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Interpersonal distance theory of autism and its implication for cognitive assessment, therapy, and daily life

Running head: Interpersonal distance theory of autism

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Abstract

The interpersonal distance theory provides a novel approach to studying autism spectrum disorder (ASD). In this manuscript, we present recent findings on the neurobiological underpinnings of interpersonal distance (IPD) regulation that are distinct in individuals with ASD. We also discuss the potential influence of environmental factors on IPD.We suggest that different IPD regulation may have implications for cognitive performance in experimental and diagnostic settings, may influence the effectiveness of training and therapy, and may play a role in the typical forms of social communication and leisure activities chosen by autistic individuals. We argue that reconsidering the results of ASD research through the lens of interpersonal distance would lead to a different interpretation of previous findings. Finally, we propose a methodological approach to study this phenomenon systematically.

Keywords: autism, autism spectrum disorder, interpersonal distance, amygdala, cognitive function, gamification

Introduction

Imagine a situation where people are traveling together in an elevator. They avoid eye contact, their gesticulation is stiff and constrained, while most of them either travel in silence or start a conversation about a strange topic. If experts in autism diagnostics were to observe our imaginary passengers, they would notice behavioural traits that could be reminiscent of autism spectrum disorder (ASD). However, if the same group of neurotypical people was to interact in the kitchen of the office or at a cocktail party (with enough space to stand at a comfortable distance or move away if necessary), they probably would have a good time by having small talk, sharing stories while gesticulating vigorously, expressing vivid emotions, and looking into each other's eyes. It is unlikely that the observed individuals had suddenly lost their social-communication competence in the elevator. Although many other elements of cultural norms influence whether we initiate a conversation in certain situations (e.g., people's lack of prior acquaintance or reason to interact), which cannot be completely ruled out as explanations for this phenomenon, it has given us an idea to think about the impact of interpersonal distance on social and cognitive functioning. We believe that interpersonal distance (IPD) is a simple but crucial element of social interactions in real-life situations that influences how effectively we can use our skills and strengths. The extent to which this effect is observed and the preferred size of interpersonal distance varies between individuals, and we believe that people with ASD are more affected than neurotypicals; however, a systematic examination is needed to exlplore the role of IPD in social interactions and this affects people with ASD compared to neurotypicals in future studies.

Neurobiology and neurodevelopment of distance regulation

Interpersonal distance is modulated by many external and internal factors and its regulation can be altered or impaired in several conditions (Kennedy et al., 2009; Candini et al., 2021). Functional brain imaging studies revealed a different pattern of brain activity and connectivity in ASD and neurotypical individuals when measuring interpersonal distance (Massaccesi et al., 2021; Perry et al., 2015). In neurotypicals, the neural activation of the dorsal intraparietal sulcus, prefrontal- and orbitofrontal cortices, ventral premotor- and somatosensory cortex, and amygdala may play a role in IPD during computerized versions of stop-distance paradigm (participants are instructed to stop or tell the experimenter to stop at a preferred distance) and comfortable interpersonal distance task (participants are instructed to indicate the most comfortable distance as someone approaches them from the perimeter of a circle) (Huang & Izumi, 2021). Besides neural activity, functional connectivity was also measured. In certain studies primarily involving healthy participants, significant connectivity was found during interpersonal distance tasks among the dorsal intraparietal sulcus (DIPS), the ventral premotor cortex, the dorsal striatum, and, in the case of social stimuli, the midbrain, the premotor cortex, and the right dorsolateral prefrontal cortex (Holt et al., 2014). In ASD, Massaccesi et al. (2021) found not only reduced activity in parietal and visual regions in parallel with observed elevated discomfort in an interpersonal space task but the dysregulation of effective connectivity between the amygdala and the dorsal intraparietal sulcus and the face fusiform area (FFA). They argue that the dysregulation of this network might prevent information integration (Massaccesi et al., 2021). Amygdala is important in signaling the motivational relevance of spatial information, and in integration with the spatial attention network, forming a salience map directing attention (Egner et al., 2008). In ASD, the increased effective connectivity from the amygdala to DIPS and FFA, and decreased connectivity from DIPS to the amygdala were associated with higher discomfort that might reflect an elevated perceived saliency. They speculate that the different effective functional connectivity emphasizes differently the relevance of spatial (where) and visual (what) information in ASD, and they compensate for the perceived discomfort by keeping a greater interpersonal distance (Massaccesi et al., 2021).

