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## DEL+DEL- APP: Promoting Social Inclusion and Digital Equity for People with Neurodevelopmental Disorders and Elderly People

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### ABSTRACT

**Background:** Social isolation and loneliness are prevalent among people with disabilities and older people. These population segments often face obstacles at the relational level and in accessing digital technologies (Vascelli et al., 2022). DEL+DEL- is an application that facilitates moments of interaction between these two groups to create new digital and relational opportunities supervised by a psychologist.

**Method:** This work describes the activities to develop DEL+DEL- in its functional and technical features. First, we assessed the specific characteristics and needs of the two population segments. This evaluation started from the experience already active with traditional videoconferencing platforms and users with similar characteristics supervised by a psychologist. After collecting this information, the developers began the creation of app flows. This process created three main streams: onboarding, participation in a call (with the possibility of asking for help if technical or interaction problems arise), and organization of a new call. Prototype testing was conducted on ten young and ten older people in two phases.

**Results:** The results obtained during the second phase of the test administration are higher than those obtained during the first one. Test results indicate that the application prototype meets the needs of the targeted population segments.

**Conclusion:** When the application is available, we hope it will contribute to replicating the results achieved so far on a national scale. DEL+DEL- could help overcome the limitations of current technological tools, reduce the sense of isolation, and promote psychological well-being, connecting the segments of the population most at risk of social isolation.

**Keywords:** *neurodevelopmental disorders; older people; social inclusion; digital equity*

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## **Introduction**

Stable and rewarding interpersonal relationships influence a person's quality of life. When these are present, they lead to mental health benefits; in fact, they help counteract stress and psychological illnesses, help the person gain emotional support, help expand support networks, gather helpful information, and receive assistance and help in life processes. On the other hand, when social networks are lacking, the person experiences social isolation and may therefore experience loneliness; these two factors, taken together, are often associated with additional psychopathological pictures, such as depression and anxiety (McVilly et al, 2006).

Social isolation and loneliness are considered distinct concepts, although closely related. Social isolation is considered an objective state: the person experiencing it has minimal contact with others and/or a low level of involvement in community life. Social isolation occurs, for example, when the person has little contact with other people, lives alone, lacks involvement in community life, and has no person with whom to confide. Loneliness, on the other hand, refers to a person's perception of his or her social relationships or level of social engagement in quantity and quality. It is considered a subjective experience, usually negative or unwelcome (Grenade & Boldy, 2008).

Thus, social factors have a powerful influence on health (Green et al, 2022). Relationships fit into the concept of social cohesion, which is an attribute of a contextual unit, such as a community, city, or state may be. It is related to, but at the same time distinguishable from, other social determinants of health that operate at the individual level (Oberndorfer et al., 2022); a cohesive social environment is characterized by close social relationships, a strong emotional connection to the social entity, and a strong orientation toward the common good (Schiefer & van der Noll, 2017). Social cohesion can reduce stress (Chuang et al, 2013), provide access to resources such as social support, and protect against loneliness; social cohesion is related to a sense of belonging, which is linked to a reduced risk of suicide and depression (Oberndorfer et al., 2022). In addition, people who are more digitally adept and participate in digitally mediated social life enjoy advantages over their digitally disadvantaged counterparts (Robinson et al., 2015).

Aging in Western societies brings challenges that aim to promote independent living and provide opportunities for social involvement. Age plays a vital role in digital technology adoption; there is a clear digital divide between younger and older generations; this divide is even more evident within the senior group, where older seniors are largely excluded (Bergström, 2017). Disability is also at the center of contemporary inclusion and digital rights discourses. There are, in fact, areas of solid inequality concerning disability, which represent

unfinished work in digital inclusion. The digital inclusion of people with disabilities is another challenge to address (Goggin et al, 2019).

Social isolation and loneliness are common among people with disabilities and the elderly, two of the segments of the population that most experience obstacles in relationships and access to digital technologies. People with disabilities often struggle to establish meaningful interpersonal relationships (McVilly et al., 2006). Let us consider, for example, people with an autism spectrum disorder or with moderate intellectual disability. They often experience difficulties in social interactions, accurately perceiving social cues, and social reciprocity, and are also at risk for manipulation (DSM-5; American Psychiatric Association, 2013). Difficulties in developing and maintaining social relationships and the tendency to rely on caregivers, even as friends, can be ascribed to the causes of the perception of loneliness that these people experience (Ballin & Balandin, 2007).

