Editorial
Science in Times of COVID-19: Remembering to Tread the Side Paths

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It is all but a trivial endeavor to edit a journal issue in the midst of turmoil such as the one created by the incessant COVID-19 crisis – all the more if the journal is new and still growing. Like other periodicals, we were tempted to dedicate an entire issue to the topic, postponing already accepted non-COVID-19 papers to a later date. Yet, after careful deliberation, we decided against pursuing a whole special issue on COVID-19 and instead chose to include a special topic within a regular one. This is why:

The measures taken to contain SARS-CoV-2 – including large-scale lockdowns – have affected the lives of millions of people worldwide and have disrupted social and economic development as well as scientific enterprise (Myers et al., 2020). Since the proclamation of the pandemic by the WHO in March 2020, COVID-19 research activities have experienced an unparalleled rise, reflected not only in the vast increase of corresponding publications (Abbas & Pittet, 2020), but also in the extraordinary number of trials related to SARS-CoV-2 or COVID-19 which were registered on ClinicalTrials.gov (Estrada, 2020). In a similar vein, the scientific landscape witnessed an increase in provision of open access articles, expedited ethical approvals, expanded third party-funding, and an upsurge of pre-print papers (Glasziou, Sanders, & Hoffmann, 2020). While the context of crisis may produce a number of advantages (e.g., improved access to papers, reduction of bureaucratic hurdles), the recent developments seem to have led to an exacerbation of already existing pitfalls in the scientific system. Generally, these may be characterized by two phenomena, which – not just at this point in time – may be regarded as problematic for science: speed and exclusivity.

Rushing to publish studies deemed critical is not a novel phenomenon. Records reaching back to the Spanish flu at the beginning of the 20th century describe the pressure to test treatments, resulting in an abundance of poorly conducted studies and excessive media coverage of doubtful cures (Estrada, 2020). The renowned problem of methodologically poor studies – with estimates going up as high as 85% (Glasziou, Sanders, & Hoffmann, 2020) – has only been aggravated by the current COVID-19 crisis and is mirrored in a paucity of randomized-control-tri-

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als (RCTs), a lack of studies on non-drug interventions such as quarantines (despite them being one of the primary virus control methods), a rise in papers with limited generalizability (Abbas & Pittet, 2020), and a profusion of duplicate publications, e.g., systematic reviews occurring in parallel (Glasziou, Sanders, & Hoffmann, 2020).

Exclusivity, in turn, manifests itself in the shift of focus – as it may seem, almost entirely – to COVID-19-related research, for which an astonishing number of funding opportunities have been created, not only by governmental agencies but also by universities themselves (Omary et al., 2020). In some cases, universities, such as the one cited by Omary et al. (2020), are reported to have instituted policies drastically limiting non-critical research. Generally, as a consequence of different measures (hygiene related, lockdowns etc.), scientists are unable to carry out their experiments, and a considerable number report that they have lost some of their work (Korbel & Stegle, 2020). In particular, young scientists with children as well as those relying on in-person (face-to-face)-contacts for their experiments are disproportionately affected (e.g., Myers et al., 2020).

Overall, the impact of the currently expedited speed and exclusivity is likely to be substantial, not only on scientists but on the science system itself. This may include funding agencies who might decide to primarily support those projects which are more durable in the face of restrictions like those experienced recently (Myers et al., 2020). Or it may involve even more subtle forms of constraints concerning the publication process, governance, and media coverage. Hence, following Ludwik Fleck that »*once a structurally complete and closed system of opinions consisting of many details and relations has been formed, it offers enduring resistance to anything that contradicts it*« (1979 [1935], p. 27), we can only affirm that the novel Journal *Digital Psychology* is dedicated to promoting plurality in the sense of a diverse, differentiated discourse, and that it will try its best to keep a thematic balance, remembering also – wherever possible – to tread the side paths.

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Towards a Common Framework for Mediated Embodiment

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Abstract

Mediated embodiment is the technologically generated illusion of replacing a person's body with an avatar body. Virtual reality is the most representative technology of mediated embodiment. However, other forms of embodiment are emerging and need to be examined. The inclusion of all mediated embodiment technologies under a common paradigm would more readily facilitate their study. Here, a unified conceptual framework of mediated embodiment is presented, which integrates robot embodiment as part of the phenomenon, and allows the inclusion under the same umbrella of embodiment technologies that might emerge in the future. The minimum conditions necessary to induce the embodiment illusion, as well as the technical principles used to create this illusion, are discussed. Furthermore, it is suggested that mediated embodiment technologies can be regarded as tools that increase human capabilities in four directions: embodiment of a new self; expansion of traveling capabilities; expansion of body capabilities; and the reach of immortality. The principal research conducted in the field of mediated embodiment is explained in connection to these categories. The framework is expected to contribute to creating awareness of the commonalities of mediated embodiment technologies among the different research communities that work with mediated embodiment.

Keywords: mediated embodiment, virtual reality, robots, robot embodiment, avatar, body-ownership

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1 Introduction

Mediated embodiment technologies are capable of generating the illusion that an avatar body temporarily substitutes for a person's body. Experiences of embodiment in avatars are generally associated with virtual reality. However, other technologies can also be used to produce similar illusions. In particular, robot embodiment has recently emerged as another important technology capable of creating this illusion (Alimardani, Nishio, & Ishiguro, 2013; Aymerich-Franch et al., 2015, 2016, 2017a, 2017b; Aymerich-Franch, Kishore, & Slater, 2019; Cohen et al., 2012, 2014; Kishore et al., 2014, 2016). While empirical evidence is not yet available, other technologies, such as holograms or drones, could potentially be used to achieve similar effects.

Technologically induced illusions of embodiment can entail important cognitive, attitudinal, and behavioral effects for the embodied user (Aymerich-Franch, Kizilcec, & Bailenson, 2014; Groom, Bailenson, & Nass, 2009; Hershfield, et al., 2011; Peck, Seinfeld, Aglioti, & Slater, 2013; Rosenberg et al., 2013; Won, Bailenson, Lee, & Lanier, 2015; Yee & Bailenson, 2007) that need to be examined and understood, especially in the most recent and emerging manifestations of the phenomenon. Thus, a unified conceptual framework of mediated embodiment would help to facilitate the study of this phenomenon as a whole.

The first step is the development of a concept that encompasses all embodiment technologies. This defining concept needs to be broad enough to embrace the illusion of embodiment produced by any type of embodiment technology. At the same time, it needs to be narrow enough to only include experiences of embodiment that are technologically induced.

The concept of *mediated embodiment* is the most appropriate for this purpose. The term has previously been used in a similar manner to describe the degree to which the user's body is coupled to the interface (Biocca, 2002). Related terminology is also regularly used to describe several processes in virtual reality: users *embody* avatars, and the feeling of experiencing the avatar's body as one's own during a mediated embodiment experience is called *sense of embodiment* (Kilteni, Groten, & Slater, 2012). Notably, *virtual embodiment* describes the process of mediated embodiment specifically using the technology of virtual reality, that is, employing virtual reality technology to substitute a person's physical body with a virtual one (Spanlang et al., 2014).

Here, *mediated embodiment* extends the concept of virtual embodiment, and is defined as the technologically-generated illusion of substituting a person's physical body with an avatar, independent of the technology used to produce the illusion (Aymerich-Franch, 2018). *Mediated* refers to the use of technical mediums (Davis, 2000). *Embodiment*, as it applies here, indi-

cates the existence in the world through a body (Csordas, 1999). However, *embodiment* is a rather complex concept, which has been applied with many different meanings in many different fields and contexts. It remains rather vague as to what exactly it means to be embodied, or how humans and other physical systems are embodied.

Metzinger (2006, 2014) proposes a differentiation between first, second, and third-order embodiment. According to this author, first-order embodiment systems are "reactive, adaptive systems, achieving intelligent behavior without explicit computation" (Metzinger, 2014: 272). Second-order embodiment systems "increase their level of causal self-control by explicitly and holistically representing themselves as embodied" (Metzinger, 2014: 274). Finally, third-order embodiment systems are those that "not only explicitly model themselves as an embodied being, but also map some of the representational content generated in this process onto the level of conscious experience" (Metzinger, 2014: 274).

Importantly, in the third-order embodiment, physical systems consciously experience themselves as embodied, while possessing affective or sensorimotor states (Metzinger, 2014). This type of embodiment is found in conscious human beings and also in experimentally induced full-body illusions (Metzinger, 2014). Mediated embodiment experiences with virtual and robotic avatars are a type of experimentally/technologically induced full-body illusion. Hence, they can be considered third-order embodiment, according to this classification.

2 The role of avatars in mediated embodiment

Avatars are a core element of mediated embodiment. When people are embodied in avatars, they experience ownership and agency over the body of that avatar (Kilteni, Groten, & Slater, 2012), and self-location within its bodily boundaries (Lenggenhager, Tadi, Metzinger, & Blanke, 2007; Slater, Perez-Marcos, Ehrsson, & Sanchez-Vives, 2008, 2009; Slater, Spanlang, Sanchez-Vives, & Blanke, 2010).

Other terms used in place of *avatar* include "incarnation" or "appearance" (Harper, 2018). In virtual reality, this concept has been largely adopted to describe users' self-representation in the mediated environment (Ahn, Fox, & Bailenson, 2012). Both its roots and its acceptance in the virtual reality field make the concept perfectly extendable to also describe users' surrogate body in other forms of mediated embodiment. If this wider definition is adopted, then avatars can be classified in two main categories: virtual and physical.

Virtual avatars represent users in virtual reality, videogames, online virtual worlds, social media, and other forms of computer-mediated communication. However, only in immersive virtual reality do users *embody* the avatar, in the sense that the space generally occupied by the real physical body is replaced by the avatar's virtual body (Spanlang et al., 2014). Generally, avatars in virtual reality resemble human bodies, but avatar bodies that represent other entities, such as animals (Ahn, et al., 2016), can also be used for this purpose. Virtual avatars could potentially be used in other emerging technologies, such as in future forms of hologram embodiment.

Physical avatars currently represent users in robotic embodiment. A robot is a physical entity situated in the physical reality. Thus, when users embody a robot, the avatar can be classified as *physical*. At present, humanoid robots of closely human (Alimardani et al., 2013; Becker-Asano et al., 2012) and non-human appearance (Aymerich-Franch et al., 2015, 2016, 2017a, 2017b; Becker-Asano et al., 2012; Cohen et al., 2012, 2014; Kishore et al., 2014, 2016) are used as physical avatars. However, other physical entities such as drones, other types of robots, or even cyborgs might potentially become physical avatars in future forms of mediated embodiment.

3 Minimum conditions necessary for experiencing sense of embodiment in mediated embodiment

Mediated embodiment is related to the process of technologically embodying a user in an avatar, whereas a s*ense of embodiment* in a virtual or physical avatar body is a result of this process.

Kilteni, Groten, and Slater (2012) define *sense of embodiment* in the specific context of mediated embodiment as "the ensemble of sensations that result from being inside, having, and controlling an avatar body" (p. 374–375).

According to Kilteni, Groten, and Slater (2012), sense of embodiment results from: body-ownership, which is the feeling that a body or a limb belongs to oneself (Gallagher, 2000; Tsakiris, 2010); self-location, which is a determinate volume in space where one feels to be located (Blanke & Metzinger, 2009); and agency, which refers to the capacity to control one's own actions (Haggard, 2017) or, in the particular case of mediated embodiment, the avatar's actions (Kilteni, Groten, & Slater, 2012).

The reason why humans are able to experience sense of embodiment in avatar bodies is a complex question. A crucial aspect to understand in relation to this process of re-embodiment is the importance of overcoming the conception of any living being – including humans – as closed, permanent units, at all levels of their existence.

In this regard, it is important to acknowledge the high malleability of human minds and bodies to permanently redefine their boundaries and to incorporate external apparatus as part of their beings (Clark, 2007). This condition of permanent change reaches as far as to the level of self-consciousness. According to the self-model theory, "there is no such thing as a substantial self (as a distinct ontological entity, which could in principle exist by itself), but only a dynamic, ongoing process creating very specific representational and functional properties" (Metzinger, 2007).

Mediated embodiment setups have been used to provide avatar bodies that extend beyond traditional human appearances, including animals (Ahn et al., 2016), bodies with extra limbs (Schaefer, Heinze & Rotte, 2009; Won et al., 2015) and tails (Steptoe et al., 2013), or highly robotic-looking avatars (Aymerich-Franch et al., 2016, 2017a, 2017b; Aymerich-Franch, Kishore, & Slater, 2019). The sense of embodiment reported by participants in these experiences varies across studies and the limits of embodiment for non-human looking entities remain unclear (Aymerich-Franch & Ganesh, 2016). The fact that avatar bodies with a closer resemblance to human bodies seem to elicit stronger sense of embodiment suggests that sense of embodiment might be regulated by a top-down perceptual body image that modulates the way in which multisensory information is processed from the bottom–up (Maselli & Slater, 2013).

The role of body image in leading to sense of embodiment is more specifically discussed by Haans and Ijsselsteijn (2012). They suggest that the three orders of embodiment proposed by Metzinger (2006, 2014) can be explained in terms of the morphology of the body – the body schema – which is "a dynamic distributed network of procedures aimed at guiding behavior" (Haans & Ijsselsteijn, 2012: 213), and the body image, which is a perceptual, cognitive, and/or emotional awareness of the body together with the fact that the body is perceived as owned and as something in itself (Gallagher, 1986). For Haans and Ijsselsteijn (2012), first-order embodiment means having morphology only, second-order embodiment entails having morphology and a body schema, and third-order embodiment implies having morphology, a body schema, and a body image (Haans & Ijsselsteijn, 2012). In a distinction between functional and phenomenological extensions of the self, Haans and Ijsselsteijn (2012) suggest that when the components of a mediated embodiment system are effectively integrated in the body schema (second-order embodiment), humans can interact with the mediated environment as if the mediating technology was not there. However, feeling embodied in an avatar cannot be explained by incorporation of the avatar into the body schema alone, as it requires consciousness of having a body image, or, in other words, third-order embodiment (Haans & Ijsselsteijn, 2012).

There are numerous empirical works that contribute to explain *how* the illusion of embodiment can be artificially induced in experimental contexts. Multisensory correlations are one of the fundamental conditions in this regard. The well-acknowledged rubber-hand illusion experiment (Botvinick & Cohen, 1998) showed how synchronous touch applied to a hidden real hand and a physical rubber hand visible to the participant led to sense of ownership over the rubber hand.