The amygdala is a complex subcortical structure, a hub of distinct neuronal networks. It contributes not just to emotional valence, salience, and reward processing but it plays an important role in social learning and other cognitive functions by assigning attention and coordination of top-down and bottom-up processes (Hennessey et al., 2018, Janacsek et al., 2022). Besides its above-mentioned functions, the amygdala is a crucial area in IPD, as it is involved in emotion and face processing, it plays a role in avoidant behaviour through the regulation of arousal, all of which are essential in social situations. It is difficult to map its specific dysfunction in ASD. We know, however, that the amygdala and its connections with other distinct brain areas develop throughout the lifespan, but its development is altered in ASD (Stanfield et al., 2008). Studies showed amygdala enlargement in early childhood in ASD, which decreased or reversed in adolescence (Barnea-Goraly et al., 2014; Schumann et al., 2009). The change in size might be a consequence of the amount of social interactions, so it could be a potential biomarker of the effectiveness of therapeutic interventions (Hennessey et al., 2018; Zalla & Sperduti, 2013). Furthermore, neuroimaging studies found increased amygdala activation during face-processing experiments (Tottenham et al., 2014), and reduced habituation of the amygdala in ASD (Kleinhans et al., 2009). The over-responsivity, hyperreactivity, and consequent hyperarousal might contribute to social avoidance and support the developmental model of hyperactivity-induced excitotoxic changes (Nacewicz et al., 2006). Decreased habituation to social stimuli can lead to difficulty discriminating salient stimuli, especially in social situations (Kleinhans et al., 2009).

Overall, altered activation of the amygdala and related functional networks in ASD might contribute to (social) dysfunction in two ways: 1) The functional connectivity differences can lead to higher discomfort in shorter interpersonal distances, 2) and decreased habituation of amygdala leads to the maintenance of hyperarousal and directs attention to social stimuli for longer than necessary. We argue that the effect of amygdala dysfunction on social cognition and behaviour might be overwhelming for people with ASD and withdraw valuable resources from other cognitive processes during social interactions. If we measure the intellectual and cognitive performance of people with autism spectrum disorder in person with the experimenter, there is a risk that we get inaccurate, unreliable results.

Altered interpersonal distance regulation as a response to adverse environmental stimuli

The phenomenon described above may be the result of atypical neurodevelopment, but we cannot rule out the possibility that environmental factors and early life experiences also have an impact on interpersonal distance. Unfortunately, adverse childhood experiences or traumatic events are common in ASD (Kerns et al., 2015; Ng-Cordell et al., 2022). Due to difficulties in social communication, autistic children often become victims of bullying or abuse (Haruvi-Lamdan et al. 2018). Furthermore, due to sensory hypersensitivity, tactile or olfactory stimuli that are normal for others may be unpleasant or uncomfortable for them (Wood et al., 2021). One possible coping strategy is disengaging with trauma, which can be manifested in social withdrawal, problem avoidance, self-protective behaviour, emotional avoidance, learned helplessness, or wishful thinking (Ng-Cordell et al., 2022). These factors might lead to a greater preferred physical distance. However, engaging with traumatic events or maladaptive self-regulatory strategies such as emotional outbursts with aggressive behaviour, or sensory-seeking behaviour (if touch or tactile stimuli are pleasant) might result in even closer but inappropriate physical proximity. At the same time, aggressive behaviour, or undesirable physical contact, could indirectly lead to feelings of rejection and isolation through avoiding other people in their environment. Distancing initiated by either the autistic person or the other person might lead to fewer positive interpersonal proximity experiences, which could hinder the acquisition of other social skills.