On the other hand, older people can experience serious health risks associated with loneliness and social isolation. Old age can be a time of loss and change; retirement, decreased mobility, worsening conditions of illness, disability, and cognitive decline, as well as the loss of a spouse and other social network members, should be ascribed among the factors that may contribute to perceptions of loneliness and social isolation (Courtin & Knapp, 2017; Coyle & Dugan, 2012).

Therefore, it is paramount to promote numerous opportunities to develop and maintain social relationships, both for people with disabilities and their families (McVilly et al., 2006) and for older people (Vascelli et al, 2022), including through the use of digital technologies. Access to more socialization opportunities could help decrease loneliness in these two population groups to increase their psychological well-being. In addition, it is crucial to foster digital opportunities for vulnerable groups.

This goal could be achieved through a technological tool that can facilitate moments of remote interaction between these two groups, with the supervision of mental health professionals acting as facilitators to help them with technological and communication difficulties. Del+Del- proposes a new way of interaction for people with mild disabilities and the elderly. Through this tool, we want to overcome the limitations of current technological tools, reduce the sense of isolation, and promote psychological well-being through an application that can connect the segments of the population most at risk of social isolation.

### **DEL+ DEL-**

Del+ Del- is a service model that, through a digital application, connects young adults with disabilities and lonely older adults. Users can interact in an easily accessible and safe

environment where a team of mental health professionals supervises and facilitates interactions. The innovativeness of the system lies in its mode of use, which provides for maximum ease of use and minimal error on the part of the older person who is not accustomed to technology; it allows for synchronous connection in video call mode of two users. A third user (i.e., an experienced supervising psychologist) can enter the conversation room to interact with the subjects or supervise the conversation in hidden mode.

The mode of use of the app is always managed by the referring professional, who mediates and supervises the user's experience at all stages: from enrollment to moments of interaction through call schedules. This mode ensures maximum security for service participants. The application provides a database of subscribers that reports the characteristics of participants (i.e., professionals, teens, and seniors); the database allows the application to create conversation dyads based on common characteristics and interests. This information is collected during the onboarding phase of the application. Each participant also has an appointment calendar that is structured according to his or her hourly availability. In case of prolonged inactivity, the application provides reminders to members to support them in scheduling new conversations. There is also always a button on the interactive screen that allows either the young person or the older adult to request support from the professional in case of any technical glitches or difficulties that might occur during the conversation. The application has a helpful tool for young people with disabilities that is activated when they cannot continue the conversation. The mode of help is text messages or augmentative communication tools (e.g., PECS), which appear only on the screen of the person in need. The application presents the aids only when certain situations occur, such as prolonged periods of silence or, in general, according to the characteristics of the participants, i.e., the peculiar mode of conversation (e.g., if the boy tends not to ask questions, then the application suggests questions to ask the conversation partner). Thus, the app is a disintermediation tool, i.e., and it allows young people with disabilities and the elderly to interact without the need for caregiver support.

### **DEL+ DEL-: functional aspects**

#### ***Registration and onboarding***

During this phase, the user, after downloading the application, can register. The user is asked to select his or her age on the initial screen, according to two options: "I am - than 30 years old" or "I am + than 60 years old." On the same screen, there is also a registration option for health professionals who want to use the application. Once the age is selected, a screen will open where the user has to enter his or her cell phone number using the keyboard at the bottom. After typing in the number, clicking the "Next" button will take the user to the screen related to the

application for access to the service.

Here the user will have the option of entering a short message before submitting the request if desired, or they can submit the request directly by clicking on the button at the bottom of the screen. At this point, the application will prompt the user for consent to send notifications to be notified when they can complete the registration. The user will first have to click on the "Notify Me" button and then " Allow " on the screen that will open in the foreground. At this stage, in case the user needs to, the application allows the user to change the phone number previously entered. The user will then receive a notification text message to complete the registration on the application. Clicking on the message will open an application screen that prompts the user to complete registration by pressing the appropriate button. After entering their phone number again, the user will need to enter the 4-digit verification code received via text message on the next screen.