Similar principles can be applied to create full-body embodiment illusions. For instance, Petkova and Ehrsson (2008) gave participants a first-person perspective (1PP) from a mannequin body and used visuo-tactile synchronization between the mannequin body and the participants' real body to show that ownership illusions also extend to the full-body.

In the specific context of mediated embodiment, there is also empirical evidence that sense of embodiment can be induced in virtual and robotic limbs and bodies when visuo-tactile synchronization is applied between the avatar and the participant's bodies (Aymerich-Franch et al., 2017a; Maselli & Slater, 2013; Slater, Perez-Marcos, Ehrsson, & Sanchez-Vives, 2009).

Given the characteristics of mediated embodiment technologies, visuo-motor synchronization is generally used to induce sense of embodiment in avatar bodies (rather than visuo-tactile synchronization). To create visuo-motor synchronization in mediated embodiment systems, the movements of the human user are mapped to the avatar body using real time motion capture (Spanlang et al., 2014).

Other than multi-sensory correlations, a 1PP over the avatar body, which translates also to a spatially coincident location between the real and the avatar body, has also been highlighted as essential for eliciting a body ownership illusion (Maselli & Slater, 2013; Slater & Sanchez-Vives, 2014).

While in certain experimental conditions it has been suggested that 1PP alone (Carey, Crucianelli, Preston, & Fotopoulou, 2019; Maselli & Slater, 2013; Slater, Spanlang, Sanchez-Vives, & Blanke, 2010), or multi-sensory correlation alone (Lenggenhager, Tadi, Metzinger, & Blanke, 2007), might be sufficient to elicit the embodiment illusion, the combination of the two seems crucial to induce sense of embodiment, especially as the resemblance of the avatar body becomes increasingly different to the human body in appearance (Maselli & Slater, 2013).

In summary, the minimum conditions that need to be satisfied in order to achieve the illusion of mediated embodiment appear to be the following:

- A physical or digital entity that acts as the avatar body
- First-person perspective from the avatar and occluded vision from the real, physical surroundings that result into a spatially coincident location between the avatar body and the physical body of the user (Maselli & Slater, 2013; Slater & Sanchez-Vives, 2016; Spanlang et al., 2014)
- Multisensory correlation between the user and the avatar bodies, which is generally translated to visuo-motor synchronization between the user body movements and the avatar movements in mediated embodiment setups (Spanlang et al., 2014)

The implementation of these conditions at the technical level in the principal existing mediated embodiment systems is described below (in section 4: Technical Commonalities of Mediated Embodiment Technologies).

4 Technical Commonalities of Mediated Embodiment Technologies

At present, virtual reality and robots are the principal technologies used to create experiences of mediated embodiment. Virtual reality environments are digitally created 3D spaces in which

users interact through an avatar. Users' movements are tracked, and their surroundings rendered in accordance with these movements (Fox, Arena, & Bailenson, 2009). *Robots*, or more specifically, *physical robots*, can be broadly defined as autonomous or semi-autonomous machines which are able to sense the environment around them and perform complex tasks within it. Robots that resemble a human body in terms of shape (limbs, head, trunk) are termed "humanoid robots". Teleoperation is the operation of a machine by a person at a distance, in which a human utilizes a master, a manipulator or joystick to give movement commands to the slave (the robot), which performs the task accordingly (Hokayem & Spong, 2006). The operator (the person controlling the machine or device) has either direct visual contact with the machine or receives visual feedback through a camera mounted on the device. Robot teleoperation could potentially lead to mediated embodiment if the minimum conditions necessary to achieve this illusion are satisfied.

The illusion of mediated embodiment is achieved following a series of technical principles which are common to all embodiment systems. These technicalities are oriented to provide sensory feedback and control of the avatar movements, and satisfy (at least) the minimum necessary conditions for the illusion of mediated embodiment to occur. Concerning sensory feedback, the technical commonalities are the following:

- **Visual feedback**: As stated earlier, 1PP is a fundamental requirement to induce the illusion of embodiment (González-Franco, et al., 2010; Maselli & Slater, 2013; Slater et al., 2010). A head-mounted display (HMD) is used to provide visual feedback from the avatar's "eyes" and occlude the participant's view of the real world. In virtual reality, HMDs display the virtual environment whereas in robot embodiment the HMD displays real time video feedback from the robot's eyes. Users are able to see the limbs and part of the body of their avatars if they look down, at the location corresponding to their real limbs. In addition, full-body identification can be achieved by reflecting the avatar's appearance in physical and virtual mirrors or other surfaces (Aymerich-Franch et al., 2016; Aymerich-Franch, Kizilcec, & Bailenson, 2014; González-Franco, Pérez-Marcos, Spanlang, & Slater, 2010).
- **Feedback from other senses**: While feedback from other senses is not a minimum condition to induce the embodiment illusion in the currently existing mediated embodiment technologies, it can be implemented to enhance the experience (Spanlang et al., 2014). Auditory feedback is implemented with the use of headsets or speakers. Haptic feedback, currently utilised less commonly, can be implemented with the aid of different types of haptic devices that facilitate grasping and moving objects, experiencing the feel of a texture, or receiving force feedback (Fox et al., 2009; Stone, 2001). Olfaction and gustation are generally not implemented.

The shared technical principles related to providing control of the avatar's movements (related to the minimum condition of visuomotor synchronization) can be synthetized as follows:

- **Head-tracking**: In virtual reality embodiment, the movements of the user's head are followed in real-time enabling the system to update the virtual viewpoint based on the data of the tracked head (Spanlang et al., 2014). In robot embodiment, head movements are synchronized to the robot's head movements and users receive video-feedback from cameras mounted on the robot's head in real-time (Aymerich-Franch et al., 2015, 2016, 2017a, 2017b; Kishore et al., 2014, 2016).
- **Body-tracking**: Users' movements can be tracked and synchronized to the avatar's movements for the control of limb and body gestures and to make the avatar move in the space. In virtual reality, a user's body movement is generally tracked and synchronized to the movement of the avatar body, with spaces rendered according to these movements (Fox et al., 2009; Spanlang et al., 2014). For physical avatars, control of the movement of the robot body can be achieved with a motion capture suit (Aymerich-Franch, Kishore, & Slater, 2019), a joystick (Aymerich-Franch et al., 2015, 2016), a brain-computer interface (Alimardani et al., 2013; Gergondet et al., 2011), fMRI (Cohen et al., 2012, 2014; Shinkareva et al., 2008), or eye-tracking technologies (Kishore et al., 2014). The ability to control the movement of the avatar body enables the user to discern the boundaries of the embodied body from the surrounding space.

Figure 1 summarizes the minimum conditions necessary for experiencing sense of embodiment and its relation to the technical commonalities of mediated embodiment technologies.

Any technology, in addition to virtual reality and robots (e.g. drones, holograms), that follows these principles and meets the minimum conditions for the mediated embodiment illusion to occur could potentially be used for mediated embodiment. For instance, a mediated embodiment system could be created from a drone provided that the users had a 1PP from the "body" of the drone, their movements were synchronized to those of the drone (e.g. moving the left arm, moves the drone to the left), and the drone presented physical features that were coherent with the body model. Smolyanskiy and Gonzalez-Franco (2017) designed an advanced drone teleoperation system using a fully immersive setup that provided stereoscopic 1PP through a virtual reality HMD, which could be regarded as a precedent in this regard. Similarly, for a hologram, the illusion of mediated embodiment could potentially take place, provided that a HMD was used which enabled the user controlling the hologram to view its perspective in its surroundings. The users should be able to see the body of their hologram when they look down. Empirical validation, however, is required to prove these assumptions.

It is worth emphasizing that a technology should only be classified as a *mediated embodiment technology* if it satisfies these minimum criteria. For instance, an avatar in a videogame displayed on a laptop screen would not fall under mediated embodiment, because the avatar and the human body do not have a spatially coincident location.

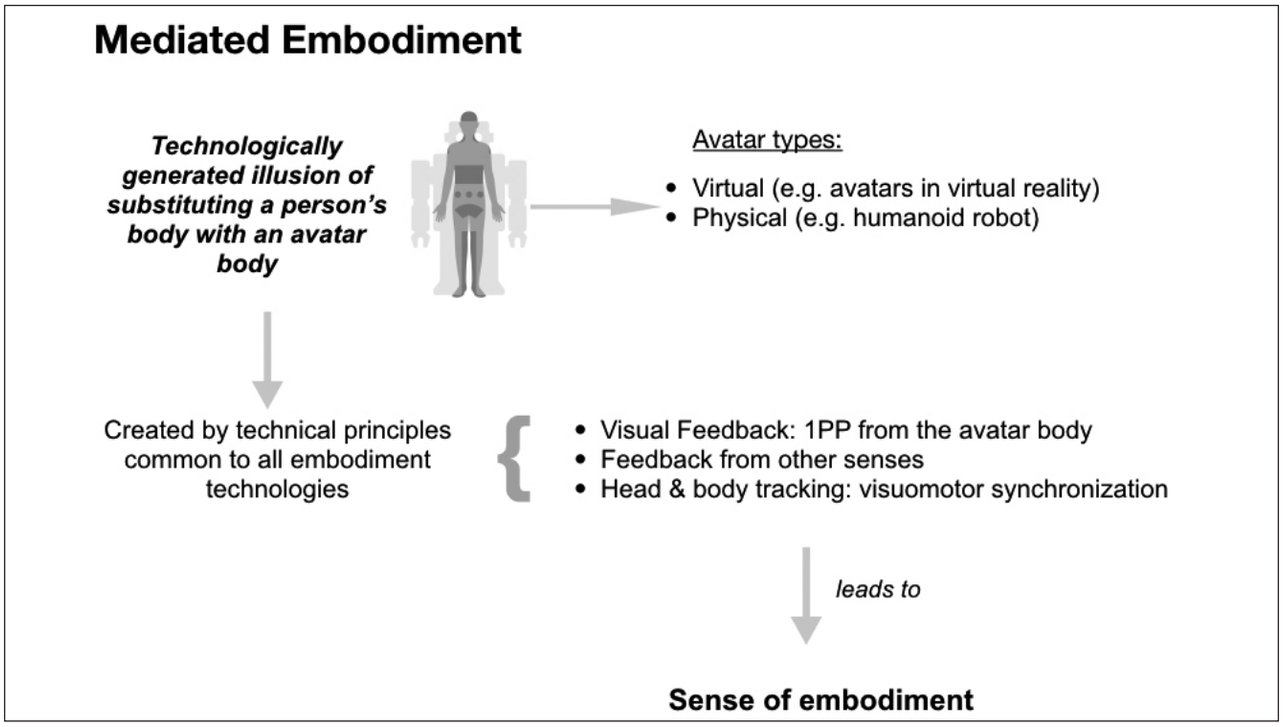

Figure 1. The Mediated Embodiment framework

5 Mediated embodiment as a tool to extend human capabilities

Since ancient times, human beings have tried to extend their capabilities with the aid of external tools and objects (Berti & Frassinetti, 2000; Maravita & Iriki, 2004). Humans integrate these tools as part of their body. There is evidence that when the cerebral representation of body space is extended to include objects or tools used by the person, space previously mapped as far can be remapped as near (Berti & Frassinetti, 2000). Mediated embodiment technologies can be regarded as an evolution of more primitive means of extending our capacities, such as using a hammer. Hence, it can be seen as a way to extend the human senses (Biocca, 1992), body, and mind (Biocca & Delaney, 1995).

Based on the principal experimental works conducted to date with mediated embodiment technologies, it is possible to identify four directions towards which mediated embodiment systems enhance these capabilities: embodiment of a new self; expanded travelling capabilities; expanded body capabilities; and immortality. Social scientists need to examine experiences of mediated embodiment in relation to each of these capabilities with the dual purpose of promoting positive uses of mediated embodient and anticipating potential negative outcomes.

5.1 Embodiment of a new self

The desire to become someone different using an avatar can be connected to its liberating effects. Mediated embodiment allows users to express their "true mind, the authentic self, unfettered by concerns of self-presentation, or even physical sanction" (Spears & Lea, 1994, p.430). These experiences give users the opportunity to create new identities and explore what it means to be someone different (Turkle, 1999). Mediated embodiment also gives users the possibility to disassociate the avatar's actions from their real identity, which can reduce feelings of vulnerability regarding self-disclosure, inhibition, or evaluation anxiety, and therefore facilitate social interaction (Suler, 2004; Spears & Lea, 1994).

When users embody an avatar, their self-representation experiences important transformations. These transformations can be as moderate as changing eye and hair color and as drastic as changing gender (Slater et al., 2010), age (Hershfield et al., 2011), or skin color (Peck et al., 2013). They can even be as extreme as changing "species" to become an animal (Ahn et al., 2016), or a robot (Alimardani et al., 2013; Aymerich-Franch et al. 2015, 2016, 2017a, 2017b; Becker-Asano et al., 2012; Cohen et al., 2012, 2014; Kishore et al., 2014, 2016).

The body plays an important role in shaping how the mind thinks (Clark, 2007; Gallagher, 2005). Thus, being in an avatar's shoes, particularly when it presents substantially different visual characteristics from the real self, may cause important alterations in human behavior. In particular, studies in virtual reality have found that users' behavior is affected by the characteristics of the avatar that they represent (Yee & Bailenson, 2007). This phenomenon, named *Proteus Effect*, describes how the appearance of the embodied avatar is able to modify the behavior of the user and it is believed to occur because individuals associ-

ate certain traits of an avatar with specific behavioral stereotypes and expectations (Yee & Bailenson, 2007). Therefore, when users believe that others will expect certain behaviors from them because of their avatars' appearance, they engage in those anticipated behaviors (Yee & Bailenson, 2007).

These findings suggest that mediated embodiment could be successfully used as a method for self-improvement. Use of mediated embodiment environments is considered a safe, controlled, and cost-effective method for treating mental health issues, such as phobias and anxiety-related disorders (Riva, 2005), substance-related disorders, or eating disorders (Freeman et al., 2017). For instance (Aymerich-Franch, Kizilcec, & Bailenson, 2014) found that modifying the appearance of the avatar so that it looks dissimilar to a user's real appearance can contribute to reducing public speaking anxiety. Falconer et al. (2014, 2016) showed how avatar embodiment can be used to increase self-compassion and to reduce depression and self-criticism. Also, Osimo, Pizarro, Spanlang, and Slater (2015) and Slater et al. (2019) found that mediated embodiment experiences could be successfully used for self-counselling.

