

## Review Article

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## AI & XR Explorations to Support Social Interactions: Speculative Design for Ubiquitous Workplace Space by and for Neurodivergent Employees

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### ABSTRACT

This study explores the potential of interdisciplinary theories and advanced technologies, such as augmented realities and artificial intelligence, to address the socio-professional integration challenges faced by neurodivergent individuals, particularly those on the autism spectrum. It investigates the design of personalized, functional spaces that integrate interconnected living environments and intelligent systems tailored to support communication needs. Using speculative design methodology, the research adopts an experiential framework to examine alternative solutions, starting with a central hypothesis and testing it through debates with researchers, experts, neurodivergent individuals, and knowledge users. The premise is rooted in the recognition that neurodivergent individuals encounter significant barriers to social interaction and communication, limiting their integration into professional and social environments. This project envisions leveraging Internet of Things devices and immersive extended reality systems to create accessible, personalized spaces where individuals can reflect, feel secure, and engage in meaningful interactions. These spaces aim to foster confidence, well-being, and adaptability while addressing the limitations of existing tools. Hypotheses are informed by frameworks addressing autistic experiences and studies on self-narratives, proposing innovative applications of AI and immersive technologies. A diegetic device illustrates an augmented reality environment allowing users to practice social scenarios, engage in interest-based interactions, and participate freely, while preserving the emotional safety of a personalized setting. The research highlights the potential for such environments to transform social and workplace adaptation, fostering inclusion and employability among neurodivergent individuals. Results and discussions delve into emerging ideas, providing a foundation for advancing adaptive strategies that meet the specific needs of this population. By bridging theoretical and technological innovations, this work seeks to open new possibilities for integrating neurodivergent individuals into society while enhancing their quality of life through tailored, intelligent, and interactive solutions.

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### Introduction

Most autistic people in North America remain unemployed and consequently this affects all areas of their life and their health [1]. Note the growing interest in inclusive businesses, which opens up new studies [2]. Nevertheless, today, although work adaptations are adopted to promote their employability, which turn out to be measures of well-being recognized and validated by neurodivergent people themselves, the statics remain unchanged. In our previous studies, we collected testimonies from autistic people and their employers about the difficulties perceived at work [3-6]. Their points of view are consistent with the postulate which shows that autistic people feel discomfort during social relationships at work, which trigger for most of them some severe burn out [7]. Sometimes, even without a social interaction, the discomfort comes from the environment itself [8].

This postulate highlights that for the same person, it is not possible to predict what they will feel and that the proposals for adaptations must be able to be detected and propose adaptations in real time. Another study shows that if face-to-face relationships create anxiety, remote ones bring greater ease in exchanges [9]. This led us to question the possibility of creating a virtual space, like a space of one's own, for the autistic person. Indeed, the autistic person does not always find the expected comfort to allow them to communicate in serene conditions and many constraints must be taken into account to achieve this [10]. From then on, our proposal was oriented towards the possibility of creating a virtual space accessible at all times, immersive, interactive, produced using technological devices, adaptable with the use of AI systems.

This virtual space could be a means of accomplishing tasks related to lifestyle habits by using functionalized communication processes that imitate the expectations of an exchange in a functionalized way and propose adjustments according to the circumstances. Also, it is remarkable to note that autistic people are very involved in the development of virtual realities [11]. Following this, we asked ourselves the following question: what is the relevance for neurodiverse people to design a virtual space so that it can become a key element, to sustainably support their activities and social interactions?

The central objective of our study is to succeed in creating alternatives that can be transferred to neurodivergent people, possibly taking the form of a secure environment, in order to support, or even supplement, with the help of technological supports of alternate realities, the necessary communication processes of autistic people, and this, by giving them a context allowing them to anticipate, train and develop a sense of confidence during these exchanges.

First, we will lay out the methodological steps of our speculative design approach. To do this, we will present our hypothesis: Based on workplace recommendations for autistic people, which present that having a place at work to isolate oneself from others and

multisensory stimuli is important [12]. We propose to examine the importance of providing a virtual place of oneself at work when it is not possible to have one. Thus, we will also present the reason why this isolation is important for the autistic person by exploring the theoretical basis to justify this angle of approach. Finally, we will present our perspectives in the form of a debate between experts, neurodivergent people. To conclude, we will discuss the importance of the notion of place of oneself for the autistic person, the possibility that they can have to cultivate their own fields of interest there and share them. As well as the fields of possibilities of alternate reality devices for their social, even professional, integration.