The following screen alerts the user that he or she will be asked to complete a questionnaire lasting up to 5 minutes, which will help find the best conversation partners. The application reminds us that the user can exit without losing any answers if the questionnaire becomes too long. To begin the questionnaire, the user must click the "Start" button at the bottom of the screen. On subsequent screens, the application prompts the user to indicate the days of the week they are available to receive calls and the times, with the possibility of indicating one or more options for morning, afternoon, and evening.

During the registration process, the user will be asked to answer short questions related to their interests (e.g., "How much do you like watching TV?"), indicating on a 5-point Likert scale from "Very much" to "Not at all" their preference for the activity described. The questionnaire also includes some open-ended questions to allow the user to specify their preferences further (e.g., "What are your favorite programs?"). At the end of this phase, the application will notify the user that he or she is ready to start using the service. By clicking on the "Start" button, the user will have access to the chat organization screen.

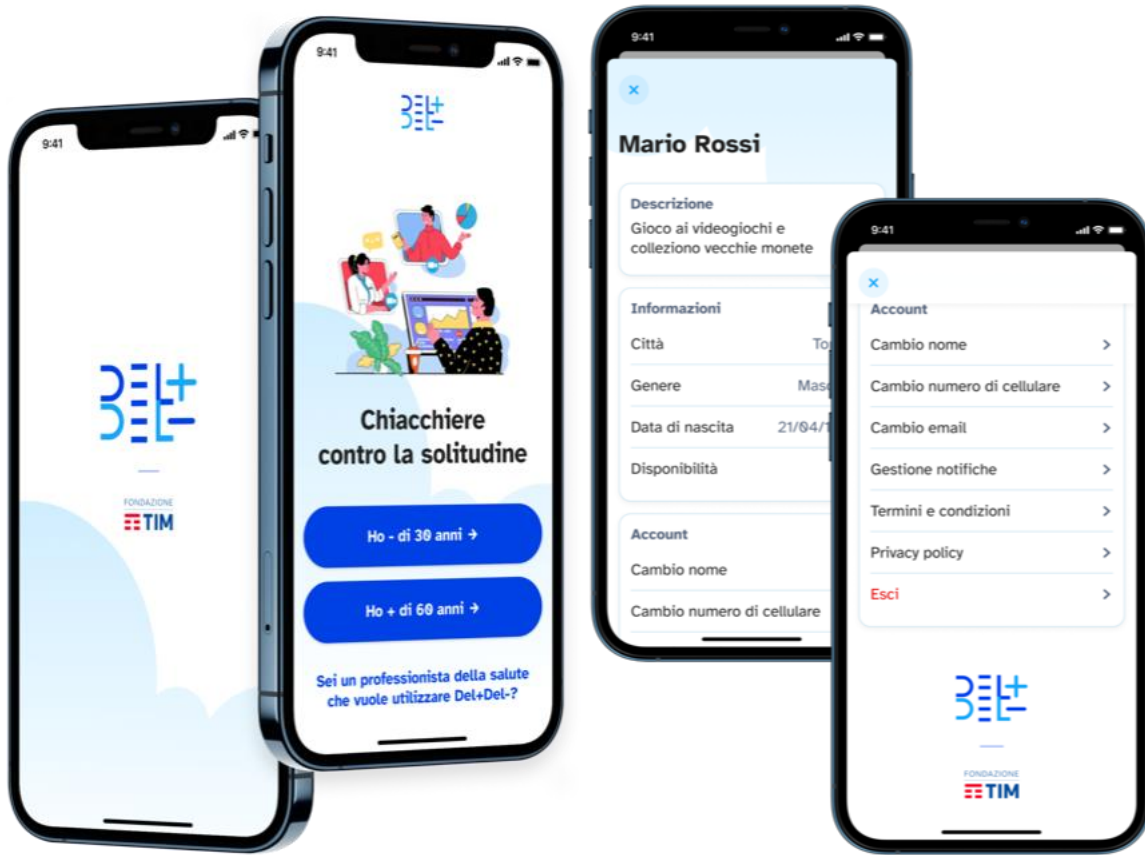


Figure 1. Screenshots of onboarding and profile section



Figure 2. Screenshots of organization of the call and call with request for help

### ***Call with request for help***

The application presents a screen showing the list of scheduled calls. Once the call activated is selected, the application briefly reminds the user of the rules of conduct to be kept during the conversation; to continue, the user must accept these rules of conduct. At this point, the application summarizes the conversation partner's favorite activities and hobbies. After reading, the user can begin the call. The screen is straightforward and intuitive: below the pictures of the participants are buttons to turn on mute and video, rotate the camera, and end the call. At the top of the screen is the image of the supervisor assigned to the call on the left side and a help button on the right side. Pressing the help button displays a list of frequently asked questions referring to the potential difficulties encountered during the call and the "Ask for Help" button. Pressing this button will notify the supervisor on the application control panel and access the call. The supervisor will have the option to access the call in video or in audio-only mode to respond to the user's requests. When there are 5 minutes left until the end of the call, a reminder combined with a countdown will appear on the screen. Users can then proceed to the farewell phase. At the end of the call, users will be asked to fill out a short satisfaction questionnaire on how they felt during the call; responses are on a five-point Likert scale and range from "Very Good" to "Very Uncomfortable."

### ***Organization of the call***

The application also provides the ability for the user to arrange a call by going to select a conversation partner from a list of users that the application will propose based on shared interests; after selecting the partner, the user will be able to select the time and day of the call based on the availability provided by the other participant during onboarding. Finally, the user will have to wait for the call request to be accepted by both the supervisor and the other participant.