Other findings connected to the benefits of mediated embodiment suggest that these experiences could also be implemented to reduce racial bias (Groom, Bailenson, & Nass, 2009; Peck et al., 2013), and promote social behavior (Rosenberg, Baughman, & Bailenson, 2013) or pro-environmental behavior (Ahn et al., 2016; Bailey et al., 2015). On the other hand, mediated embodiment may also engender negative effects, such as inducing aggressive behavior (Calvert & Tan, 1994), that also need to be examined.

5.2 Expansion of travelling capabilities

A particularity of physical avatars is that they can be controlled remotely. Thus, users and physical avatars can be situated in different physical spaces – even in different countries (Cohen et al., 2012, 2014; Kishore et al., 2014). In the future, users embodied in physical avatars could be transported to the most remote places on Earth, into space, or even to other planets. As for virtual avatars, users embodied in these entities have the chance to explore digitally created fantasy worlds that are non-existent in reality. In fact, the expansion of human travelling capabilities is nothing new. Communication technologies such as cinema or television, as well as literature, have performed this function for centuries (Green, Brock, & Kaufman, 2004). The core and constituting difference of mediated embodiment compared to these precedents is that, in mediated embodiment, users are able, through their avatars, to interact with and in the remote or virtual environments, and their actions have consequences on that environment.

The sense of *Presence* is a thoroughly researched area in relation to the extended capability of travelling, especially in virtual reality. Presence is defined in virtual reality studies as the sense of being 'there', in the virtual environment (Lombard & Ditton, 1997). When users feel present in the location of the avatar, they behave and respond emotionally very similarly to how they do in reality (Bailenson et al., 2001; Bailenson et al., 2003; Garau et al., 2005; Sanchez-Vives & Slater, 2005).

A series of applied uses of mediated embodiment can be identified in connection to the extended capability of transportation. For instance, feeling present in the avatar's environment (and separated from the real environment) can be used as a pain distraction method during an operation or for someone suffering from illness (Malloy & Milling, 2010; Wiederhold & Wiederhold, 2007). Likewise, it could also be used for mood management and stress relief, a function largely attributed to communication technologies (Bryant & Zillmann, 1984; Knobloch, 2003; Zillmann, 1988).

5.3 Expansion and restitution of body capabilities

A physical avatar of a robot can possess capabilities far beyond the typical human body. A robot body can be considerably stronger, have the ability to fly or to spend extended periods underwater, resist extremely high or low temperatures and adverse climate conditions as well as toxic, radioactive, and non-oxygen environments, and may have extra and/or longer limbs. The nature of a digital avatar is non-corporeal and therefore free of all constraints linked to corporality such as gravity or perishability.

It is worth noting that even if the resemblance of the avatar to a human body may improve the sense of embodiment (Tsakiris & Haggard, 2005; Maselli & Slater, 2013), users are able to experience sense of embodiment in avatars that do not reflect their real appearance (Ahn et al., 2016; Aymerich-Franch, 2012; Steptoe, Steed, & Slater, 2013; Won et al., 2015). Thus, users can embody avatars that present substantially different body structures from humans and integrate body-parts that do not correspond to their real body structure, such as extra limbs (Won et al., 2015) or tails (Steptoe, Steed, & Slater, 2013). Research has also found that people embodied in avatars are able to rapidly learn to use a novel body with substantially different body schemas to successfully complete a task (Won et al., 2015).

Avatars, especially of a physical nature, might play an important assistive role in hazardous situations, such as rescue activities, nuclear disasters, or natural catastrophes. In addition, people with mobility impairments and amputees could use avatar bodies for sensorimotor performance, or could control a secondary body to carry out daily routines (e.g. to go shopping or help them to dress). Assistive technologies such as advanced prosthetics or wearable exoskeletons provide precedents in this regard (Cowan et al., 2012).

Mediated embodiment technologies could also be implemented for neurorehabilitation purposes (Perez-Marcos et al., 2012). For instance, techniques such as virtual mirror visual feedback could be useful for motor rehabilitation in people recovering from strokes (Perez-Marcos, 2018).

5.4 Immortality

Physical avatars (principally represented by robots) are made of long-lasting materials such as metal and plastic, and digital avatars are non-corporeal entities which cannot expire. The abiding nature of avatars, in comparison to the perishable flesh-and-bones human body, has led some to envisage avatars as containers of the human mind that can support a perpetual existence (2045Initiative, 2015). This perspective assumes that immortality could be achieved if human consciousness could be transferred to avatar bodies (2045Initiative, 2015). This idea implies re-conceptualizing the notion of the "self" and raises a series of challenging questions: What is the self, exactly? What are the minimal necessary requirements to experience it? And does a mind exists as an independent entity from the body? Similar questions have occupied philosophers and scientists for centuries (Descartes, 1644/1984; James, 1890; Kant, 1781/1999) and still remain unresolved.

In this regard, advanced mediated embodiment systems could be used as methodological tools to study the relationship between body and mind as well as the nature of the self (Ehrsson, 2007; Lenggenhager et al., 2007). Some studies have used mediated embodiment as a method to explore self-consciousness (Aymerich-Franch et al., 2016; Ehrsson, 2007; Guterstam & Ehrsson, 2012; Lenggenhager et al., 2007; Maselli & Slater, 2013; Petkova & Ehrsson, 2008; Slater et al., 2009; van der Hoort, Guterstam, & Ehrsson, 2011). Other studies have highlighted the usefulness of mediated embodiment experiences to explore (virtual) mortality and near-death experiences (e.g. Barberia et al., 2018).

Given that users experience the properties of the avatars' bodies as if they were their own (de Vignemont, 2011; Kilteni, Groten, & Slater, 2012), mediated embodiment could also be used as a methodological tool to empirically explore philosophical stances that argue that consciousness and cognition is dependent on the body and the environment (Aymerich-Franch, 2018). One of the most representative theorists in this regard is the phenomenologist philosopher Merleau-Ponty (1945/2002), who defended the body and perception as the primary sources to understand the world. Also, the Embodied Cognition approach sustains that cognition is highly dependent on the characteristics of the physical body and its interactions with the world (Shapiro, 2010; Thelen, Schöner, Scheier, & Smith, 2001). According to this view, the particular form of embodiment determines the way the environment appears to the agent as well as the way in which the organism can interact with it (Lakoff & Johnson, 1999; Varela, Thompson, & Rosch, 1991).

6 Conclusion

Mediated embodiment technologies are experiencing a tangible process of democratization. The commercialization of low-cost virtual reality visualization devices exemplifies this process. Systems for robot embodiment might also follow a similar path to reach the market, considering that low cost robots are already available to consumers (e.g. *Pepper*). The use of drones or holograms for embodiment might potentially evolve as other technologies of mediated embodiment, provided that these technologies apply the minimum conditions necessary to produce the illusion of embodiment.

Experiences of embodiment in these technologies might engender important behavioral, cognitive, and attitudinal effects for users, similar to those identified for avatar embodiment in virtual reality (Aymerich-Franch, Kizilcec, & Bailenson, 2014; Groom, Bailenson, & Nass, 2009; Hershfield, et al., 2011; Peck, Seinfeld, Aglioti, & Slater, 2013; Rosenberg et al., 2013; Won, Bailenson, Lee, & Lanier, 2015; Yee & Bailenson, 2007). These consequences are still unknown and need to be carefully examined.

Throughout this article, I have crafted the foundations of a unified framework of mediated embodiment that facilitates the analysis of the emerging mediated embodiment technologies. The framework should also contribute to creating mutual awareness of the commonalities between the work of scholars in different disciplines examining mediated embodiment related topics. Specifically it can highlight links between researchers working in robotic embodiment and robot teleoperation from a Robotics perspective, and those working with virtual reality in the Communication, Media Psychology, or Neuroscience fields. The common framework is expected to facilitate knowledge transfer and collaboration among these and other research communities involved in the research and development of embodiment technologies.

At the core of this framework, I placed the concept of *mediated embodiment*, which defines the technologically generated illusion of substituting a person's body with an avatar body, independent of the technology used to produce the illusion. I suggested that the minimum conditions necessary to create the mediated embodiment illusion are: a digital or physical avatar to act as a substitute body; 1PP from the avatar and occluded vision from the real surroundings; and visuomotor synchronization of the user' movements to the avatar. Furthermore, I identified a series of technical commonalities across mediated embodiment technologies that are used to create the illusion of embodiment. These commonalities will need to be periodically revised as mediated embodiment technologies evolve.

In the second part of the article, I framed mediated embodiment technologies as an advanced tool to increase human capabilities and identified four directions towards which this technology evolves: the embodiment of a new self; the expansion of traveling capabilities; the expansion of body capabilities; and the reach of immortality. Finally, in addition to understanding the effects of this phenomenon, I emphasized that the scientific community has an important responsibility in promoting positive uses of mediated embodiment technologies (Riva, Baños, Botella, Wiederhold, & Gaggioli, 2012). I further suggested a series of positive implementations for these technologies within the frame of the four extended human capabilities highlighted.

Finally, mediated embodiment raises important ethical and legal questions that need to be addressed (Aymerich-Franch, Kishore, & Slater, 2019; Aymerich-Franch & Fosch-Villaronga,

2019, 2020; Metzinger, 2013). For instance, shall we consider avatars as part of the self from a legal perspective? (Aymerich-Franch & Fosch-Villaronga, 2019). Shall we follow the same moral principles that we use in interacting with a flesh and bone human body, to interact with an avatar? There is evidence to indicate that during mediated embodiment users cognitively and emotionally experience the surroundings of their avatar as if they were their real immediate surroundings (Bailenson et al., 2001, 2003; Garau, Slater, Pertaub, & Razzaque, 2005; Lee, 2004; Sanchez-Vives & Slater, 2005), and respond to threats to the avatar as if their real body was actually in danger (González-Franco et al., 2010; Slater et al., 2010). Thus, in a way, it can be assumed that users integrate the avatar's body as part of themselves and that the sense of self expands to this new body. All things considered, the need to maintain interpersonal distance when we interact with an avatar, and the desire to develop legislation to safeguard its integrity, do not seem unjustified (Aymerich-Franch & Fosch-Villaronga, 2019). Future research in mediated embodiment will also need to address these matters.

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Conflict of Interest

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Development of a Multidimensional App Quality Assessment Tool for Health-Related Apps (AQUA)

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Abstract

Background: A multitude of health-related mobile applications are available to the public in app stores. Many of these apps were not developed by health professionals and are not scientifically valid. To facilitate a safe handling and use of such apps, it is important to assess their quality in a standardized way. Some instruments for app quality assessment already exist, although they have some limitations, which we want to improve upon with a new multi-dimensional assessment tool.

Objectives: The objective of this paper is to explain the development of a new multidimensional criteria-based tool for the quality assessment of health-related apps (AQUA).

Method: Based on existing app-quality assessment tools and guidelines for evaluating health-related app-quality, questionnaire items were constructed to assess the quality of mHealth apps from the perspective of both experts and users. Before the finalization of the questionnaire that would form the basis of AQUA, we conducted a pretest of the original German items with six participants, who gave qualitative feedback on the items while filling them out as they completed the surveys.

Results: An expert and a user version of AQUA were developed in English and German. The expert version consists of 31 items in seven dimensions: Usability; User Engagement; Content; Visual Design; Therapeutic Quality; Security; and Information. The user version consists of 31 items in the following dimensions: Usability; User Engagement; Content; Visual Design; Therapeutic Quality; Impact; and Information.

Conclusion: AQUA is a brief multidimensional app-quality assessment tool that can be used by experts and app-users to quickly determine the quality of health-related and mental health-related apps.

Keywords: mHealth, health-related apps, digital health, quality assessment, evaluation

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1 Introduction

Mobile app-based mental health interventions are becoming increasingly popular in the field of mobile health (mHealth) as they have the potential to reach more people in need of mental health care than traditional mental health services (Kazdin, 2017). They are low-threshold interventions that can support people in the self-management of their health if adequately designed (Baldwin, Singh, Sittig, & Giardina, 2017). Different mHealth apps exist for a multitude of conditions, including diabetes (Barreda-Pérez, De la Torre, & López-Coronado, 2013), depression (Shen et al., 2015), and smoking-cessation (Abroms, Padmanabhan, Thaweethai, & Phillips, 2011). The impact of such interventions depends on different factors, such as users' motivation and ability to engage with them (Kohl, Crutzen, & de Vries, 2013). To improve user engagement in health-related mobile apps, the concept of therapeutic persuasiveness, meaning a persuasive design and an app's therapeutic potential (Webb, Joseph, Yardley, & Michie, 2010), or a human factor (e.g. a chatbot or avatar), that supports the therapeutic alliance between user and intervention in the app (Ly, Ly, & Anderson, 2017), can be incorporated. A myriad of health-related and mental health-related apps are currently available in different app stores such as the Google Play Store[1] and the Apple Store[2]. However, many of these apps are often hastily developed without an empirical basis (BinDhim, Hawkey & Trevena, 2015). Consequently, quality assessment for these apps is becoming increasingly crucial to ensure their

[1] https://play.google.com/store

[2] https://www.apple.com/at/ios/app-store/

safe and effective use. BinDhim, Hawkey, & Trevena (2015), for example, suggested the use of evidence-based guidelines to systematically assess app content and to avoid consumer ratings to judge the quality of health-related apps. A recent meta-analysis by Nouri et al. (2018) of the existing literature on mHealth app quality reviewed 23 studies concerning mHealth app quality assessment tools. Based on this review they suggested seven main categories of app quality assessment criteria: Design; Information/Content; Usability; Functionality; Ethical Issues; Security and Privacy; and User-perceived value. Based on an earlier systematic review of headache apps, Hundert et al. (2014) established a set of seven quality criteria an ideal headache app should contain. Among other criteria, it should "be created with clinical and/or scientific headache expertise, have undergone testing…, measure clinically relevant headache variables" and "be usable". To measure the usability of an app, they suggested a list of ten usability heuristics, which includes criteria such as aesthetic design, and user anonymity and/or transparency regarding saved data (Hundert et al., 2014, p. 3). Mcmillan et al. (2016) identified the following nine dimensions relevant for app quality assessment based on the National Institute for Health and Care Excellence behavior change guidance (2014): Purpose; Planning and development; Usability; Initial assessment and tailoring; Behavior change technique; Maintenance & relapse prevention; Evaluation; Documentation; and Data protection.