In order to have the appropriate attitude towards children with autism, it would be critical to understand the origin of atypical IPD preferences. Mothers of autistic individuals often report that they had the impression that their autistic child was different, resistant, or even distant. Besides this anecdotal evidence, a prospective study found that infants with a high likelihood of ASD and insecure-resistant attachment were over nine times more likely to be diagnosed later with ASD than those with a high likelihood but secure attachment by assessing attachment style at an early age (15 months) (Martin et al., 2020). However, this result does not provide evidence as to whether atypical IPD was also present in autistic infants, or whether it develops as a result of negative experiences. It is also possible that neurobiological and environmental factors are not independent but enhances each other's adverse effect on interpersonal distance regulation. It would be in line with the concept of autism as a condition of generalized imbalance in adaptation (Gernert et al., 2020). To understand this relationship in more depth in terms of interpersonal distance, anamnestic information about traumatic experiences, moreover, longitudinal studies are needed.

In this paper, we want to highlight the importance of cross-sectional studies to measure 1) whether there is a disturbance in interpersonal distance regulation in autism and 2) how it affects performance in other areas, especially cognitive functioning. As ASD is a highly diverse and heterogeneous condition, it is likely that individuals will be affected to different degrees. Some people with ASD may be perfectly comfortable with a closer personal distance, while others may prefer a greater distance. We argue that during the systematic cognitive and/or psychological assessment of autistic people, it is necessary to consider the interpersonal distance at which the study is conducted.

Results of behavioural measures of interpersonal distance in autism spectrum disorder

The underlying neural processes are challenging to study in ecologically valid settings at the moment. Neuroimaging and electrophysiological studies are capable of examining only the cognitive component but, unfortunately, cannot reflect on the kinetic component of interpersonal distance regulation. There are only a handful of studies measuring the preferred interpersonal distance in autism in a real physical environment. Greater interpersonal distance (lower permeability of personal space) and/or altered flexibility of its regulation has been found in most of the studies (Candini et al., 2017, 2020; Farkas et al., 2023; Gessaroli et al., 2013; Kennedy & Adolphs, 2014; Perry et al., 2015), only one study from Japan found reduced personal space in autism (Asada et al., 2016) which raises the possibility of cultural effects on interpersonal distance regulation. In summary, not only do neuroimaging studies suggest altered neural activation in ASD, but behavioural studies also show that interpersonal distance and/or its regulation are different in autism.

Cognitive functions and distancing in ASD

As the concept of autism has evolved over the past decades, so has the extent to which cognitive dysfunction (including executive functions) can be considered specific to it (Hill, 2004; Ozonoff et al., 1991; Ozonoff & McEvoy, 1994; Demetriou et al., 2019; Friedman & Sterling, 2019; Ozonoff & Provencal, 2007; Zhang et al., 2020). Accurate and reliable measurement of the cognitive profile of individuals with autism is critical to the clinical diagnosis, treatments, and therapy, and in educational settings. However, the measurement may not be reliable and accurate without the consideration of the distance between the investigator and the autistic individual. Previous research does not report this data, even though it might significantly affect cognitive performance. Weismer et al. (2018) found that deficits in executive functions (e.g., shifting, inhibition, working memory update) diminished after controlling for social communication characteristics; they assumed that difficulties in verbal communication and the verbal instructions might result in task impurity. Participants matching criteria are not uniform across studies (age vs. nonverbal IQ, or language level), which can be problematic, especially in studies involving children; and finally, social interaction with the experimenter might have an impact on performance, which is eliminated in computerized measurements (Weismer et al., 2018). A systematic review on executive control in ASD showed that impaired executive control, planning, or cognitive flexibility on both the Wisconsin Card Sorting Test and tower tasks are attenuated with computer administration.