### **DEL+ DEL-: user-specific trainings**

Users of the application will benefit from specific training. The training for young people is conducted by experienced psychologists and aims to achieve the highest level of autonomy in using the application. It is structured according to the characteristics of the participants and aims to help them acquire the soft skills necessary for successful participation in the project. It is divided into several phases following some main guidelines: communication skills, socialization skills (Vascelli et al., 2022), and soft skills (Iacomini et al, 2021) for the management of the activities to be carried out on the application. On the other hand, the training for the elderly involves work on autobiographical memory (Leahy et al, 2018). It involves

exercises proposed by the young person with disabilities to be carried out during socialization times under the operator's supervision.

Users are thus both beneficiaries and conductors of the training. During calls, the young person practices conversation skills with the older person, who in turn receives the training on autobiographical memory proposed by the young person. This occurs during socializing moments intended to reduce the perception of loneliness for both participants. The whole process takes place under the supervision of the trained professional, who facilitates the achievement of the specific goals for both participants.

### **DEL+ DEL-: technical choices**

To facilitate the achievement of the intended macro-objectives for these two population segments, we developed ad hoc technology, as the apps that still needed to be in circulation could meet the project's functional specifications.

In the next section, we will describe the technological choices and solutions adopted in the development of Del+Del-.

To facilitate the achievement of the intended macro-objectives for these two population segments, we developed ad hoc technology, as the apps that still needed to be in circulation could meet the project's functional specifications.

The ecosystem is based on a Cloud infrastructure that allows high network configuration, security, and scalability of services. A release has been made on Linux machines for apparent advantages from the point of view of lightness, security, maintainability, and documentation guaranteed by the world's largest community.

The architecture is composed as follows:

- Authentication service, the service to which is delegated the management of the user, his profile, notifications, and the whole user lifecycle in general; this exposes documented REST APIs that allow interaction.

- Application service represents the service in which the characterizing features of Del+Del- are implemented. This service is tasked with managing calendars and calls, primarily from a data point of view. A dedicated database is used for the persistence of application data. The service also makes possible the notification of in-app messages to the user.

- Signaling service is the technology that can put users in Audio/Video communication. It is based on a service that generally implements the SDP (Session Description Protocol) useful for negotiating video call sessions; in summary, we can say that this service enables direct communication between users, and this task is not trivial if we think about the different hardware that users use to transmit and receive A/V streams.