Boudreaux et al. (2014, p. 363) proposed the following seven strategies for evaluating the quality of mHealth apps:

"(1) Review the scientific literature,
(2) Search app clearinghouse websites,
(3) Search app stores,
(4) Review app descriptions, user ratings, and reviews,
(5) Conduct a social media query within professional and, if available, patient networks,
(6) Pilot the apps, and
(7) Elicit feedback from patients."

Although such a comprehensive evaluation process can help health care providers in selecting reliable mHealth apps, it might require too much effort to be efficiently used in routine practice. Standardized app quality assessment tools can therefore help facilitate this process.

One widely used instrument for specifically assessing the quality of apps is the Mobile App Rating Scale (MARS; Stoyanov et al., 2015). MARS is a 23-item multidimensional app quality assessment tool with the following five dimensions: *Engagement; Functionality; Aesthetics; Information quality;* and *Subjective quality*. The user version (uMARS) consists of 20 items in the same dimensions (Stoyanov, Hides, Kavanagh, & Wilson, 2016). Another tool for measuring the quality of apps is *Enlight*, a multidimensional set of scales that was developed for the quality assessment of internet-based electronic health (eHealth) programs (Baumel, Faber, Mathur, Kane, & Muench, 2017), but can also be employed for the assessment of app-based (mHealth) interventions for (mental) health related behavior. To our knowledge, it is the first instrument to incorporate the concepts of therapeutic persuasiveness and therapeutic alliance into the quality assessment of web-based and app-based interventions. Both of these assessment tools are valuable in the process of mHealth app quality assessment but have some limitations. While MARS is easy to use, it does not include all relevant criteria that have to be considered when assessing mHealth app quality and shows psychometric inconsistencies such as only moderate inter-rater reliability described on some items (Stoyanov et al., 2015). *Enlight* consists of a quality assessment section and an additional checklist section, which increases the amount of information that can be obtained for the assessment, although the differing answer formats complicate the assessment process. Going one step further, assessing an app's quality during the development phase – before its release to the public – would facilitate the process of selecting reliable mHealth apps for both health care providers and end users by making developers responsible for ensuring the quality of an app. In this context, our aim was to create an app quality assessment tool to assess an app's quality during the development process, that can be used by both experts involved in the development process and possible users. This would ensure all quality dimensions are optimized before an app is released to the public.

Table 1. Similarities and Differences between MARS and Enlight

MARS	**Enlight**
5 Dimensions of quality criteria (MARS & uMARS)	7 Dimensions of quality criteria
Engagement	User engagement
Aesthetics	Visual design
Information quality	Content
Functionality	Usability
Subjective app quality	General subjective evaluation
	Therapeutic persuasiveness
	Therapeutic alliance
	Checklist section
	Credibility
	Privacy explanation
	Basic security
	Evidence-based program ranking

We therefore wanted to create a multidimensional mHealth app quality assessment tool that combines the strengths of the above-mentioned instruments by not only assessing further relevant quality criteria, but also by establishing an easy and efficient evaluation process. In contrast to the existing tools, we want to create an assessment instrument specifically tailored to people involved in app development, to obtain valid app ratings. As Grundy, Wang, & Bero (2016) suggest involving end users in the study design when developing health-related apps, as well as using multi-dimensional quality assessment tools, another aim was to also create a user version of AQUA to enable a quality assessment process of health-related apps from the user's point

of view. Such a tool would allow end users to be involved in the development process, which would give app developers the opportunity to improve certain aspects that are important to end users before releasing the app to the public.

2 Method

The AQUA questionnaire was developed in the context of the EU Project CHRODIS+. CHRODIS+ is an initiative of 21 EU-countries to improve the treatment of chronic diseases with a three-year time frame (2017-2020) As part of this project, health-related apps for patients with chronic diseases, such as Tinnitus, are being developed and tested respectively by developers and app users in a two-step process. The principal aim of the development of AQUA is to facilitate this process by making it possible for both experts and end users to assess app-quality and demonstrate which dimensions of an app need to be improved. The primary approach to the development of the AQUA app was to combine the existing set of criteria included in MARS (Stoyanov et al., 2015) and *Enlight* (Baumel et al., 2017) and format it in a coherent way to enable a more efficient app-quality assessment process. We constructed a pool of items based on the dimensions included in these instruments. Additionally, we conducted an exploratory literature review to identify further app-quality criteria not mentioned in *Enlight* or MARS. English and German language articles from the years 2010 to 2019 were retrieved from PsycInfo and Scopus. The search terms used were "mobile" OR "mhealth" AND "app*" PAIRED WITH "quality" AND "assess*" OR "criteria" OR "evaluat*". Relevant criteria for the development of AQUA were gathered using a novel guideline for the certification of internet-based self-management interventions proposed by Klein et al. (2018). They introduced a set of eight criteria, with 17 sub-criteria, that internet-based interventions including mobile app-based interventions must fulfill in order to be certified. The central criteria are therapeutic quality requirements, patient and data security, and evidence of efficacy. Klein et al. suggest differentiating between so-called knockout (K.O.)-criteria, that must be fulfilled by an intervention for it to be certified, and descriptive quality criteria, which should be fulfilled but do not influence whether an intervention receives certification. Named K.O.-criteria include: transparency regarding the aim of the intervention; an evidence base; and a detailed and comprehensible description of the intervention including disclosure of eventual costs. Descriptive criteria include transparency regarding which user data is saved, where it is saved, and for what purposes. Ease of use and intuitive navigation are also included in the descriptive criteria (Klein et al., 2018).

The criteria extracted as a result of the literature review were categorized into dimensions and added to the already existing dimensions extracted from MARS and *Enlight*. Following this categorization, items were formulated in a way to assess the extent to which health-related apps adhere to these criteria from both an expert and a user point of view. After the items were created, we conducted a pretest of the user questionnaire similar to cognitive pretesting with a convenience sample of possible future users, which consisted of six participants (3 women and 3 men, aged 19 to 58 years old). We chose participants who had already installed some mHealth apps on their phones, and expressed an interest in being involved in the process of mHealth app development by assessing an app's quality before release. We pretested the user version of the questionnaire to ensure that the items were as clear as possible to future participants not involved in the development of apps. After verbal consent was obtained from participants, they were asked to each test a health-related app already installed on their phone, before assessing the quality of this app with the questionnaire. The tested apps were Headspace[3], Runtastic[4], Moodpath[5], and TinnitusTipps[6]. Only the German version of the questionnaire was pretested, as all the participants were German-speakers. In cognitive pretesting, the participants are usually asked to think aloud while filling out a questionnaire (Hilton, 2017). In our case, we asked the participants to write any emerging thoughts as well as positive or negative feedback next to the items in the questionnaire while filling it out. The items were then optimized based on the resulting feedback.

3 Results

These methods resulted in the following eight basic dimensions of app-quality: Usability; User Engagement; Content; Visual Design; Therapeutic Quality; Security; Information; and Impact. We developed both an expert version and a user version of AQUA to assess mHealth app quality from different perspectives. All items use a 5-point Likert scale from 5 – strongly agree to 1 – strongly disagree, except for the item *email confirmation* which uses a yes/no format. By calculating the mean scores for each dimension, the quality of an app with regard to each of the dimensions can be determined and compared. A total score can also be calculated by calculating the overall mean. This is less precise, but it allows for the comparison of different health-related apps. Both versions of AQUA exist in English and German languages.

4 Expert Version

The expert version of AQUA is designed for persons who are actively involved in the development of apps and are thus more aware of the aspects to be considered in the design of an app than users or even (mental) health professionals. It consists of 31 items in the following seven dimensions: Usability (4); User Engage-

[3] https://www.headspace.com
[4] https://www.runtastic.com/de/
[5] https://mymoodpath.com/en/
[6] https://tinnitustipps.lenoxug.de/

ment (5); Content (5); Visual Design (4); Therapeutic Quality (5); Security (3); and Information (5). The dimension Usability is composed of the items: *Performance*; *Navigation*; *Learnability*; and *Ease of Use.* User Engagement is composed of: *Personalization*; *Interest*; *Entertainment*; *Interaction*; and *Gamification*. Content comprises the items: *Evidence-Base*; *Information*; *Completeness & Conciseness*; *Goal & Purpose;* and *Sequence*. Visual design contains: *Aesthetics*; *Graphics*; *Format;* and *Size*. Therapeutic Quality comprises the items: *Call to Action*; *Therapeutic Principle*; *Expectations*; *Adaptive Content;* and *Therapeutic Alliance*. Security includes: *Privacy Policy*; *Subjective Security;* and *Credibility*. Finally, the dimension Information consists of the items: *Developer*; *Frequency of Use*; *Costs*; *Crisis Support;* and *Email*.

5 User Version

The user version consists of 31 items in the following 7 dimensions: Usability (4); User Engagement (5); Content (4); Visual Design (4); Therapeutic Quality (5); Impact (4); and Information (5). The Impact dimension was added to the user version of the questionnaire to assess the subjective effectiveness of a health-related app from the user's point of view. Most other items are consistent with the expert version. The item *Evidence-Base* was not included in the user version because it is not a subjective quality criterion but an objective one and should be assessed by health-care professionals. The items included in the Impact dimension are: *Achievement*; *Symptoms*; *Health Behavior;* and *Recommendation*.

6 Discussion

The principal aim of the development of AQUA was to facilitate the assessment process of newly developed mHealth apps by making it possible for app-quality to be assessed by both experts and users, thereby enabling identification of the specific dimensions of an app that need to be improved. In contrast to MARS, which does not explicitly specify the difference between users and experts, we specify experts as persons involved in the development of mHealth apps. The resulting dimensions in the expert and user versions of AQUA resemble in large part the seven main categories of app quality criteria proposed by Nouri et al. (2018).

Calculating a total score for all items increases the comparability between different apps but contradicts the purpose of multidimensionality. For this reason, AQUA was formatted in a way that allows for the determination of a score for each dimension by calculating the mean item score for each dimension. This procedure preserves the multidimensionality and makes it easier for developers to identify the strengths and weaknesses of an app, while the calculation of a total score permits global comparison of different health-related apps. The same level of measurement scales is used throughout the questionnaire to allow for factor and item analyses in the future. Data security is a crucial aspect for health- and mental health-related apps. Ideally, the assessment of security and data protection quality in the field of mHealth should be undertaken in cooperation with experts in that field and persons involved in the process of developing such apps. This is why we developed an expert version of AQUA explicitly for people actively involved in the development of mHealth apps.

7 Limitations

A study reviewing data security and privacy policies of health apps focused on depression found that most of them lack transparency regarding data security (O'Loughlin, Neary, Adkins, & Schueller, 2018). Assessing the quality of data security is therefore a crucial part of improving the use of health-related apps, and the development of methods to identify possible risks to personal privacy and data security is important (Grundy et al., 2016). The dimension of security and data protection in AQUA takes this aspect into consideration, yet in its current state does not cover enough criteria of the data protection aspect of mHealth. We therefore plan to improve AQUA in future collaborations with data protection specialists. This was an exploratory pilot study with the aim of creating a preliminary mHealth app quality assessment tool which can be used in the development of mHealth apps. Another limitation is that we did not conduct an exhaustive literature review as this was not the aim of this study, and thus did not cover all of the relevant literature on the topic of app quality assessment. Furthermore, the current sample size did not allow for reliable testing of the psychometric qualities of AQUA, which is why we plan to conduct this testing in a future study with a larger sample size.

Pretesting was only undertaken with the German user version of the questionnaire. The expert version and the English versions should be tested with the same procedure in the future. Furthermore, AQUA does not establish K.O.-criteria and all of the items in AQUA have the same weight. This approach was taken to ensure an efficient assessment process and for better comparability between the dimensions. To highlight the importance of data security and evidence-based content, it could be relevant to more clearly distinguish between the user experience, data security, and the evidence base and to reflect this in the further development of specific expert questionnaires for (mental) health professionals and app developers. AQUA does not assess any ethical questions. As this is also an important aspect to consider in the field of mHealth (Nouri et al., 2018), this should be incorporated in the further development of this tool.

8 Conclusions and Future Prospects

The AQUA is a brief multidimensional app-quality assessment tool that enables a quick and efficient assessment of health-re-

lated apps by both experts and users in both the English and German language. We plan to test the psychometric qualities of this instrument in a study with a stress-monitoring app and a larger sample. We furthermore plan to obtain approval from an ethics commission for that study. As the development of any scientifically valid mHealth app should also include clinicians, we plan to create an expert version of AQUA specifically targeted at (mental) health professionals. In addition to the questionnaires, a semi-structured Interview guide has been developed to gather more detailed feedback from app-users and is available in both English and German.

Future studies in this area should especially focus on the dimensions of privacy and data security. While the dimensions of user engagement, usability, and functionality are crucial for users, the dimensions of data security, as well as content and therapeutic quality, are important aspects for experts rating the quality of an app. Future studies could also investigate how the quality ratings of experts and users differ from one another and what aspects of specific dimensions are important to these two groups. For example, the dimension of user engagement is highly relevant for users, as continuous user engagement with mHealth apps provides a challenge and various factors can influence user engagement (Mclean, 2018). Incentive management is a promising approach to ensuring ongoing user engagement with mHealth apps (Agrawal et al., 2018). Gamification and serious gaming is another approach that should be considered in this regard when assessing the quality of mHealth apps, although most gamification applications seem to yield only short-term effects on user engagement (Sardi, Idri, & Fernández-Alemán, 2017). Therefore, more research is needed on how to improve user engagement with serious gaming and how to identify valuable gamification aspects to assess app quality.

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Declaration of interest

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Conflicts of Interest

The authors have no conflict of interest to report.