These findings suggest that dealing with social feedback and rules is difficult for individuals with autism (Kenworthy et al., 2008). A recent meta-analysis studied the characteristics of executive dysfunction in ASD. They found overall robust group differences between neurotypical and autistic participants assessing a wide range of potential mediators, however, the effect size was reduced after excluding the self-report/questionnaire data (Demetriou, 2018). They also find an attenuating effect on executive dysfunction of the computerized assessment format overall and on concept formation and response inhibition subdomains (Demetriou, 2018). Since different conditions might result in various outcomes, it is important to take results from many scenarios into account in order to accurately quantify executive functions in autism.

The IPD theory proposes that preferred interpersonal distance in ASD is a key aspect that needs to be considered. We think that the change in perceived group differences is not only due to the more predictable, standardized form, and the visual instructions in computerized tests, but also the greater distance from the experimenter in these situations. As the information on this parameter is not available in most of the previous studies, it is not possible to systematically investigate the already existing studies on the effect of interpersonal distance with meta-analyses. In the future, studies with experimental distance manipulations are warranted to address this issue.

Technology-based interventions provide comfortable interpersonal distance

Cognitive training and cognitive remediation

Based on our IPD theory, technology-based interventions could help improve skills in autism and other neurodevelopmental syndromes. When using computer-based remote solutions, the interpersonal distance is certainly large enough to ensure that existing competences are available to achieve the right performance. The benefits of computerized solutions are obvious in many areas, but can this approach work in situations that were previously explicitly human-assisted, such as education, skills development, and therapy? Systematic reviews and meta-analyses found technology-based interventions (via a desktop computer, interactive DVD, shared active surface, and virtual reality) overall effective in ASD to improve social and communication skills; however, the results on generalizability and maintenance of the effect, or improvement on standardized tests remain controversial (DiGennaro Reed et al., 2011; Grynszpan et al., 2014; Ramdoss et al., 2011; Wainer & Ingersoll, 2011).

In a recent review, Pasqualatto et al. (2021) examined the effect of cognitive training programs on executive functions, comparing the computerized and non-computerized interventions in ASD. Non-computerized training had positive effects on executive functions (shifting, flexibility, and problem-solving) when delivered at home or school (ecologically valid) environment, while cognitive remediation contributed to the improvement of working memory and verbal fluency. In the case of computerized training attention (divided and sustained), working memory and inhibition control improved more among participants than in the control group. However, without human interaction, the improvement of executive functions seemed to be less generalizable to other (e.g. social and communication) skills (Pasqualotto et al., 2021). Yet, the benefits of digital technology are not negligible. Computerized methods are more predictable, and offer clearly defined and often visually supported instructions or visual or auditory feedback. The setting decreases sensory stimulation, requires less social interaction, and provides self-paced application. Moreover, in line with our theory, they provide comfortable enough interpersonal distance. All the above can help reduce experienced stress and arousal, providing the best learning environment and cognitive performance (A. Murray et al., 2021; D. Murray, 2011; Pasqualotto et al., 2021).

Gamification and gaming culture

In line with computerized cognitive training, IPD theory promotes gamification to support treatments by providing a large enough distance. Computers, computational tools, and gamification have become increasingly widespread to support treatments of a wide variety of diseases. Recently, mental health professionals have also started to contribute to the development of gamified tools for ASD. The aim of these experiments is to make certain that therapeutic or skill-training elements are playful while providing a good gaming experience. Games would provide a safe environment for facilitating collaboration and social interactions (e.g. Benton et al., 2012; Parsons et al., 2004; Whalen et al., 2010), the gamification of classical therapeutic elements, however, is not engaging enough yet (Malinverni et al., 2017), and their applicability is limited (Ben-Sasson et al., 2013; Marwecki et al., 2013). However, the development of video games and virtual reality environments to improve social communication and other skills is becoming increasingly popular (e.g., Kim et al., 2020; Terlouw et al., 2020, 2021); for a recent review see: Atherton & Cross, 2021).