- Control Panel, this component represents a web server for the administrative panel pages that TICE administrators and professionals use from web browsers, either from desktop locations or via tablets. This application allows the browser to talk to the authentication service, the application service, and the signaling service, which also, via web-technology, will make video calling with users possible from the browser.
- Mobile devices (App), which in short run the native Del+Del- application that connects to the services, as shown in the architectural diagram.
- Desktop devices, which having screens with optimal resolution for the use of the web application Control Panel, make it possible for administrators and professionals to intervene.
- Tablet devices, from these devices it is possible to use both the native application designed for the end user and the control panel, via web browser for administrators and professionals.

The architecture described above, in addition to allowing the use and integration of free software, also makes it possible to concentrate the logic characterizing the application in the application service. The cost to be incurred is thus limited to its development, that of adapting the authentication system to make it adhere to requirements, and that of developing native applications for mobile devices. The heavy burden of video call management will be completely delegated to open-source software that has already been extensively tested by users around the world.

The adoption of JAVA Virtual Machine-based technologies and, in particular, the use of Java and Scala-based frameworks was chosen for the development of the REST services and related backends, which allow not only a high level of abstraction but also high performance due in particular to the evolution of programming paradigms that over the years have greatly improved the quality and quantity of source code and eventually pushed toward architectural optimizations that can also be found at runtime. For example, the Play Framework, Akka, Cats, Cats Effect, and ZIO libraries are used for development and Docker on Linux for the service execution. In comparison, WebRTC technology is used for video calling: an open-standard-based, open-source framework for signaling service and related JavaScript libraries for client-side management.

Client applications, on the other hand, are developed with cross-platform frameworks that allow the release of applications native to the device's system but with the application part essentially based on Web technologies that, thanks to today's HTML standards, allow easy access to hardware resources and manage connections between peers.

The ecosystem also includes a pipeline for recording and storing the raw conversations (audio and video) that occur between users so that Machine Learning algorithms can be trained in later developments to recognize particular situations and/or those considered "at risk," such as:

- shouting and dangerous situations;
- inappropriate behavior on webcam;
- use of swear words or expletives;
- nudity and pornography.

All ecosystem elements are under an Open Source license, so the application is available for replicability and use by anyone.

## **Method**

### **Prototype Test**

The design of the application was divided into several phases. In the first phase, we assessed the specific characteristics and needs of the population segments to develop a product in line with their needs. The evaluation was carried out starting from the experience already active with traditional videoconferencing platforms and users with similar characteristics supervised by a psychologist. Particular attention was given to how the organization of calls is currently carried out, to what types of disabilities the user has, and to the methods currently used by the psychologists involved in the project to support the attempts in the modes of interaction.

After collecting the information, the developers began the creation of app flows. This work led to the creation of three main streams:

1. Onboarding phase to the application (registration and creation of user profile);
2. Participation in a call (with the possibility of asking for help if problems of a technical nature or related to the methods of interaction should arise);
3. Arrange a new call.

Before starting the tests, the developers informed the psychologists who would conduct tests on how to use the prototypes properly; this initial phase ensured effective testing that would provide valuable insight into what still needed to be improved in the app's design.