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Supplementary Material

Table 2. English Expert Version

	strongly agree	agree	undecided	disagree	strongly disagree
Usability					
Performance: The app functions without problems (bugs, crashing, etc.).	5	4	3	2	1
Navigation: It is easy to navigate through the app.	5	4	3	2	1
Learnability: It is easy to learn how to use the app.	5	4	3	2	1
Ease of use: It is easy to use the app.	5	4	3	2	1
User Engagement					
Personalization: Settings (e.g. volume or brightness) can be customized.	5	4	3	2	1
Interest: The app is interesting.	5	4	3	2	1
Entertainment: It is fun to use the app.	5	4	3	2	1
Interaction: The app has interactive functions (e.g. user input, sharing, reminders, etc.)	5	4	3	2	1
Gamification: The app uses game-typical elements such as rewards, point systems, badges, etc.	5	4	3	2	1
Content					
Evidence base: The app offers evidence-based measures to accomplish its intended purpose.	5	4	3	2	1
Information: The information is depicted in a coherent way (complexity, grammar, etc.).	5	4	3	2	1
Completeness & Conciseness The content is complete, but not redundant or irrelevant.	5	4	3	2	1
Goal & Purpose: The goal and purpose of the app is clear.	5	4	3	2	1
Sequence: The sequence of elements (features, images, exercises, etc.) is reasonable.	5	4	3	2	1
Visual Design					
Aesthetic: The app's visual design is appealing (colors, images, fonts, etc.).	5	4	3	2	1
Graphics: The quality of the graphics is good.	5	4	3	2	1
Format: The app is well structured.	5	4	3	2	1
Size: The size of the elements is appropriate and can be customized if necessary.	5	4	3	2	1
Therapeutic Quality					
Call to action: The app offers actions that can be successfully completed with little effort.	5	4	3	2	1
Therapeutic Principle: The underlying therapeutic principle is clear.	5	4	3	2	1
Expectations: It is clear what is expected of the user.	5	4	3	2	1
Adaptive Content: The app content adapts to the user's progress.	5	4	3	2	1
Therapeutic Alliance The app establishes a therapeutic alliance with the user (e.g. by chatting) through a human factor (doctor, therapist, avatar).	5	4	3	2	1
Security					
Privacy Policy Declaration: It is explained to the user whether and for what purpose user data is stored and how it is protected.	5	4	3	2	1
Data Protection: The app undertakes relevant data protection measures.	5	4	3	2	1
Credibility: The app was developed by a credible source (existing website, contact information, etc.).	5	4	3	2	1
Information					
Developer: Who developed, provides and distributes the app is displayed transparently.	5	4	3	2	1
Frequency of Use: The app's ideal frequency of use is displayed in a transparent way.	5	4	3	2	1
Costs: All costs of the app are transparently disclosed.	5	4	3	2	1
Crisis Support: The app provides advice on how to handle psychological crises. Contact information for emergency support services or helplines is displayed.	5	4	3	2	1
Email Confirmation: Is an email confirmation required to use the app?	yes	no			

Table 3. German Expert Version

	trifft zu	trifft eher zu	teils – teils	trifft eher nicht zu	trifft nicht zu
Usability					
Leistung: Die App funktioniert ohne Probleme (Programmfehler, Abstürzen, etc.).	5	4	3	2	1
Navigation: Es ist einfach sich durch die App zu navigieren.	5	4	3	2	1
Erlernbarkeit: Die Benutzung der App ist einfach zu erlernen.	5	4	3	2	1
Benutzerfreundlichkeit: Die App ist einfach zu benutzen.	5	4	3	2	1
User Engagement					
Personalisierung: Einstellungen wie z.B. Lautstärke oder Helligkeit können personalisiert werden.	5	4	3	2	1
Interesse: Die App ist interessant.	5	4	3	2	1
Unterhaltung: Es macht Spaß, die App zu benutzen.	5	4	3	2	1
Interaktion: Die App hat interaktive Funktionen (Nutzerinput, Inhalte teilen, Erinnerungen, etc.).	5	4	3	2	1
Gamification: Die App verwendet spieltypische Elemente, wie Belohnungen, Punkte, Abzeichen, etc.	5	4	3	2	1
Inhalt					
Evidenzbasis: Es werden evidenzbasierte Maßnahmen bereitgestellt, um den Zweck der App zu erreichen.	5	4	3	2	1
Informationsdarstellung: Die Informationen werden in einer klaren und verständlichen Sprache dargestellt (bzgl. Komplexität, Grammatik, etc.)	5	4	3	2	1
Vollständigkeit & Prägnanz: Der Inhalt ist vollständig, aber nicht ausschweifend oder irrelevant.	5	4	3	2	1
Ziel & Zweck: Ziel und Zweck der App sind klar.	5	4	3	2	1
Reihenfolge: Die Reihenfolge der Elemente (Funktionen, Bilder, Übungen, etc.) ist sinnvoll.	5	4	3	2	1
Visuelle Gestaltung					
Ästhetik: Das visuelle Design der App ist ansprechend (Farben, Bilder, Schriftarten, etc.).	5	4	3	2	1
Grafik: Die Qualität der Grafik ist gut.	5	4	3	2	1
Format: Die App ist gut strukturiert.	5	4	3	2	1
Größe: Die Größe der Elemente ist passend.	5	4	3	2	1
Therapeutische Qualität					
Handlungsaufforderung: Die App beinhaltet Handlungen, die mit wenig Aufwand erfolgreich durchgeführt werden können.	5	4	3	2	1
Therapeutisches Prinzip: Das zugrundeliegende therapeutische Prinzip ist klar.	5	4	3	2	1
Erwartungen: Die Erwartungen der App an den Nutzer sind klar.	5	4	3	2	1
Adaptiver Inhalt: Die App passt sich dem Fortschritt des Nutzers an.	5	4	3	2	1
Therapeutisches Bündnis: Die App stellt durch einen menschlichen Faktor (Arzt, Therapeut, etc.) ein therapeutisches Bündnis mit dem Nutzer her (z.B. durch Chatten).	5	4	3	2	1
Sicherheit					
Datenschutzerklärung: Dem Nutzer wird erklärt ob und wofür Nutzerdaten gespeichert und wie sie geschützt werden.	5	4	3	2	1
Datenschutz: Die App unternimmt entsprechende Datenschutzmaßnahmen.	5	4	3	2	1
Vertrauenswürdigkeit: Die App wurde von einer vertrauenswürdigen Quelle entwickelt (z. B. vorhandene Kontaktinformationen, Website, etc.).	5	4	3	2	1
Information					
Entwickler: Es liegt ein Impressum vor, in dem transparent beschrieben wird, wer die App entwickelt hat, anbietet und vertreibt.	5	4	3	2	1
Verwendungshäufigkeit: Es wird transparent darüber informiert, in welcher Häufigkeit und Frequenz die App genutzt werden sollte.	5	4	3	2	1
Kosten: Die vollständigen Kosten der App werden transparent dargestellt.	5	4	3	2	1
Krisenunterstützung: Die App gibt Empfehlungen zum Umgang mit psychischen Krisen. Es werden Hilfsangebote bzw. Kontaktinformationen für Notfälle angegeben.	5	4	3	2	1
Emailbestätigung: Wird eine Emailbestätigung benötigt, um die App benutzen zu können?	ja	nein			

Table 4. English User Version

	strongly agree	agree	undecided	disagree	strongly disagree
Usability					
Performance: The app functions without problems (bugs, crashing, etc.).	5	4	3	2	1
Navigation: It is easy to navigate through the app.	5	4	3	2	1
Learnability: It is easy to learn how to use the app.	5	4	3	2	1
Ease of use: It is easy to use the app.	5	4	3	2	1
User Engagement					
Personalization: Settings (e.g. volume or brightness) can be customized.	5	4	3	2	1
Interest: The app is interesting.	5	4	3	2	1
Entertainment: The app is fun to use.	5	4	3	2	1
Interaction: The app has interactive functions (e.g. user input, sharing, reminders, etc.).	5	4	3	2	1
Gamification: The app uses game-typical elements such as rewards, point systems, badges, etc.	5	4	3	2	1
Content					
Quality of information: The information is depicted in a coherent way (complexity, grammar, etc.).	5	4	3	2	1
Quantity of information: The content is complete, but not redundant or irrelevant.	5	4	3	2	1
Purpose and Goals: The goal and purpose of the app is clear.	5	4	3	2	1
Sequence: The sequence of elements (features, images, exercises, etc.) is reasonable.	5	4	3	2	1
Visual Design					
Aesthetic: The app's visual design is appealing (colors, images, fonts, etc.).	5	4	3	2	1
Graphics: The quality of the graphics is good.	5	4	3	2	1
Format: The app is well structured.	5	4	3	2	1
Size: The size of the elements is appropriate and can be adjusted if necessary.	5	4	3	2	1
Therapeutic Quality					
Call to action: The app offers actions that can be successfully completed with little effort.	5	4	3	2	1
Therapeutic Principle: The underlying therapeutic principle is clear.	5	4	3	2	1
Expectations: It is clear what is expected of me.	5	4	3	2	1
Adaptive Content: The app content adapts to my progress.	5	4	3	2	1
Therapeutic Alliance There is a human related to the app (doctor, therapist, etc.) I feel connected to (e.g. through chatting).	5	4	3	2	1
Impact					
Achievement: I have achieved the app's intended goal.	5	4	3	2	1
Symptoms: My symptoms have improved using this app.	5	4	3	2	1
Health behavior: My health behavior (mindfulness, habits, etc.) has improved using this app.	5	4	3	2	1
Recommendation: I would recommend this app.	5	4	3	2	1
Information					
Developer: Who developed, provides and distributes the app is disclosed transparently.	5	4	3	2	1
Frequency of Use: The app's ideal frequency of use is displayed in a transparent way.	5	4	3	2	1
Costs: All costs of the app are transparently disclosed.	5	4	3	2	1
Crisis Support: The app provides advice on how to handle psychological crises. Contact information for emergency support services or helplines is displayed.	5	4	3	2	1
Email Confirmation: Is an email confirmation required to use the app?	yes	no			

Table 5. German User Version

	trifft zu	trifft eher zu	teils – teils	trifft eher nicht zu	trifft nicht zu
Usability					
Leistung: Die App funktioniert ohne Probleme (Programmfehler, Abstürzen, etc.).	5	4	3	2	1
Navigation: Es ist einfach sich durch die App zu navigieren.	5	4	3	2	1
Erlernbarkeit: Die Benutzung der App ist einfach zu erlernen.	5	4	3	2	1
Benutzerfreundlichkeit: Die App ist einfach zu benutzen.	5	4	3	2	1
User Engagement					
Personalisierung: Einstellungen wie z.B. Lautstärke oder Helligkeit können personalisiert werden.	5	4	3	2	1
Interesse: Die App ist interessant.	5	4	3	2	1
Unterhaltung: Es macht Spaß, die App zu benutzen.	5	4	3	2	1
Interaktion: Die App hat interaktive Funktionen (Nutzerinput, Inhalte teilen, Erinnerungen, etc.).	5	4	3	2	1
Gamification: Die App verwendet spieltypische Elemente, wie Belohnungen, Punkte, Abzeichen, etc.	5	4	3	2	1
Inhalt					
Informationsdarstellung: Die Informationen werden in einer klaren und verständlichen Sprache dargestellt (bzgl. Komplexität, Grammatik, etc.)	5	4	3	2	1
Vollständigkeit & Prägnanz: Der Inhalt ist vollständig, aber nicht ausschweifend oder irrelevant.	5	4	3	2	1
Ziel & Zweck: Ziel und Zweck der App sind mir klar.	5	4	3	2	1
Reihenfolge: Die Reihenfolge der Elemente (Funktionen, Bilder, Übungen, etc.) ist sinnvoll.	5	4	3	2	1
Visuelle Gestaltung					
Ästhetik: Das visuelle Design (Farben, Bilder, Schriftarten, etc.) der App ist ansprechend.	5	4	3	2	1
Grafik: Die Qualität der Grafik ist gut.	5	4	3	2	1
Format: Die App ist sinnvoll strukturiert.	5	4	3	2	1
Größe: Die Größe der Elemente ist passend.	5	4	3	2	1
Therapeutische Qualität					
Handlungsaufforderung: Die App beinhaltet Handlungen, die mit wenig Aufwand erfolgreich durchgeführt werden können.	5	4	3	2	1
Therapeutisches Prinzip: Das zugrunde liegende therapeutische Prinzip ist mir klar.	5	4	3	2	1
Erwartungen: Mir ist klar, welche Erwartungen die App an mich hat.	5	4	3	2	1
Adaptiver Inhalt: Die App passt sich an meinen Fortschritt an.	5	4	3	2	1
Therapeutisches Bündnis: Es gibt einen Menschen (Arzt, Therapeut, etc.) oder einen Avatar, mit dem ich mich verbunden fühle (z.B. durch Chatten).	5	4	3	2	1
Wirkung					
Zielerreichung: Ich habe das von der App angestrebte Ziel erreicht.	5	4	3	2	1
Symptome: Meine Symptome/mein Gesundheitszustand haben/hat sich durch die Nutzung der App verbessert.	5	4	3	2	1
Gesundheitsverhalten: Mein Gesundheitsverhalten (Achtsamkeit, Gewohnheiten, etc.) hat sich durch die Nutzung der App verbessert.	5	4	3	2	1
Empfehlung: Ich würde die App weiterempfehlen.	5	4	3	2	1

Continued Table 5. German User Version

	trifft zu	trifft eher zu	teils – teils	trifft eher nicht zu	trifft nicht zu
Information					
Entwickler: Es liegt ein Impressum vor, in dem transparent beschrieben wird, wer die App entwickelt hat, anbietet und vertreibt.	5	4	3	2	1
Verwendungshäufigkeit: Es wird transparent darüber informiert, in welcher Häufigkeit und Frequenz die App genutzt werden sollte.	5	4	3	2	1
Kosten: Die vollständigen Kosten der App werden transparent dargestellt.	5	4	3	2	1
Krisenunterstützung: Die App gibt Empfehlungen zum Umgang mit psychischen Krisen. Es werden Hilfsangebote bzw. Kontaktinformationen für Notfälle angegeben.	5	4	3	2	1
Emailbestätigung: Wird eine Emailbestätigung benötigt, um die App benutzen zu können?	ja	nein			

EDITORIAL SPECIAL TOPIC

Digital is the New Normal: The Role of Digital Media during the COVID-19 Crisis

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We hope you are all well despite the current situation with the COVID-19 pandemic. In 2020, the daily lives of people worldwide have changed. The outbreak of SARS-CoV2 and the necessary measures to contain it (Nussbaumer-Streit et al., 2020) have caused emotional distress and increased the risk of negative mental health outcomes for broad sections of the population (Vindegaard & Benros, 2020). In Austria, for example, data indicates that mental health problems increased during lockdown as compared to before the pandemic (Pieh, Budimir & Probst, 2020). Moreover, there were more new onsets of depression than remissions following the lifting of lockdown restrictions (Probst, Budimir & Pieh, 2020). During the crisis caused by the SARS-CoV2 virus, the process of digitalization has become more prominent. For example, health care providers had to shift from provision of in-person care to remote treatments via digital media in order to maintain mental health care services. The Spanish flu caused a comparable worldwide pandemic 100 years ago, but this is the first time we are faced with such a situation since the rise of globalization. This is why the second issue of Digital Psychology includes a special topic about how COVID-19 changed our digital media behavior. We made the inclusion because the current situation led to a proliferation of COVID-19-related research, and the changes and challenges in digitalization are manifold in the face of this crisis.