### Methodology Description: Speculative Design

Our methodological approach is based on a design fiction framework, structured into three phases. This methodology was proven to bring great insights and problem-solving path for exploring probable future situations [13]. Remarkably, due to the fact that this methodology uses storytelling and pathos effects in the sense of dialectical theory, it has been shown that this approach allows for a better depiction of the situation experienced by autistic people and thus to be more in line with the context to be taken into consideration [14]. Finally, the justification for this approach lies in the fact that it proves relevant for the development of Human-Computer Interaction type systems [15]. There are many possible variations to implement the speculative design methodology and here we have adopted the one that seemed closest to our situation [16].



First, it involves establishing a context that presents a central position and associated suppositions. In our case, this took the form of the question: “What if an autistic individual could access a virtual personal space at any time-would this improve their social and professional condition?” Our hypothesis is that such a space would enable communication through an interface, allowing the individual to reveal only what they wish. Part of this space could be dedicated to the development of personal interests and the exchange of ideas on those topics. Second, we present a diegetic prototype, which was defined by [43] “as a technology that does not yet exist in the real world but is considered real and functional in the fictional narrative”. It was designed to address this need to some extent. Through an exploratory video, we illustrate its potential applications and limitations [17]. Following this asynchronous phase, a group of participants will review and debate the proposals. An initial preparatory phase will enable participants to familiarize themselves with the concept, carefully consider the suggestions, hypotheses, and assumptions, and prepare for a synchronous discussion session. Finally, a synthesis of reflections, proposed solutions, and critiques will form the results of this study. This process ensures a comprehensive evaluation of the speculative design approach and its capacity to support the unique needs of autistic individuals.

### Diegetic Device and AI Technology for Rehabilitation and Social Integration

Supporting the social interactions of autistic individuals requires an approach that involves a nuanced understanding of the processes

underlying withdrawal behaviors that may arise during exchanges, the contradictions these behaviors produce, and the potential of technological tools to offer solutions. These solutions draw on a corpus of technological devices aimed at rehabilitation and social integration, grounded in the concept of communication support. This section defines the scope of the topic while highlighting the perspectives and limitations of such an approach. Notably, the *World Health Organization* includes the implementation of intervention processes as a fundamental part of rehabilitation, described as:

“a set of interventions designed to optimize the functioning and reduce the disability of people with health problems when they interact with their environment” (WHO, 2025).

In this study, we relied on the *Human Development Model-Disability Creation Process (HDM-DCP)*, which:

“... shows that the achievement of lifestyle habits can be influenced by the strengthening of capacities or the compensation of disabilities through rehabilitation and technical aids, but also by the reduction of obstacles in the environment...” (RIPPH, 2025).

This model involves human and technological mechanisms to achieve these enhancements or compensations, grouped here under the term “device.” Foucault [38] defines a device as:

“...a resolutely heterogeneous whole comprising speeches, institutions, architectural developments, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral, philanthropic propositions...” (RIPPH, 2025).

The device establishes a relationship between elements of human discourse, distinguishing it from a mere technical system. Our project primarily focuses on studying the psychological and technical processes involved in online interactions. It aims to understand mechanisms that can be modeled and simulated within an interactive online system to help autistic individuals, with the aid of functional tools and human assistance, achieve self-expression and sharing in a context similar to face-to-face experiences.



**Figure 1:** Illustration from the Storytelling Relating our Diegetic Prototype Suggestion (Generated with LDX Studio)

It is essential to acknowledge that not all components of in-person interactions can be simulated - this remains a mere modeling effort. If the system cannot replicate the interaction context, it may seem inadequate for supporting communication, especially for vulnerable individuals. It is, therefore, important to justify this approach and set realistic expectations for a system that supports interactions without fully reproducing all components. While online platforms for social interaction offer promise, they cannot replicate the complexity of human interaction as understood in Shannon’s communication model, which defines communication as the transmission of content from sender to receiver [18]. Functionalized transmission may be

nearly instantaneous, creating an impression of direct contact, but lacks the depth of human interaction in physical presence.

However, this limitation can also be a significant advantage. It creates a conducive framework for exchanges, as autistic individuals leverage the system’s functionalities to communicate without the burden of interpreting non-verbal cues, such as gestures, breathing patterns, or intonations. These implicit signals, often pivotal in understanding communication, can be difficult to decode for autistic individuals without specific contextual codes, leading to misinterpretation, exhaustion, or withdrawal from interactions.