Children, adolescents, and adults with ASD have a well-developed gaming culture in an extensive range of computer or video games (Mazurek & Engelhardt, 2013), however, their preferences and habits are different from neurotypical peers (Craig et al., 2017; A. Murray et al., 2021). They perceive the benefits of computer-mediated communication, but they use it in specific ways (Gillespie-Lynch et al., 2014). An ethnographic case study of three children with ASD has shown that social interactions in online multiplayer games, such as sharing information, making requests, communicating rules, maintaining engagement, or using, interpreting, and mirroring gestures in virtual spaces might support their capacity to initiate and sustain social interactions in physical spaces (Stone et al., 2019). Another interesting exploratory case study used a multiplayer online role-playing game to explore the emotional awareness and expression skills of five young adult participants with ASD. The authors suggest that advancements in virtual environments might help with social skill development in the future (Gallup & Serianni, 2017). A semi-structured interview with three adolescents and young adults with ASD revealed that participants perceived the virtual platform of video games as a safe environment and an increased level of comfort and self-awareness. However, children with ASD tend to play more role-playing games rather than first-person shooting games, avoiding the sensory overload of fast-paced, audio-visually intense, and psychological arousal enhancer, violent games (Mazurek & Engelhardt, 2013). By avoiding the unpredictable and anxiety-provoking face-to-face interactions of the physical world, they could cooperate, develop conversations, and even maintain relationships from a distance (Gallup et al., 2016). These findings support our hypothesis that the impairments in the functioning of people with ASD are not solely due to a lack of competence, but also to the overwhelming and suboptimal environment in which their performance is significantly below the best possible.

Downsides and differences of computer-mediated communication and gaming in ASD

Individuals with ASD might prefer computer-mediated communication because it allows interactions from a safe distance with higher control and fewer contextual and sensory distractions, however, they do not necessarily profit from it in real-life social situations (Paulus et al., 2020). Moreover, a longitudinal study has shown that although higher autistic traits in general do not relate to the overuse of internet but gender is a risk factor: women with higher autistic traits are at higher risk for compulsive internet use (Finkenauer et al., 2012). A recent study reported that individuals with ASD diagnosis play more often by themselves rather than in multiplayer mode. In their study, they found that young participants with ASD are vulnerable to gaming disorders (Paulus et al., 2020), a recent systematic review has confirmed that children and young adults with ASD spend more time playing video games, and are at a higher risk for problematic gaming (A. Murray et al., 2021).

Results so far suggest that individuals with autism prefer a safe distance, reduced sensory information load, slower, self-paced tempo, and written/visual instructions in computerized communication or gaming. Despite the presumably lower levels of stress, they cannot fully exploit the social benefits of these activities. It is possible that, in some cases, the distance is no longer safe, but is so large that it leads to a permanent withdrawal, isolation, from which it is very difficult to establish contact. However, video games are sometimes the first or only opportunity for social interaction. It is not only an opportunity to communicate casually with other players in the game, but also to build friendships between people from distant parts of the world, to use the game as a common topic to start a conversation in offline gaming-themed gatherings or in general social situations (Finke et al., 2018). To sum up, based on the IPD theory, computer game-based treatment methods may be applicable to children and adults with ASD. More studies are warranted to discover and develop guidance to avoid the negative effects of computer games.

Challenging factors, counterarguments

Although the importance of interpersonal distance or even preference for larger IPD can be seen in a wide range of situations, in real life, there are two extreme scenarios: when someone is at zero distance with full skin contact (e.g., sexual intercourse), or when the other person is not present at all. Social interactions are inherently complex and besides the spatial dimension (e.g., preferred IPD), additional factors need to be considered. The sensory preferences (e.g., hypersensitivity), and the ability to communicate them are highly relevant while having sex (Gray et al. 2021). We think that low IPD could more easily result in sensory overstimulation and some autistic people can cope with this difficulty and enjoy sexual activity, whereas others voluntarily deprive themselves of sexual experiences, at least partly, to avoid sensory overstimulation. Furthermore, we believe that even autistic people who can cope with sensory stimulation have different preferences than neurotypical individuals considering the pace of a romantic relationship. Autistic people possibly need a longer time period to get to know a new partner, develop trust, and be ready for sexual intercourse. Moreover, communicating their preferences to their partner can also be more challenging for autistic people. In addition, these difficulties and a preference for a slower pace can also emerge in non-sexual intimate relationships, such as with close family members, friends, and peers. Further studies are warranted to investigate this topic, especially because the well-being of autistic people could benefit from the implications of such studies. However, a deeper discussion of this topic is beyond the scope of the present manuscript.

