10
39 women and 1 man) who professionally handle education and care of people with ASD.
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41 Among the interviewed, there were: the principal of a special education school, his deputy, six
42 teachers and therapists of special education working with young adults, psychologist, the
43 president of a non-governmental organization supporting individuals with ASD and
44 additionally a parent of an adult individual with ASD. Due to the preliminary character of
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3 research, no individuals with ASD were included in the research sample. The aim of an author
4 was to propose a set of possible tailored AT solutions, then discuss it with experts, and later
5 on, to test these solutions by people with ASD in the real work environment. According to the
6 author's knowledge, so far such tailored AT solutions based on digital technology are not
7 available in the contemporary workplace yet, so there is no possibility to discuss it with real
8 users with ASD. An open interview technique was used, based on a list of loosely formulated
9 questions/problems, as described by Kvale (2007). Those interviewed were asked to share
10 their opinions about AT solutions which were presented above covering three fields of
11 assistance: communication process facilitation, stress monitoring for stress management, and
12 oppressive and distracting factors reduction.
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27 The results of expert interviews showed that the solutions proposed actually meet the
28 expectations and possibly should fulfil the needs of the group addressed. All the interviewed
29 respondents agreed that non-verbal communication process promotes expressing of feelings
30 and emotions for individuals with ASD, as well as showing their expectations. According to
31 the respondent's opinions, this type of communication would be even more beneficial when
32 besides the textual communication, also other graphical forms as emoticons or pictograms
33 were used. But the general assumption was that the usage of electronic mediated forms of
34 communicating based on non-direct and non-verbal contact should be also accompanied by
35 training programs for neurotypical employees in order to educate them and make them
36 familiar with specific needs and behaviors of their colleagues with ASD. One of interviewed
37 experts emphasized that non-verbal communicators also have the potential to be utilized as
38 time management facilitators (e.g. by displaying in advance upcoming tasks within the work
39 plan), becoming another factor influencing the improvement of work performance.
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56 Furthermore, one of respondents pointed out the limitation of communication facilitators
57 described above. In her opinion, the online communicators do not fit for all the people with
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3 ASD, and are only limited to high-functioning individuals, who will be able to overcome own
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5 deficits.
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8 Discussing the stress monitoring devices for stress management, all experts
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10 interviewed perceived this concept as very important but also pointed out the strong need of
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12 adjusting the ways of stress-reducing according to individual needs. After stress level increase
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14 detection, the AT user should start the procedure of effective stress reduction which is the
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16 most appropriate for his or her individual needs. For some, it can be some physical activities
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18 like walking, jumping or using the anti-stress objects (e.g. ball, for others listening to music or
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20 breath stabilization). As a result, similarly as for facilitating the communication process, the
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22 wearable device usage should be preceded by appropriate training of effective stress reduction
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24 techniques for a single user. What is worth emphasizing is that some of the interviewed
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26 experts declared that for some individuals with a high level of sensory sensitiveness the wrist-
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28 worn device can be disturbing and even become a stress increase factor itself.
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34 Moving to oppressive and distracting factors reduction, all the respondents confirmed
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36 the importance of work environment customizing according to the individual needs of every
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38 employee. A few examples of stressors counteracts were mentioned during the interviews:
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40 reducing the number of objects in surroundings, providing a certain type of background
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42 music, changing the character of lighting, or even providing the possibility to leave the work
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44 station and spend several minutes in a separate soundproof room to calm down. The character
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46 of counteractions should be subordinated to the individual needs. Only one of the respondents
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48 had a few doubts, and recommended caution while implementing such adjustments, in order
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50 to prevent isolating people with ASD from the other group members and not to create
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52 a security umbrella over them.
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3 The best summary of great importance and necessity of implementing the solutions
4 similar to these presented above can be a statement of one of the respondents quoted below:
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8 *“The most important thing is the workplace integration should be not only*
9 *with a name, but with actual parallel functioning of neurodiverse, and*
10 *neurotypical individuals within the shared work environment”.*
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16 It is a very long and difficult process, so surely it is worth profiting from the newest
17 technological development achievements. Nowadays, the use of assistive technology should
18 be considered not only as a facilitator of the digitized workplace integration for people with
19 ASD, but as a necessary condition of this process.
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26 **Discussion and Limitations**