Information technologies for autistic individuals appear to address specific constraints encountered during interactions. Yet, simply opting for a remote solution is insufficient; it is necessary to present clear evidence of situations and explore concrete solutions. For this reason, the following section identifies psychological processes that may trigger withdrawal behaviors in autistic individuals, paving the way for addressing these challenges.

### **Justification for the Use of a Technological System and Perspectives on Individuality**

Interaction, broadly defined, intersects with numerous fields, including theatrical studies, social cognition, and caregiving relationships, making it difficult to identify a domain unaffected by this concept. Even in areas where solitary work is emphasized, interaction with oneself is the foundational step toward engaging with others. For autistic individuals, self-relation can manifest undesirable effects, which often intensify when others are introduced into the interaction. Neurotypical individuals who lack understanding of the autistic experience may struggle to comprehend their interlocutor’s reactions. However, these reactions are consequences rather than inherent causes. It is crucial to acknowledge that the exact origins of autistic individuals’ experiences remain unknown.

Psychoanalysis provides some insights, though it does not establish direct causal links. It posits that the relational process experienced by autistic individuals may be hindered by a distinct, altered sense of self (ipseity), which prevents them from perceiving a relationship with the world that distinguishes them from it [19]. Ipseity can be understood as a unique psychic anchor for each individual, an intimate internal space manifested through the articulation of “I,” which forms the unity of what we perceive ourselves to be. This emerges from the sensation of being oneself, grounded in a fundamental distinction achieved by recognizing “the other.” This awareness begins when a baby distinguishes between their own intentions and actions and those of their mother, which they cannot directly control. This realization allows the infant to perceive themselves as distinct from their mother, enabling intersubjectivity, without which interaction cannot occur. Lacan describes the “mirror stage” as the critical phase for the emergence of self-awareness [20].

When this psychic boundary fails to fully develop, as in autism, the presence of others may be perceived as a potential danger, leading the individual to isolate themselves to restore a sense of security [21]. Consequently, the concept of a “habitat,” or personal space, acquires particular significance for autistic individuals. When adequately designed, such a space can serve as a substitute-potentially physical-for this psychic boundary, providing a protected, exclusive area free from the perceived threat of others or even oneself, as the distinction may not be clearly perceived.

Nonetheless, autistic individuals actively seek interaction, which remains indispensable for fulfilling daily life routines [22]. The inability to engage in interactions can lead to severe health

consequences over time [23]. Therefore, the notion of a personal space for autistic individuals is equally critical to their social integration. Recent studies highlight autistic individuals' interest in online environments and the potential of these modalities to facilitate interaction [9].

Simondon views the use of technical objects as a way of engaging with the world and enhancing awareness of one's actions [24]. While not a definitive solution for individuation, the technical realm provides fertile ground for initiating and supporting this process. This may explain why Saade identifies a positive impact of online digital environments on autistic individuals' interactions [9]. Following this perspective, interactive systems enable a cycle of action and feedback with characteristics reminiscent of Lacan's mirror effect. Furthermore, virtual reality tools reify and simulate human processes by simplifying the complex components of life into manageable models, significantly reducing the cognitive burden of deciphering social codes [25].

However, this approach must be nuanced. While individuation may be facilitated by technical tools, Simondon notes that this applies to individuals who have already developed what he terms a "pre-individual system," capable of giving rise to individuation [24]. In cases of altered ipseity, the use of technical tools without this foundational system may not trigger the individuation process. As Simondon himself cautions, this is not a recipe or a process to impose, but an experience that inherently depends on an individual's initial perception of the world [24]. Thus, technological support serves as a means to strengthen the sense of self but cannot be considered a standalone solution.