The other extreme end is the situation when the other person is absent. A recent study on communication mode preferences in ASD shows that phone calls are generally avoided among autistic people (Howard & Sedgewick, 2021). If the IPD would be the only defining factor in autism, this would be contradictory: during phone calls, IPD is large, so it should be pretty comfortable. But this is not the case. The narrative analysis revealed that partial information (the visual metacommunicative signs are missing, while the hardly interpretable vocal signs are remaining), instant reply, difficulty with appropriate timing, or the unpredictability of an unknown person might be relevant too (Howard & Sedgewick, 2021). Individuals with autism preferred face-to-face communication to written form only when the setting was safe and settled for a longer time (family, friends, education, or employment). In this study video chat and video conference platforms were not included; they became widely used during the COVID pandemic. One would assume that if IPD were the only thing that mattered, lockdown and online communication would be seen as a positive change. A recent study (Pellicano et al. 2020) highlights that a reduction in face-to-face activity (education, work, commuting, even therapy sessions, etc.) is not a problem to a certain degree and for a certain type of autistic people, but it also has drawbacks, and it isn't easy for everyone (Pellicano et al. 2020). It raises the issue that during video conferences the other's face on the screen may seem too close, or the distance cannot be controlled, and more people are in front of you at the same time compared to a real-life situation.

Overall, in addition to distance, the following factors require further investigation: 1) Temporal dynamics: social relationships in ASD can develop either extremely slowly (a lot of patience is required even in therapeutic relationships), or, in some cases, uncomfortably fast. Here, again, the dysfunction of the ability to adjust approaching behaviour and the diversity of ASD seems to be important factors. 2) Quality of relationships: the level of trust, safety, familiarity, etc. (caregiver, spouse, very close friend, professional helper, acquaintance, unknown person) and the number of people who can fit in each category or can be present at the same time (limited by the mentalization capacity) might be also considered relevant.

We think there may be other processes involved in fine-tuning IPD than the basic discrepancies mentioned above. For example, it should involve appropriate timing, verbal- and non-verbal reciprocal communication, and mentalizing (reading and expressing nonverbal, metacommunicative cues). Difficulties in these areas are also characteristic of autism. We consider IPD as a separate, potentially atypical "symptom" dimension. In this article, we emphasize the importance of systematic measurement of IPD in a time-limited, cross-sectional setting, by an unknown investigator, which is a laboratory prototype for many everyday situations.

Recommended study design to test cognitive functions in different settings

Based on the empirical evidence discussed above, IPD seems to be an important factor to consider in ASD; however systematic studies are warranted. We suggest comparing the cognitive, social, and communication performance with well-established methods in five different settings: (A) in-person task administration (with a measured distance), (B) with computerized versions of the same tests in the presence of the experimenter (with a measured distance), (C) with the examiner at a higher distance, (D) under laboratory conditions with the experimenter in separate rooms and (E) without social interaction, by remote online participation at home (Figure 1). The five different settings allow the following comparisons.

The difference between the settings (A) and (B) provides information about the effect of the human, verbal, and acoustic versus the computerized, written, and visual instructions and feedback; the (B) vs. (C) comparison shows the effect of greater distance; (C) vs. (D) reflects difference between the presence (distant but physically perceptible) or the absence of the experimenter (only a mental representation available); (D) vs. (E) marks the difference between laboratory, unfamiliar (including potential sensory distractors) and the natural, familiar environment.