The special topic consists of four high-quality and interesting articles addressing a variety of topics related to COVID-19. In this issue, experts Martina Zemp and Helmut Hlavacs discuss technological developments in the fight against COVID-19 as well as the problems of homeschooling and remote work. The Spotlight communication by Humer and Probst (2020) focuses on the transition to remote psychotherapy during the COVID-19 crisis across different countries. Another Spotlight communication by Huscsava et al. (2020) reflects the perspectives of psychiatric patients on remote therapy during the pandemic using a qualitative approach. Further, as the pandemic provokes the dissemination and proliferation of misinformation about COVID-19 in social media, the contribution by Goreis and Kothgassner (2020) provides an overview of current research on conspiracy beliefs in the context of COVID-19, and explores containment of misinformation in social media. Finally, Montag et al. (2020) report on the benefits and potential of digital phenotyping to gain insights into the mental health of the general population during a pandemic, and how it can contribute to decision-making processes of policy makers.

We want to thank all the authors and reviewers for their hard work on this special topic. Moreover, we thank our readers for their interest in this thematic issue.

Oswald D. Kothgassner & Thomas Probst
Topic Editors

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Experts View on …
… Digital Media in Times COVID-19

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We asked two experts from two different fields about the impact of digital media during the pandemic. Martina Zemp from Psychology and Helmut Hlavacs from Computer Sciences (both from University of Vienna) spoke to ***Digital Psychology*** about these topics.

[DP] How can we fight COVID-19 using digital media?

Helmut Hlavacs: The spread of COVID-19 is fully determined by the behavioral adherence of the populace, or the lack thereof, to virus control measures. Media in general may influence this adherence drastically – or not – by communicating the right message tailored to the specific needs of different social groups and personality traits. Ordering or even suggesting lifestyle changes for many people is a red flag. We should be able to avoid echo chambers of social networks which otherwise remain closed bubbles of misinformation. Digital media can prove to be very effective in this endeavor. So far, technological innovations have focused on fostering home offices and remote working, social distancing, video conferences, determining physical proximity etc.

[DP] Do you expect problems and threats with digital media in the light of this crisis?

Helmut Hlavacs: Any technology made for influencing people, even those made with the best of intentions, can and will be used by autocrats to influence the pliant masses to help them stay in power. Technologies detecting physical proximity can easily be misused for tracking people's whereabouts. Also, if messages are not tailored to the specific requirements of their target audience, the effect of spreading them through digital media may have the opposite impact of what was intended.

[DP] Are there any technological developments that can help us avoid echo chambers? How do they work?

Helmut Hlavacs: Typical AI-based recommender systems used by Facebook, YouTube, etc. help to create echo chambers by analyzing interests and recommending mostly similar content, e.g. based on clicks or key words. Furthermore, clickbait-abusing extreme headline claims move attention to untrustworthy sources. But while AI contributes to the formation of echo chambers, it can also help break open such chambers by e.g. flagging possible fake news, correcting untruthful claims, identifying abusive language, searching for approved statements from other trustworthy sources, or flagging or even banning clickbait.

[DP] Are there specific problems or threats for children or adolescents?

Martina Zemp: Whilst the use of digital media among children and adolescents is likely elevated during the crisis, I would not expect that the potential for problems is significantly different to at other times. There are a few well-known possible threats related to digital media use, such as a certain addiction potential of computer games, aggressive media content, or exposure to other content not suitable for minors. At the same time, surrounding factors have changed in the light of the crisis. For instance, during pandemic restrictions, we expect that adolescents' fear of missing out might become less of a problem, because they know that others have to stay at home as well. Or in the event that parents work at home, they may have more control over their children's media use.

[DP] Digital media was used by almost everyone for teleconferencing, working from home and homeschooling during this crisis. What do you think about this development? Should we keep this new mode of operating after the crisis has come to an end?

Martina Zemp: These options are both a blessing and a curse for most of us. They enable us to stay in touch with family and friends despite physical distance, not to lose the thread at work, and during school shutdowns they prevented the complete interruption of children's education. However, many of us wonder how to find an adequate dose of these tools in future. For sure we will have to deal with them in some way or another after the crisis. The crucial question is: What is the reasonable middle ground to ensure public health, while at the same time preventing isolation, loneliness, and disconcertment in the population? Concerning homeschooling we probably all agree that what parents have done for their children during the lockdown deserves greatest recognition. But we also know that parental stress levels were extremely high in most households. This is one of the many reasons why I don't deem homeschooling as an appropriate concept in the long term.

Helmut Hlavacs: Remote working is something that has been done for many years, for instance in physically dispersed companies, or programming. In many traditional companies however, old school thinking still confuses physical presence with productivity. The COVID-19 crisis has forced organizations to deploy home offices no matter what, and this is something that will definitely stay where it makes sense. However, there are many areas like schools, social work, maintenance, police, etc. where physical presence is and will remain necessary.

[DP] How do you perceive the impact of social media on the development of children and adolescents?

Martina Zemp: It has repeatedly been shown in previous research that social media has addiction potential, especially for children and adolescents. Some youngsters – although it is a minority – even display clinically relevant symptoms of addiction, such as excessive use, loss of control, and psychological withdrawal symptoms. However, current studies clearly demonstrate that real world relationships matter most, also for today's youth. The desire to live in a loved family environment is stable and universal, and is among the most important values in digital natives' lives. On the surface, friendships of children and adolescents appear different nowadays compared to those of previous generations, but they are underpinned by the same basic motivations at the core. It is still about the desire to be recognized, socially included, and loved, although many aspects of interaction currently take place online on social media. We have to learn to navigate through offline and online spheres without impairing our relationships and to model for our children a functional and well-balanced approach to media use.

[DP] Do you think that digital media use during the COVID-19 crisis will influence family dynamics and parent-child interaction?

Martina Zemp: There is a growing body of research about the effects of family members' digital media use on parent-child interactions. The phenomenon of interference and interruptions of everyday face-to-face interactions through technology, in particular smartphones, has been referred to as "technoference". Not only youngsters, but also parents of the present generation use digital media on a regular, daily basis. In the long run, this might affect family relations, parents' sensitivity, and child attachment. During the COVID-19 pandemic, average digital media use in families of course increased sharply, but simultaneously, shared family time did as well. Ongoing research will inform whether effects of media use differ during the crisis compared to before the onset of the pandemic.

Bios

Univ.-Prof. Dr. Helmut Hlavacs studied Mathematics at the University of Technology Vienna, and received a Master's degree in 1993 and a PhD in 2001. In 2004 he became Associate Professor at the Faculty of Computer Science at the University of Vienna, and in 2011 he became Full Professor of Computer Science there. His research interests include computer games, gamification, gaming technologies and applications of computer games.

Univ.-Prof. Dr. Martina Zemp is professor of clinical child and youth psychology at the University of Vienna. She studied psychology and education at the University of Zurich. She received her doctorate in 2014 with a PhD thesis about interparental conflict as a risk factor for children's attention problems. Her current research and teaching focus on family risk and protective factors in the development of children and adolescents. She is a trained psychotherapist in cognitive behavior therapy and systemic therapy.

Provision of Remote Psychotherapy during the COVID-19 Pandemic

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Abstract
The outbreak of the novel coronavirus disease (COVID-19) creates significant challenges not only for mental health but also for mental health care services. The measures implemented to combat the rapid spread of the virus have created severe barriers to patients accessing in-person, face-to-face psychotherapy services around the world. As direct contact with others should be avoided where possible to prevent virus transmission, adaptations in the therapeutic settings are necessary. Therefore, remote psychotherapy became a valuable option for continuity of mental health care during the COVID-19 pandemic. This article reviews recent studies on the transition to remote psychotherapy during the COVID-19 pandemic. Studies conducted in Austria, the Czech Republic, Germany and Slovakia revealed a strong increase in the provision of psychotherapy via the internet or telephone during the pandemic as compared to the months before. Several differences emerged with regard to country and gender, while the therapeutic orientation was of minor importance. In central Denmark, referrals to psychiatric services declined considerably during the lockdown. But in a psychotherapy program at a public hospital in Massachusetts, a switch to remote psychotherapy led to a reduction in the number of missed appointments. Results imply that the necessary supply of mental health care services could not be sufficiently maintained in all countries during the COVID-19 situation, and that measures are required to further facilitate the provision of mental health care during and after the pandemic.

Keywords: psychotherapy, COVID-19, remote psychotherapy, telephone, internet

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1 Introduction

The novel coronavirus disease-2019 (COVID-19) dramatically impacts global health, economics and social connections around the world (Hasson-Ohayon & Lysaker, 2020). In an attempt to combat the uncontrolled spread of the virus, measures such as curfews, quarantine, isolation and social distancing have been implemented in many countries (Ghosh et al., 2020). These measures required rapid adaptations in the provision of mental health care around the world (Wind et al., 2020). The protocols implemented to prevent the spread of the virus present a significant challenge to mental health care as face-to-face psychotherapy has to be reduced (Williams & Tsiligianni, 2020).

Several reviews and meta-analyses highlight that the COVID-19 pandemic and the measures necessary to fight it increase psychological distress and risk of negative mental health consequences in the general population (Brooks et al., 2020; Salari et al., 2020; Vindegaard & Benros, 2020). These may comprise fears of infection and health anxiety, existential fears, insomnia, depression and post-traumatic stress disorder symptoms (Pfefferbaum & North, 2020). Especially for individuals with mental health disorders prior to the eruption of the pandemic, a new traumatic or stressful event is likely to aggravate psychological distress and can also trigger prior anxieties and stimulate earlier traumatic memories (Briere & Scott, 2015; Ronen-Setter & Cohen, 2020). Therefore, adequate mental health care is of crucial importance in the time of the COVID-19 pandemic.

However, the situation around COVID-19 also poses a challenge for many psychotherapists used to providing treatment through personal contact. To provide mental health care while reducing the risk of transmitting the infection between patients and therapists, in-person, face-to-face psychotherapy is often replaced by remote psychotherapy (Probst et al., 2020; Qiu et al., 2020; Xiang et al., 2020). The provision of mental health care at a safe distance seems to be the obvious solution to ensure sufficient psychotherapeutic support in times of increasing mental health problems (Qiu et al., 2020; Wang et al., 2020; Wind et al., 2020). However, some psychotherapists and their patients have reservations about the use of remote psychotherapy, as the personal contact is often considered as an essential part of the therapy (Apolinário-Hagen et al., 2018; Connolly et al., 2020). If patients and/or therapists are not willing to switch to remote

psychotherapy, an undersupply of mental health care might emerge. Therefore, this review aims to summarize recent studies on the provision of mental health care during the COVID-19 pandemic.

2 Studies conducted on changes in the provision of psychotherapy

During the early weeks of the COVID-19 lockdown in Austria, an online survey was conducted in which all licensed psychotherapists in the list of psychotherapists of the Austrian Federal Ministry of Social Affairs, Health, Care and Consumer Protection were contacted (all those for which a valid email address was available). In total 1,547 psychotherapists participated in the survey, which revealed that the total number of patients treated on average per week in the early weeks of the COVID-19 lockdown was on average 28% lower compared to the months before the lockdown ($p < .001$) (Probst et al., 2020). Besides this change in the total number of patients treated per week, there was also a significant change in the mode of delivery. While on average most patients were treated through personal contact before the COVID-19 pandemic, the most preferred treatment format in the early weeks of the lockdown was telephone, followed by internet. In more detail, the number of patients treated per week via personal contact decreased by on average 81% ($p < .001$) during the COVID-19 lockdown, while the number of patients treated on average per week via telephone increased by on average 979% ($p < .001$). The strongest relative change was observed for the number of patients treated on average per week via the internet, which increased on average by 1,561% during the COVID-19 lockdown as compared to the months before ($p < .001$). However, the increase in remote psychotherapy (telephone + internet) was not sufficient to compensate for the strong decrease in the provision of in-person, face-to-face treatment ($p < .001$), indicating an undersupply of mental health care during the early weeks of the COVID-19 lockdown in Austria. In addition, possible differences among therapeutic orientations (behavioral, humanistic, psychodynamic, and systemic) were investigated, showing comparable changes between the four therapeutic orientations in the changes in the provision of psychotherapy.

An online survey of 112 psychotherapists in the Czech Republic was conducted two weeks after lockdown measures were lifted, in which participants were contacted via email using the list of the Czech Association for Psychotherapy. The study revealed that the total number of patients treated on average per week in the months before the COVID-19 remained the same as the number of patients treated during the COVID-19 pandemic ($p = .086$) (Humer et al., 2020). However, significant changes in the way psychotherapy was provided were observed, with a 71% decrease in the number of patients treated on average per week via personal contact ($p < .001$). The number of patients treated via telephone increased by on average 417% ($p < .001$). The strongest change was observed for the number of patients treated via the internet, which increased by on average 1,200% during the COVID-19 situation ($p < .001$). Overall, the preferred treatment format before the COVID-19 pandemic of face-to-face psychotherapy shifted to psychotherapy via the internet during the COVID-19 pandemic. However, more patients were still treated in personal contact as compared to telephone during the COVID-19 pandemic.

In Germany, an online survey of psychotherapists was conducted two weeks after the lockdown measures began to be lifted. Participants were contacted via e-mail, whereby the addresses were gathered from the directories of four different regional and national psychotherapeutic associations. In total, 130 therapists participated in the survey, which revealed that the number of patients treated on average per week actually increased by on average 12% ($p = .014$) during the COVID-19 situation as compared to the months before (Humer et al., 2020). Although the number of patients treated on average per week in personal contact decreased by 18% ($p < .001$), face-to-face psychotherapy remained the most common treatment format during the COVID-19 pandemic. Significant increases in remote psychotherapy were also observed, with an average increase in the number of patients treated via telephone on average per week of 213%, ($p = .001$), and via internet of 6,558% ($p < .001$).