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29 There are of course some limitations in the use of assistive solutions presented above.
30 Firstly, the newest technological inventions are usually expensive and as a result, some
31 potential users may be excluded from using it. As a counteraction, governmental funds can be
32 supportive to make the devices more accessible (public funding programs, tax waivers
33 programs) and also by providing promotion actions (social campaigns encouraging employers
34 to participate in costs). On the other hand, luckily, due to a decrease in cost, technology has
35 become more accessible in recent years, both for general use, and for people with disabilities
36 (Seaman & Cannella-Malone, 2016). Secondly, there is a risk of stigmatization of employees
37 with ASD as AT users as a result of the social habit of rejecting individuals with disabilities
38 based on their ties with the technology products (Silvers, 2011). To avoid this risk, AT
39 developers need to focus on designing the devices to make them as discreet as possible. At the
40 same time, adapting already existing technologies for assistive purposes (e.g. smartphones,
41 tablets; O’Brolcháin & Gordijn, 2018) in order to diminish potential stigma (Parette &
42 Scherer, 2004). The major advantages of mobile devices as smartphones and tablets are that
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3 they are portable, can take/record, store and display pictures and videos, have become more
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5 and more affordable and accessible, and can be successfully used by people of different ages
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7 and cognitive abilities requiring different levels of support (Pérez-Fuster, Sevilla, & Herrera,
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9 2019). Thirdly, another difficulty which may occur during the AT implementation process is
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11 the possibility of refusal or reluctance to use them (O’Brolcháin & Gordijn, 2018). However,
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13 it is worth believing that people with ASD will be able to consciously decide to use assistive
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15 technology. The perspective of possible improvement in their work comfort, work
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17 performance and as a result, in their labor market situation, should be sufficient motivation for
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19 this group to use the solutions and devices described above. Finally, what was also
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21 emphasized by interlocutors during the interviews, all the AT devices should be also preceded
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23 by tailored training programs both for neurodiverse employees as final users, as well as for
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25 their neurotypical colleagues. Support for individuals with ASD should also include
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27 interventions targeting inclusive organizational cultures with diversity climate, together with
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29 employing leaders with transformational qualities (Hayward, McVilly, & Stokes, 2019). It
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31 seems to be an important condition of successful implementation of such solutions.
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38 Work activity as an element of rehabilitation and a part of the process of social integration is
39
40 an undeniable benefit for both individuals with ASD and the whole society. There are also
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42 significant benefits for employers and organizations, such as the possibility to utilize the
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44 unique competencies of people with ASD, and creating the positive and inclusive image of the
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46 company as an element of Corporate Social Responsibility (CSR) and Employer Branding
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48 (EB).
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53 The author is aware of a fact that solutions presented in this preliminary study, and
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55 designed to support adults with ASD in the workplace, need surely to be tested further in a
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57 real working environment on people with ASD.
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Conclusion

A diverse workforce, and also diverse by disabilities such as ASD, is a reflection of a changing world. Most workplaces are made up of diversity, so there is no doubt that organizations need to learn how to adapt to be successful (Green et al., 2002). Wide usage of assistive technology for employees with ASD can become an important element of companies' diversity policies. Considering the dynamic changes of contemporary digitized workforce and workplace, this problem will gain in significance. Paradoxically, the digitized economy and technological development can provide a tremendous opportunity for workers with ASD by creating a better work environment, taking advantage of their strengths and fostering dealing with their limitations. Even today it is possible to, among other things, adjust the communication process in organizations to the needs of people with ASD by providing wider use of electronic mediated forms of communicating based on non-direct and non-verbal contact. In the near future, it will be also possible to design and implement substantial AT solutions like multi-sensor based stress level measurement and notification combined with a network of sensors and controllers dynamically customizing ambient environment parameters.

Finally, the digitized workplace of the future can become more friendly for employees with ASD, which of course will be beneficial not only for them but also for their colleagues, the HR managers, the employers, whole organizations and the labor market in general. The question is, if this opportunity will be created or not, and surely needs to be examined by further research.

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Preprint Review Only

Table 1

Selected Competencies of People with ASD Useful in Work Activity Context and Exemplary Fields of Utilizing It in the Digitized Workplace

The competencies of people with ASD useful in work activity context	Exemplary fields of utilizing the competencies of people with ASD in digitized workplace
Data analyzing	Database administration
Information cataloging	Database design
The need of order and predictability	IT systems administration
Scrupulosity, sensitivity for details	Software development
Reflection towards patterns	Computer systems administration Web administration
Long-term recurrent tasks performing and tolerance for monotonous actions	Software testing

Note: Own study.

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Table 2

Proposed Solutions of Assistive Technology Devices Usage Facilitating Integration into the Work Environment for People with ASD

The character of obstacle/limitation	Solution proposed	Estimated results
Communication and interpersonal relations difficulties	Wider use of electronic mediated forms of communicating based on non-direct and non-verbal contact (e.g. e-mail, online communicators, chats, discussion forums, chatbots)	Communication process facilitation. Interpersonal conflict reduction
Stress management and emotion control difficulties	Multi-sensor based stress level measurement (e.g. skin resistance, pulse, temperature). Stress level increase up to date notification by dedicated mobile device application	Stress management facilitation. Interpersonal conflict reduction
Sensory sensitiveness	Stress level measurement combined with a network of sensors and controllers dynamically customizing ambient environment parameters (e.g. temperature, humidity, noise, smell, sunlight exposure)	Oppressive and distracting factors reduction. Work comfort and work performance level increase

Note: Own study.