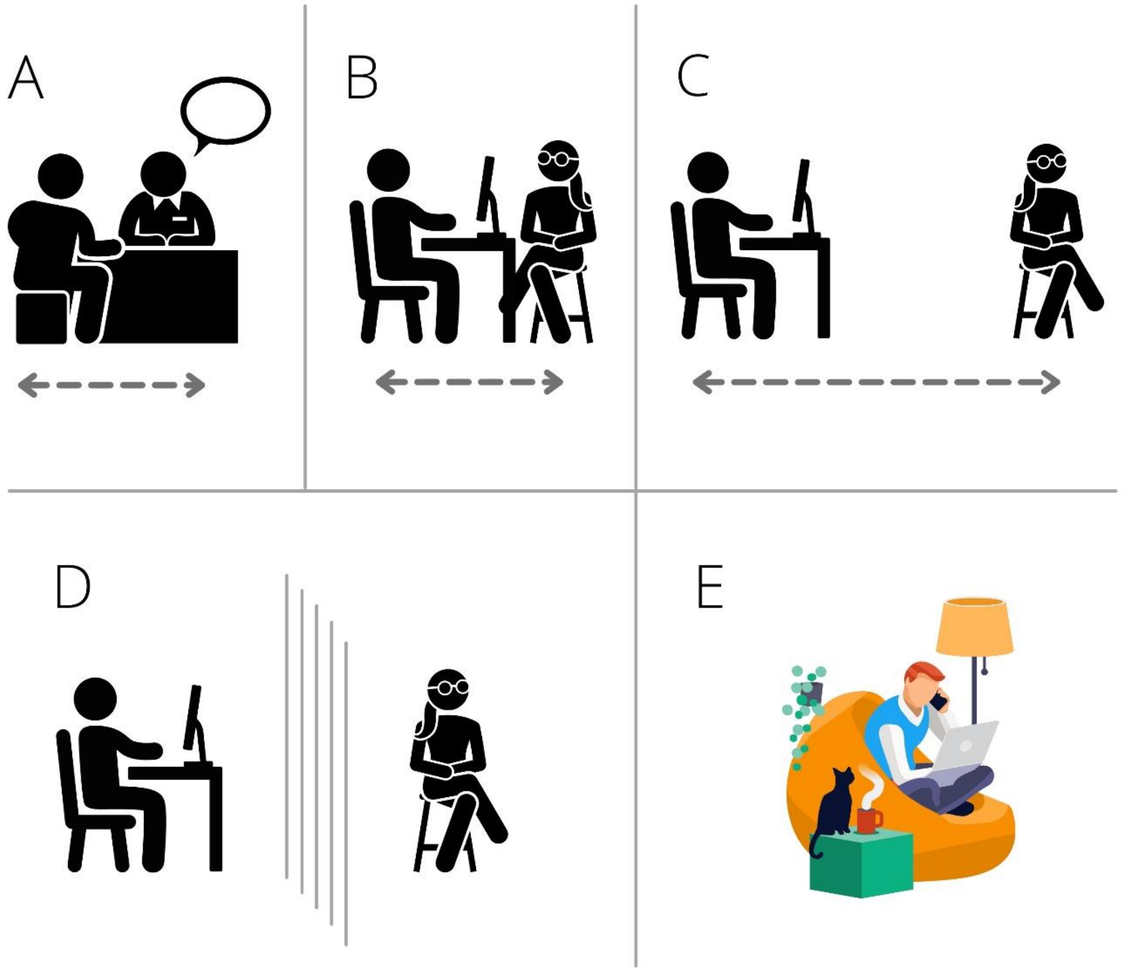

Figure 1. Measuring performance in five different settings. A. In-person task administration. B. Computerized task administration with same and measured distance. C. Computerized task administration with larger measured distance. D. Computerized task administration in separate rooms. E. Remote task administration, online participation from home.

Potential relevance, real-life implications

If behavioural and neuropsychological studies support the IPD theory in autism, namely, that interpersonal distance does indeed play a role in the social and cognitive performance of autistic people, it will be worth taking this into account in interactions with people with ASD in many areas of life. First, it might be necessary to provide more interpersonal space during therapy and education for special needs: teaching and applying the techniques needed for social interaction, either first without face-to-face interaction (from an age ripe for electronic device use), and then from a greater distance. However, it might be generalized even to intellectually disabled, non-verbal individuals with autism as well. To work out how to determine the comfortable distance in their case, and how this information could be used properly, requires further consideration. The message for them might be that caregivers and helpers should keep in mind that preferred interpersonal distance might vary in different situations, and it might affect the motivation and performance of these people too.