Three weeks after lockdown restrictions began to be lifted in Slovakia, psychotherapists were asked about the number of patients treated on average per week in the months before the COVID-19 pandemic as compared to the current situation (Humer et al., 2020). The chair of the Slovak Psychotherapeutic Society and the chairs of special psychotherapeutic societies invited the psychotherapists to provide input via email. In total 96 psychotherapists participated. A decrease in the total number of patients treated per week by on average 25% ($p < .001$) was observed. Before the pandemic most patients were treated face-to-face. This altered considerably during the COVID-19 situation, with an average decrease of the number of patients treated face-to-face per week by 76% ($p < .001$). This decrease could not be compensated for by increases in remote psychotherapy, although the number of patients treated on average per week via telephone increased on average by 187% ($p < .001$), and the number of patients treated on average per week via the internet increased on average by 343% ($p < .001$).

Among the surveys conducted in the Czech Republic, Germany and Slovakia a stronger reduction of in-person, face-to-face psychotherapy was observed for female psychotherapists, showing a lower number of patients treated via personal contact ($p = .036$) and a higher number of patients treated via telephone ($p = .015$) during the COVID-19 pandemic as compared to the months before. In the months before the COVID-19 situation, no differences between male and female psychotherapists were observed with regard to the mode through which psychotherapy was provided ($p \geq 0.725$) (Humer et al., 2020).

Different explanations exist for the varying changes in the provision of psychotherapy among countries. First, there are

country-specific regulations regarding the provision of psychotherapy via the internet or telephone. For instance, in Austria internet-based psychotherapy was rejected by the Austrian Internet guideline for psychotherapists (Bundesministerium für Gesundheit und Frauen, 2005). Second, there are differences between countries in relation to the reimbursement of the costs of psychotherapy via the internet by insurance companies. Third, different time points (during the lockdown in Austria, after the lockdown in the Czech Republic, Germany and Slovakia) have to be considered as legal restrictions, regulations of insurance companies regarding the reimbursement of costs of remote psychotherapy, preferences in the format psychotherapy is provided as well as risks and fears of COVID-19 infections likely change dynamically. Fourth, there are also likely differences between countries in relation to the fear of infection due to participation in face-to-face psychotherapies, and also with respect to gender. Indeed, the lowest fear of infection was observed in German psychotherapists as well as male psychotherapists, a group which showed the smallest reduction in the provision of face-to-face psychotherapy (Humer et al., 2020). Fifth, experience in the use of digital media might also differ among countries.

3 Studies conducted on changes in referrals to psychiatric services

In Denmark all referrals to psychiatric services in the first weeks of the nationwide curfew were compared to the corresponding weeks in the previous year (Kølbæk et al., 2020). A total reduction of 40% was observed. This is especially concerning, as in the weeks preceding the lockdown in 2020, almost 20% more referrals were observed as compared to the corresponding weeks in 2019. During the weeks of gradual lifting of the lockdown in 2020, the number of referrals was almost comparable to those of the corresponding weeks in 2019 (on average -6%). As it is unlikely that the mental health improved during the COVID-19 lockdown, it seems more reasonable that patients with mental health issues were not referred to psychiatric services, possibly due to the fear of this leading to an increase in COVID-19 infections.

A recent report on mental health care in the USA and Israel focusing on individuals with schizophrenia highlights the initial difficulties faced by many patients with the shift from face-to-face psychotherapy to psychotherapy via telephone or videoconferencing, such as limited access to the required technology and reduced privacy (Hasson-Ohayon & Lysaker, 2020). However, positive aspects were also reported by some patients, such as an ease to talk openly when not being present in the same room as the therapist, which was highlighted particularly when psychotherapy was conducted using the telephone.

A study investigating the caseloads in an outpatient psychodynamic psychotherapy training program at a public hospital in Cambridge (Massachusetts) revealed a substantial decrease in missed appointments upon switching to remote mental health services (Silver et al., 2020). While the mean missed appointment rate before the transition to remote psychotherapy was approximately 14%, it decreased to approximately 6% ($p = 0.03$) after the transition to remote psychotherapy. Possible explanations reported by the authors are: a higher need for human relationships and contact during crises; a higher ability to tolerate attending sessions due to an additional layer of insulation between patient and psychotherapists in psychotherapy conducted from a distance; and a reduction of barriers to treatment, such as logistical or family-related challenges.

4 Technical-based applications

There are a number of technical-based e-mental health applications that have the potential to extend treatment far beyond the provision of psychotherapy via the internet or telephone in the current crisis. Several guided but also self-guided interventions, such as self-help apps or online therapeutic modules, might also be a valuable option in the provision of mental health care (Wind et al., 2020), especially in countries with scare mental health resources (Christiani and Setiawan, 2018). E-mental health applications have already been developed for a wide range of psychiatric conditions. These are cost-effective and have displayed promising outcomes, in some cases being shown to be as effective as face-to-face psychotherapy (Andersson, 2016, 2018). However, there are also several limitations of replacing psychotherapy with technical-based e-mental health applications. One is that psychiatric diagnosis cannot reliabely made solely using self-reports, as unless the patient is seen by a mental health care professional, important information may be lost. A further drawback is the difficulty of validating the accuracy of responses and of obtaining additional information. Studies report higher drop-out rates from internet interventions as compared to face-to-face interventions, and indicate improved adherence to a treatment program with the involvement of therapist support. A further important aspect is that the high-prevalence of comorbidity is to date not adequately addressed by e-mental health applications, as these applications commonly target specific disorders. Finally, issues related to user privacy have to be considered, which is relevant for data collection and storage, especially when smartphone applications are used (Andersson & Titov, 2014; Cunningham et al., 2014). Therefore, future studies are needed to assess the potential of e-mental health applications to replace psychotherapy, both during and after the COVID-19 pandemic.

5 Conclusions

To summarize, although efforts to substitute face-to-face psychotherapy with psychotherapy at a safe distance have been made in many countries, these attempts have not been sufficient to provide adequate mental health care services in all investi-

gated countries. In general, studies reported that the actual effectiveness of the psychotherapy, treatment satisfaction and the therapeutic alliance can be achieved equally by psychotherapy via telephone or the internet as in face-to-face psychotherapies (Backhaus et al., 2012; Bashshur et al., 2016; Jenkins-Guarnieri et al., 2015; Langarizadeh et al., 2017; Lopez et al., 2019). Therefore, it is important to highlight the utility of remote psychotherapy to those psychotherapist and patients who have concerns to maintain mental health care in times of COVID-19. Overall, this review implies that remote psychotherapy initiatives are required in mental health care systems in several countries to cover the need for professional mental health care during and after the COVID-19 pandemic.

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Teletherapy for Adolescent Psychiatric Outpatients: The Soaring Flight of so far Idle Technologies during the COVID-19 Pandemic

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Abstract

Background: As a consequence of the COVID-19 pandemic, teletherapeutic offers for patients skyrocketed. In a moment of great need, offers were emerging seemingly faster than the background technology and training required to facilitate them could be provided.

Objective: This Spotlight-Communication provides an overview of results and ideas on teletherapeutic offers for adolescent psychiatric outpatients and areas for further investigation.

Methods: It reports the insights gained from conducting follow-up interviews with 30 adolescents in weekly outpatient treatment Data were analyzed qualitatively using standard software ATLAS.ti 8. Therapists' views were collected via informal discussions and are, although not systematically analyzed, integrated where applicable.

Results: On average, patients rated teletherapy as compared to face-to-face contacts as rather good to mediocre (3,2 on a 5-point-Likert scale). Main positive aspects were accessibility and continuity of treatment, as well as an "anchor"-function. Main negative aspects were technical issues, a lack of privacy and therapy being more superficial.

Conclusions: Although the results are not generalizable, they show that patients overall benefit from teletherapy. The main positives and pitfalls of teletherapy are described, as well as ideas for problem-solving and refinement, which are of utmost importance in light of potential further waves of the COVID-19 pandemic.

Keywords: child and adolescent psychiatry, adolescents, teletherapy, COVID-19, outpatients

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1 Introduction

The COVID-19 pandemic hit countries worldwide and confronted systems, as well as individuals, with enormous challenges in almost every aspect of life. Decision making processes had to be adapted at an extremely rapid pace, with almost no prior warning or preparation. In this rapidly changing situation, communication and the dissemination of information proved to be crucial, yet extremely challenging. In the midst of all this turmoil, already marginalized groups, like psychiatric patients, were deemed to be at an increased risk of disproportional harm. (Cui et al., 2020; Druss, 2020; Fegert et al., 2020; Kavoor, 2020; Yao et al., 2020) Thus, much effort, creativity and innovation went into establishing structures to comply with regulations and control spreading of the virus on the one hand, but facilitate continued treatment of those in need on the other. Basically overnight, teletherapy became the number one treatment option and is still on the rise. (Liu et al., 2020; Torous et al., 2020; Torous & Wykes, 2020; Wind et al., 2020; Zho et al., 2020) Although the genesis of teletherapy was not the COVID-19 pandemic, its widespread application is definitely owed to it. Our clinic, the Department of Child and Adolescent Psychiatry, Medical University of Vienna, a tertiary care center and university hospital, switched its outpatient services overnight to therapy via video-call, keeping face-to-face contact as an option if absolutely unavoidable (acute presentations). Staff eager to serve their patients went into the *"experiment" teletherapy* without prior training or experience, being confronted not only with insecurity in relation to the technical aspects of this treatment, but also concerning the dynamic of the situation and resulting needs of the patients. Teletherapy as discussed herein refers to planned, individual videocalls only, other applications (e.g. emergency services, online-trainings) have not been examined.

2 Aim and method

The aim of this Spotlight-Communication is to concisely discuss patients', as well as psychiatrists' and psychologists', experiences

with teletherapy, including positives, pitfalls and opportunities for future development. Given the novelty of the situation and the velocity of change, there is not a large volume of prior research to build upon in investigating diverse aspects of the current crisis. This article was thus conceptualized as brief communication discussing a small number of results from an ongoing investigation (Huscsava et al., 2020), integrating further ideas in a spotlight format. We followed up 30 mostly female patients (86,7%), ranging from 12 to 18 years of age, who were in established weekly outpatient treatment before the onset of the COVID-19 pandemic, in the process of transition into teletherapy. Teletherapy, in the sense of planned, individual videocalls, was conducted using Instahelp (brand of Insta Communications GmbH/Up to Eleven Digital Solutions GmbH), an existing platform conforming to Austrian data safeguarding measures. In addition to videocalls, the platform also provides the function of an end-to-end encrypted individual chat. Ethical approval for this investigation was obtained from the institutional review board of the Medical University of Vienna (#1383/2020) and patients and guardians gave written consent for participation in the study. Data were collected via interviews – videocall or phone call, according to the respective patient's preference – with outpatients in well-established, continuous weekly treatment before the COVID-19-associated lockdown. Interviews, conducted by two 5-year residents in Child and Adolescent Psychiatry, were semi-structured including open questions and questions to be rated on 3-, 4-, or 5-point Likert-scales. A description of the interview content, as well as sample characteristics and detailed results concerning the transition into teletherapy are available as preprint. (Huscsava et al., 2020) Thoughts expressed by psychiatrists and psychologists obtained in informal discussions are integrated where appropriate to provide a comprehensive overview.

Structured qualitative data analysis was conducted following the principles of Grounded Theory (11) using the computerised qualitative data analysis tool ATLAS.ti 8 (ATLAS.ti Scientific Software Development GmbH, Berlin, Germany).

3 Results

3.1 Patients' topics

To get an idea on what moved our patients when lockdown measures in Vienna were at their maximum, including homeschooling, part-time work, and restrictions on physical contact, Figure 1 provides a word cloud drawn from asking the patients to freely express current thoughts. To obtain the presented word cloud, patients' answers were reduced to nouns, verbs (excluding auxiliary verbs), adverbs and adjectives. Translations were carried out by a study member, checked with Merriam-Webster Thesaurus and cross-checked with Collins Dictionary. (*Collins Wörterbuch*, 2020; *Merriam-Webster Thesaurus*, 2020) The built-in word-cloud-function of ATLAS.ti 8 was used to obtain the cloud-presentation of the initial word list.A higher word count is indicated by a larger font. As can be seen, thoughts about the future and family, followed by those relating to friends and school preoccupied our patients the most. Teletherapy was provided by staff well-trained in the provision of non-teletherapy treatments, who have not been asked to give their thoughts in the same manner. It can be assumed though, that the picture might coincide in some points. Numerous investigations, dating from prior events (e.g. disasters, epidemics and pandemics), and also stemming from the current COVID-19 pandemic, assessed mental health consequences for health care workers, focusing on those who were "frontline workers". (Hu & Chen, 2020; Lu et al., 2006; Lung et al., 2009) Mental health professionals providing teletherapy during the current pandemic suffered as many restrictions as other medical staff and the rest of the population, but have not been specifically investigated as a subgroup. This has to be taken into account when discussing teletherapy in this situation. Working with a novel technology in an environment of – global – insecurity, and situationally reduced exchange with colleagues, is rather challenging. In this light, it seems even more surprising (or convincing) that the patients we interviewed rated teletherapy to be on average between rather good and mediocre, as compared to the face-to-face contacts they were used to (3.2 on a 5-point-Likert scale, 1 indicating "bad" and 5 indicating "good").

3.2 Main arguments in favor of teletherapy

Most patients expressed great relief about the fact that they still had access to continuous treatment while basically everything else was locked down. In fact, to date not a single patient we followed up dropped out of treatment during the pandemic. This is not straightforward, nor is the seamless continuation of therapy. Given our observations, the patients' feedback, and opinions and experiences expressed by colleagues in informal discussions, the content of many therapeutic processes changed in the sense that it became somewhat more superficial and oriented toward every-day life. However, in all cases, it was possible to keep in touch. This was the case regardless of the device used, a surprising result, because it was assumed that seeing one's therapist on a computer screen would be different than seeing them on a 5-inch cell phone. Many patients also mentioned that teletherapy was an anchor in their week, something they could be sure of while everything else felt "endless" and "surreal". Furthermore, patients commented that it was easier to fit teletherapy into their schedule, because they did not have to spend time travelling to the treatment centre, and some also found it to be more flexible. While a number of patients mentioned that although they would prefer face-to-face contact, teletherapy gives them the opportunity to "really see" their therapists, because that way no one had to wear a mask. Most patients also appreciated the chat function of the video-call system as an extra facility to note thoughts and questions and to keep track of appointments.