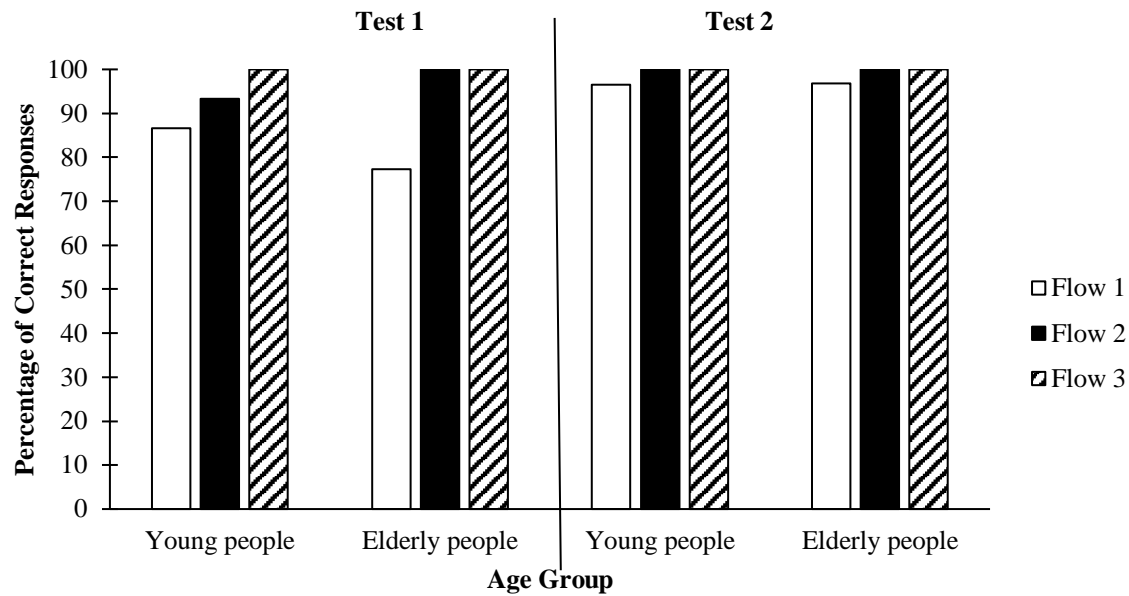
Prototype testing was conducted on ten young and ten elderly people. Table 1 shows the demographic characteristics of the participants.

<b>Diagnosis</b>	<b>Gender</b>	<b>Mean Age</b>	<b>Dev.St.</b>
Autism Spectrum Disorder	M=3	20	2,00
Prader-Will Syndrome	M=2	23,5	0,71
Tourette syndrome	M=1	21	N/A
Mild intellectual disability	F=3 M=1	21	2,94
<b>Status</b>	<b>Gender</b>	<b>Mean Age</b>	<b>Dev.St.</b>
Retired	F=5 M=5	72,1	5,55

**Table 1.** Participant demographics

The tests were conducted in the presence and a 1:1 ratio. The psychologist was sitting next to the participant and asked to simulate the registration and use of the application. The psychologist then delivered a smartphone on which the flows were present and observed the participants' use. Each stream consisted of a different number of screens (22 for the onboarding flow, 6 for the onboarding stream, and 5 for the onboarding stream) that scrolled if used correctly; the expected behavior had to be performed correctly to move from one screen to the next. For example, the participant had to select their age correctly to switch from the "Select age" screen to the next. Figure 1 and 2 show some screenshots used. The psychologist collected data on the mode of use: if the participant managed to move to the next screen independently, he recorded the correct answer. If, on the other hand, the participant needed help, then he recorded the answer as incorrect.

Figure 3 shows the results obtained. The results are high. However, during the first testing phase, some problems emerged, especially concerning the first flow. One of the most frequent problems among the people who tested the app was accessing the panel to choose the time to make the call. The developers then updated the screens in question and made the time options button more visible to improve the user experience. It can be observed that the results obtained during the second phase of the administration of the test are higher than those obtained during the first administration. Test results indicate that the prototype of the application meets the needs of the targeted population segments.



**Figure 3.** Mean UI prototype test results

## Discussion

This work aims to illustrate the activities undertaken to develop a technological tool that can connect the segments of the population most at risk of social isolation. The research on how to socialize between young adults and older people shows that this type of training is effective and could help decrease loneliness in these two population groups and increase their psychological well-being (Vascelli et al., 2022).

Before the application is operational, however, further steps are required. The developers have developed a functional analysis document (which can be requested from the authors), essential to identify and describe in detail the flows and functionalities of the application, starting from the UX and UI of the platform.

When the application is available, we hope that it will contribute (together with the support provided by mental health professionals) to replicating the results achieved so far on a national scale. We hope this application could help overcome the limitations of current technological tools, reduce the sense of isolation, and promote psychological well-being through an application that can connect the segments of the population most at risk of social isolation.

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**Declaration of Interest statement:** None

### Authors' contribution

All authors contributed to and have approved the final manuscript.

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