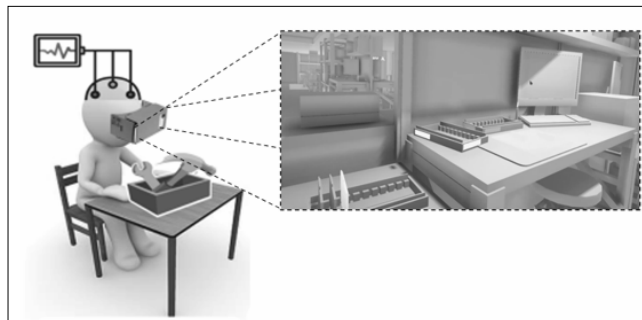
### **Towards the Development of Intelligent Environments for a Personal Space**

A personal space designed to support the interactions of autistic individuals, enabling them to carry out daily routines and access various activities to ultimately promote autonomy, cannot be exclusively virtual. The creation of an intelligent environment requires linking the physical and virtual spaces through sensors, actuators, and interconnected systems within the user-defined real personal space. These systems collect data to inform the virtual environment. User involvement is essential and requires a methodology that positions them as designers, creators, and active participants, ensuring that the intelligent environment aligns with their needs. Autistic individuals must have the ability to modify certain parameters, adjust objects in the environment, select their interlocutors, and define the types of interactions they wish to engage in. They can also use this space to perform tasks related to daily routines, participate in online learning, engage in remote work, and access social and medical services.

The personal space is also designed to facilitate and solidify the process of individuation. The system enables users to validate their experiences through physiological measures such as stress levels, cognitive load, and other well-being indicators. This information updates the user's presence and creates a perceptible envelope within the interface. It manifests as a virtual structure that influences user perception through real or virtual objects and allows the system to react to environmental actions, for example, using collider-type responses or visualizing physiological signals.

It has been demonstrated that reactions during reciprocal interactions can be analyzed using AI-based systems [26]. Accordingly, this project focuses on making the synchronization of interactions—an indicator of quality-tangible [6]. Furthermore, neurofeedback

systems have been shown to positively impact social interactions and daily activities for autistic individuals [27]. Building on these perspectives, the developed system aims to create a framework that supports both daily life interactions and self-narratives.



**Illustration - Presentation of a Simulated Environment that, depending on the Context, allows the user to become aware of their Own Brain, Physiological, and Parasympathetic Activities.**

The mediation of an individual's narrative function reveals their identity through their own story. According to Ricoeur, this represents a potential process for constructing selfhood. Within our system, we have integrated this individuation process, which relies on self-interaction encouraged through the involvement of a third party—a human supporter intervening remotely based on the individual's specific preferences to facilitate moments of conversation [28]. This interaction is calibrated to the person's needs, aiming to foster an exchange centered on self-expression (what Ricoeur refers to as the Self) for autistic individuals. Conversations are moderately guided to enable autistic individuals to present their specific interests, which, according to Lizon, allow them to refocus on themselves through the exploration of personal passions [29]. Over time, the self-narrative approach seeks to engage autistic individuals in regular exchanges grounded in their interests, ultimately fostering a bond with the interlocutor that might not have otherwise formed. The virtual environment thus becomes a platform for developing and expressing their interests differently, preserving tangible traces of moments where they have showcased facets of themselves. This supports their individuation and autonomy. The intelligent environment, in this context, functions as an interfaced boundary supplementing the interaction process while enabling the establishment of a personal space.

### **Synthesis of Collaborative Design Session and Debate**

The speculative design session takes place around a prospective question [30, 31]. Thus, before the phase of exchanging ideas to establish a debate between the participants, a diegetic prototype presenting the working hypothesis was presented [32]. It takes the form of a video file sketching the story of a young autistic adult who is at work. The staging shows his participation in a meeting with his co-workers. Adaptations for his participation in the work are taken into account as presented in the literature, nevertheless this interaction brings him discomfort [33, 34]. The diegetic prototype uses visual communication to present the speculative working hypothesis based on the possibility of having a virtual space to isolate oneself sensorially thanks to a virtual or extended reality device that would allow one to feel at a distance while being present, and this, to answer the question: How can an autistic person feel included at work while accommodating their specific needs?

The scenario presented clearly shows the impossibility in which the autistic person is immersed at work. It is necessary to highlight the recurring triggering factor that is particularly difficult to circumvent