It could be especially important to provide space for withdrawal after/during emotionally demanding situations, for example, at school and at workplaces. This would be beneficial not only because it might prevent (or help manage) potential meltdowns, shutdowns, or tantrums, but also to help use existing skills and resources, or even achieve optimal performance for individuals with ASD (Figure 2). IPD theory can be used to explore the issue of competence versus performance in neurocognitive functions in this population. Specifically, using IPD theory, we can disentangle whether a cognitive or social function in ASD is truly severely impaired at the level of competence, or an overwhelming social factor such as short interpersonal distance is impeding their performance.

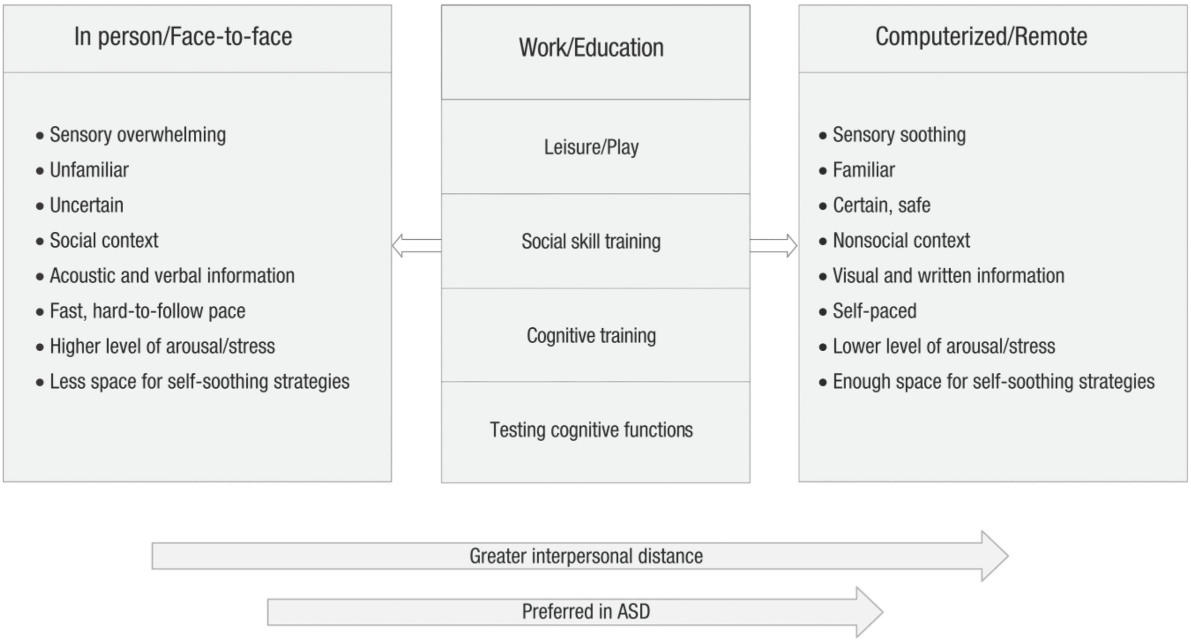

Figure 2. Summary of the differences between in-person and remote activities.

Conclusion

Here, we described the IPD theory of ASD, which implies that autistic traits (including social difficulties, cognitive dysfunctions, etc.) might be affected by social context involving uncomfortable IPD. The IPD theory explains inconsistent empirical findings on several measures, such as executive functions or social communication, and provides a context for the typical gaming culture in ASD. Moreover, it provides a framework for therapeutic and educational approaches, suggesting that these processes might benefit from the adjustment of IPD.

Declarations

Data availability statement: Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

Ethical statement: No human participants were included in the study.

Conflict of interest statement: The authors declare no conflict of interest.

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