and that was identified in our preliminary work: impromptu social interactions [5]. It should be noted that these manifestations are not systematic [35]. In such a way that for the same person, the same situation, the reactions will not be the same. Thus, there cannot be a recommendation for a given situation since the variables are too important to take into consideration. The hypothesis raised which is presented by the diegetic prototype consequently considers the possibility of being able, in the event of a feeling of discomfort, to isolate oneself, while being able to obtain information from the meeting in order to feel included. In some way, the virtual space would allow the autistic person to isolate themselves sensorially while remaining on site, but also while being informed, and possibly being able to interact via the virtual space (figure 1) or after the fact. Therefore, this isolation can be total or partial and according to its possibilities granted by the XR extended reality support, its degree of comfort, it can become aware of what happened in the meeting thanks to the AI system and agents which synthesizes the meeting and highlights what the worker must remember. It can possibly participate while remaining in its space. The virtual space allows it to have a customizable place. The advantage of this customization allows the autistic person to showcase their personal interests and thus find at work what brings them comfort and value. After having read the statement of this hypothesis, a session of exchange of ideas around this proposition took place between the participants who are either neurodivergent people (n=6); or experts whose fields of study are related to that of autism (n=10).

The exchange of prospective ideas can take place in synchronous or asynchronous mode and is divided into two sections. The first aims to collect alternatives to the proposal to create a virtual space in the event of autistic manifestation at work in a setting where presence is required and aims to confront these proposals in the form of a debate that integrates the ideal visions of each participant from the first stage of exchanges, with the presentations of the obstacles and constraints envisaged. The second proposes different approaches. The solution envisaged and described in the rest of the article does not present the consensus of this debate, because this is not the objective of this type of session. On the contrary, it is a question of relying on the constraints stated in order to try to circumvent them. The objective of this method is based on awareness-raising, the sharing of lived experiences and possibly the development of critical thinking with regard to the situation and solutions presented that can lead to appropriation.

Here we summarize the visions evoked during the first phase in order to try to present or amend the proposal of the diegetic prototype. These visions are made anonymous in accordance with the ethics certificate that approved this study (). The first remark states that a virtual space should allow him to take stock of his physiological state, for example, thanks to biometric systems to measure his stress levels, physiological, mental load and cardiac coherence which are potential indicators of his level of well-being. Another remark states that it is not certain that the person can really feel isolated with this type of system and that this requires a process of habituation both for him and for the people of the meeting, so that the person does not feel stigmatized. The third part of the previous reflection and proposes an augmented reality solution, that is to say a relative, even progressive isolation. Another, questions the possibility of having an intelligent agent to interact and remains completely physically remote, because what can create autistic manifestations are also the perceptions of the activities of others (breathing, physical contact, smells, hyper frequency sound of the meeting room) and not all of them allow sufficient isolation in virtual mode. The second phase presents the different approaches. Here, an idea that is often found

in the statements that is presented by autistic people themselves in search of a solution to facilitate their employability is based on the possibility of being able to train and thus anticipate impromptu interactions in various contexts [36]. The proposal to create a game for this training, but also to allow neuroatypical coworker to be made aware of the difficulties experienced, gave rise to another series of ideas based on the importance of introducing into this “game” components to create collaboration, a common effort to accomplish a specific task. The format of an escape game was mentioned. Another proposal focused on the valorization of the autistic person through their association in this collaboration that can only be accomplished with them.

## Discussion

Our initial approach to developing an intelligent personal space-a defined area capable of collecting and interpreting data to support the user both virtually and in person, co-designed by and for autistic individuals-has focused on creating a system to facilitate their employability [6]. Autistic individuals face significant barriers in professional and social integration, often clashing with current interpretations of social exchange theory, which underpins practices aimed at fostering employee inclusion and retention [37].

Inclusion processes taught in corporate management training, for example, cannot be reasonably applied to autistic employees without adaptation. Our system aims to raise awareness among neurotypical and neurodivergent interlocutors about implicit challenges while addressing unmet expectations for validation or reciprocity that are often delayed or absent. Preliminary results from our study are promising, with testimonials from autistic individuals highlighting the need for further technological adjustments and confirming alignment with their expectations.

It is important to recognize that difficulties in perceiving selfhood may not be the sole cause of accessibility issues faced by autistic individuals. Nonetheless, this challenge remains underexplored and insufficiently addressed. The effort to interface interactions between autistic individuals and their close networks, enabling greater autonomy, represents a significant societal challenge and raises ethical issues surrounding data sharing that cannot be elaborated upon within this chapter's limited scope. Addressing these issues requires not only revisiting managerial practices, social and healthcare services, and societal perceptions of autism, but also implementing necessary adaptive measures. With the help of intelligent environments, autistic individuals can fulfill daily routines, access essential services, participate in leisure activities, and achieve greater autonomy, ultimately fostering equitable participation in social life [38-42].

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