3.3 Main arguments against teletherapy

The arguments against teletherapy varied between the patients who rated teletherapy as rather bad or bad as compared to those who rated it at least as mediocre. Patients who rated teletherapy more highly focused on technical aspects. It should be noted that all patients and therapists complained about technical issues, most notably problems concerning the internet connection. Other negative aspects mentioned by most patients centered around the feeling of a lack of privacy, even if they had their own room or private space. They also highlighted that they felt they could not be quite as open. Some patients indicated that they experienced a high level of distraction, e.g. due to alerts on any of their devices, such as their cell phone, notebook, or tablet, or because of people entering the room. Those who rated teletherapy as rather bad or bad stressed that they felt unsafe and were more bothered by not having a direct face-to-face counterpart.

4 Conclusion and discussion

The reported results are drawn from a small sample, as well as informal discussions with colleagues, and are thus hardly generalizable. Nevertheless, they provide some important insights worth highlighting. Prior studies on teletherapy could show that results of assessments match those from direct contacts (Diamond & Bloch, 2010) and overall acceptance and satisfaction by patients is good (Pesämaa et al., 2004). Also, barriers to use teletherapy have been evaluated, where important aspects seem to lie on the providers' side (e.g. policy, reimbursements). (Cowan et al., 2019) Although diverse facets of teletherapy have been explored, most studies focused on service provision in remote and rural areas and on teletherapy as an explicit offer and choice. Also, the transition of well-established face-to-face treatment into teletherapy with the same therapist has not been addressed explicitly. Our study focused on these aspects and could show that teletherapy generally seems to be a feasible option for adolescent psychiatric outpatients, even if they are in intensive treatment, although not all may benefit equally from it. For a continuation of teletherapeutic offers, infrastructure definitely needs to be adapted (high speed up- and download internet connections and the guarantee of unlimited data transfer). Interestingly, the size of the display was not a relevant factor for our patients, which indicates that teletherapy could potentially increase access to services in remote areas, because of the availability of mobile phones. Concerning the aspect of distraction, it might be sensible to set up a "teletherapy contract" with patients, guardians, or families, which includes commitments to turn off alerts during therapy and to not be disrupted by family members. Some therapists mentioned they felt more insecure in having limited options to act in the event of crises and escalations, especially in case of an unstable internet connection. It might be useful to discuss this aspect with patients and guardians beforehand and sharpen the guardians' awareness, have their telephone numbers at hand, and discuss a solid and up-to-date crisis plan with both parties. Extra communication paths like

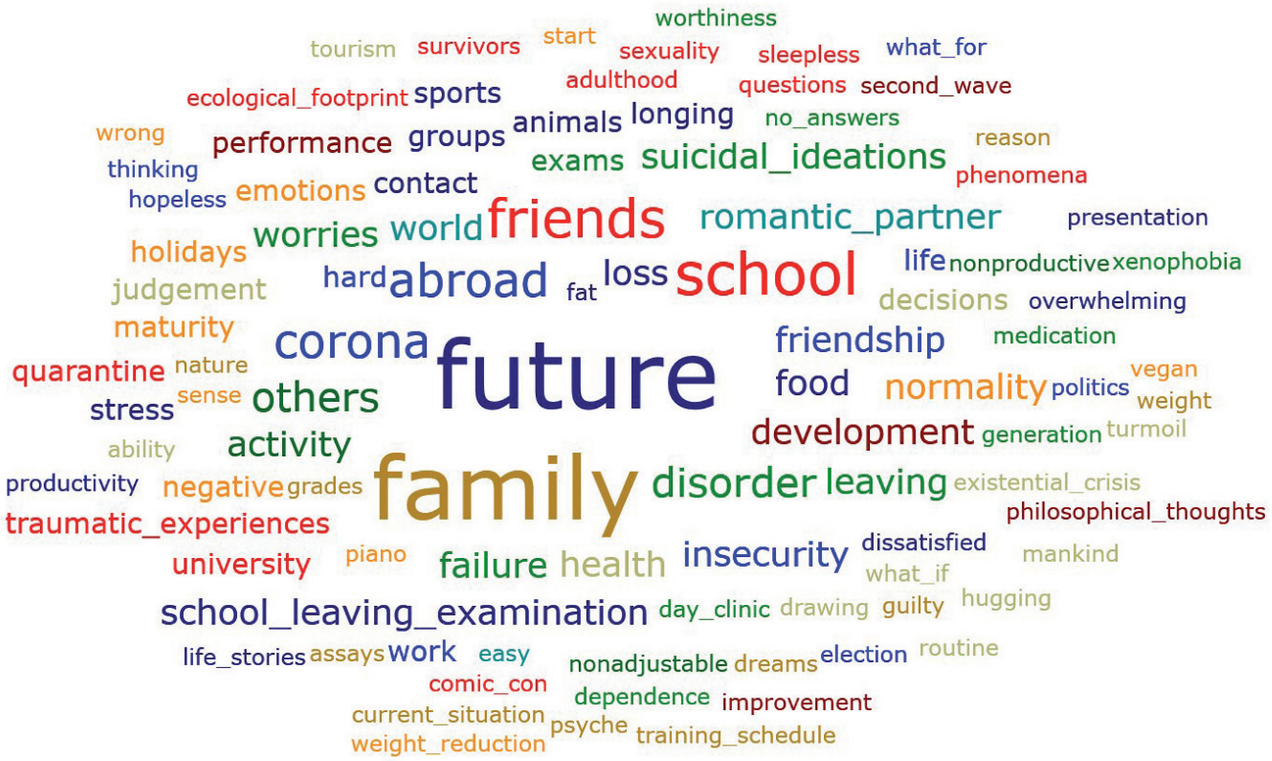

Figure 1. Word cloud indicating main themes preoccupying patients during lockdown

chats were also welcomed and used frequently by our patients. The possible flip side of potential overuse of the patients did not prove true in our observations, so that these pathways can also be seen as a chance, e.g. for interim boosters. Although teletherapy with children and adolescents is still in its infancy, the COVID-19 pandemic led to a massive expansion of the application of these technologies, resulting in an increased and growing body of experience. Further investigations are necessary to develop guidelines for a proper framework for teletherapy and on how to distinguish patients who will benefit from teletherapy from those who should be offered face-to-face contact. Furthermore, teletherapy should be included in the training curricula for psychiatrists, psychologists and psychotherapists.

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Social Media as a Vehicle for Conspiracy Beliefs about COVID-19

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Highlights

Conspiracy beliefs are spread via social media platforms and may have a negative impact on preventive health measures.

Preventive measures against fear and misinformation need to consider the differential effects of different forms of conspiracy theories on behavior.

Fostering awareness in society about COVID-19 misinformation in social media is crucial.

Keywords: conspiracy theory, social networking sites, pandemic, COVID-19

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The SARS-CoV2 virus has caused a global pandemic and health crisis with millions of people suffering from Coronavirus Disease 2019 (COVID-19). The symptoms of the disease include fever, dry cough, dyspnea, and loss of taste and smell, and are similar to those caused by severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS), both of which are caused by a coronavirus (Shi et al., 2020, Xydakis et al., 2020). However, the 2020 COVID-19 outbreak represents a massive global health crisis, and conspiracy beliefs relating to the origins and spread of the virus began to manifest themselves in the earliest stages of the pandemic. This is not especially surprising, since in times of acute crisis people tend to attribute significant events to a single, primary cause (Leman & Cinnirella, 2007; van Prooijen & Douglas, 2017). Misinformation and conspiracy theories are spread, proliferated, and amplified over social media platforms – most prominently Twitter and Facebook (Frenkel et al., 2020).

Conspiracy beliefs are usually defined as beliefs in the existence of a secret network of multiple actors who join together and try to achieve a hidden goal that is perceived as unlawful or malevolent (Bale 2007; van Prooijen & Acker, 2015). In other words: someone is pulling the strings. In times of uncertainty and during ubiquitous events, such as the COVID-19 outbreak, some people are drawn to conspiracy theories about the cause or even motivation behind the spread of the virus. The outbreak of the bubonic plague in the 14th century, for example, led to beliefs that Jewish people caused the epidemic and were actively spreading the disease through poisoning wells. Other conspiracy theories include the belief that HIV was disseminated to kill Black people, and that the Zika virus was developed as a biological weapon (Geissler & Sprinkle, 2013, Klofstad et al., 2019). More recently, the Ebola outbreak in West Africa – which lasted from 2013 to 2016 – was accompanied by misinformation conspiracy beliefs (Allgaier, & Svalastog, 2015). Similar conspiracy beliefs with analogous themes are now emerging during the COVID-19 crisis. There is a wide range of theories and beliefs about the outbreak and its development into a pandemic. An unsystematic review of Facebook content, YouTube channels, and videos from blogs about "COVID-19" reveals a wide spectrum of information about conspiracy beliefs relating to the disease, including the proposition that the pandemic is a governmental conspiracy, and the idea that COVID-19 is all a hoax.

Another observation during the COVID-19 crisis was people defining themselves as experts who interact via social media channels or webpages to inform the community about the actual threat of coronavirus, or the threat of measures against the coronavirus. There are also blogs and YouTube videos of physicians reporting anecdotal evidence from their clinical practice, with some arguing that COVID-19 provokes symptoms no more serious than those of a mild flu, and thus is not a clear and present danger to global health. For observers prone to conspiracy beliefs of this type, this messaging may result in confirmation bias – people being drawn to interpretations of evidence which are related to or support an existing hypothesis, belief, or expecta-

tion – thus further fostering these beliefs (Douglas & Sutton, 2008). Another explanation could be incorrect interpretations of causality, which means that simple relations are interpreted in a concrete direction.

1 Who is prone to fall for conspiracy theories?

Aside from logical fallacies and analytic thinking styles, studies have found socio-political factors to have reliable associations with conspiracy beliefs. Marginalized people and those with authoritarian and right-wing views have been shown to be more attracted to these theories (for a review, see Goreis & Voracek, 2019). The general paradigm in this regard, however, seems to be one of transition. Due to the ubiquitous availability and virality of conspiracy beliefs, as well as a rise in the distrust of institutions, they appear to be increasingly crossing over into the mainstream (Freeman et al., 2020). Uncertainty during impactful and threatening events – such as a global pandemic – may heighten personal distress. Conspiracy theories are a sense-making devices that provide comprehensive and causal explanations for events, potentially easing distress. Further, some of the conspiracy beliefs can be trademarked by the Dunning-Kruger-Effect, a bias that refers to the erroneous tendency in the self-image of people to overestimate their knowledge and skills (Motta et al., 2018).

2 Different types of conspiracy theories about COVID-19

As noted by a recent study (Imhoff & Lamberty, 2020), conspiracy beliefs about COVID-19 have direct implications for human behavior. Misinformation additionally causes confusion and spreads fear, which may further obstruct the response to the pandemic (Depoux et al., 2020). The director of the WHO called this the fight against "trolls and conspiracy theories", in addition to battling COVID-19 itself. Further, different believes lead to different behaviors. The belief that COVID-19 is a hoax may lead to a decreased perception of threats and danger, while increased risk-taking behavior, in turn, contradicts prevention purposes against the virus. Furthermore, the belief that COVID-19 is a man-made bioweapon will lead to more prepping (i.e. actively preparing for emergencies) and self-centric behavior.

Popular claims are that the pandemic is caused and/or spread by electromagnetic waves via telephone masts (see Kouzy et al., 2020). Using social network analysis, an investigation of Twitter posts showed that the 5G conspiracy was posted only by isolated groups and a few individual users, with some accounts being set up for the sole purpose of spreading this theory (Ahmed et al., 2020). This study also noted that only a third of the users posting on this topic at the time expressed endorsement and belief in the theory, while the remainder mocked it or shared posts humorously, inadvertently drawing more attention to the topic. Importantly, users may also be presented with this kind of (and adjacent) content due to filter bubbles, the combination of personal preferences and learning algorithms that display content in the news feed of social media (Mortimer, 2017). Users of social media may, therefore, be exposed to information that aligns with their pre-established beliefs, fostering an echo chamber (Messing & Westwood, 2014). Another recent study found that four main conspiracy narratives were being disseminated during COVID-19:

- the virus being related to 5G networks, which explains Chinese provenance and assumes a link with the Chinese technology company Huawei, which develops equipment for the networks;
- the release of the virus as a bioweapon;
- the virus being a hoax or no more dangerous than the mild flu;
- the virus being connected to Bill Gates, and a plan to develop a global surveillance system (Shahsavari et al., 2020).

Social media seems to be a strong carrier for conspiracy beliefs, as, people who have conspiracy beliefs are more likely to get their knowledge from social media (Allington et al., 2020).

3 Impact of COVID-19 conspiracy theories on mental health and health behavior

Inherent in conspiracy beliefs is a negative association pertaining to compliance with health-protective behaviors as indicated in earlier research about conspiracy theories on vaccines, HIV, and birth control (Thorburn & Bogart, 2005; Dunn et al., 2017; Grebe & Nattrass, 2012). In many countries, government-mandated social-distancing measures were implemented as a response to the pandemic. As long as no pharmacological interventions are available, social distancing and quarantine are the only means feasible to combat the pandemic. Indeed, a first large-scale evaluation of the implementations in six countries confirms their feasibility and efficacy (Hsiang et al., 2020). Some conspiracy theories, however, target prevention and treatment of COVID-19, suggesting that there is no need for decreasing physical contact with others, wearing masks in public hospitals, and general services such as vaccines, or drugs. This spread of conspiracy theories led to a rise of misinformation and unverifiable content (Kouzy et al., 2020). First investigations confirm that endorsement of such theories reduces compliance with mandated measures (Marinthe et al., 2020; Swami & Barron, 2020). People who believe that COVID-19 symptoms seem to be connected to 5G radiation in particular are less compliant with guidelines on virus control measures, e.g. social distancing, washing your hands more often etc. This indicates that conspiracy beliefs spread via social media undermine guidelines designed to protect public health.

First interventions and programs are implemented in an attempt to counter this development, those reach from simple accuracy reminders and subtle nudges to positive impact games and psychological inoculation (e.g. games that help to increase the ability to detect fake news) and visualized video experiments (e.g. videos that show that the prolonged use of medical masks does not lead to oxygen deficiency) (e.g. Pennycook et al., 2020; Roozenbeek & van der Linden, 2019, van Bavel et al., 2020). Striving to counter the above-mentioned cognitive and statistical biases, and increase analytic thinking, such programs utilize similar strategies that have proven viable to address fake news (Lazer et al., 2018).

4 Conclusions and Recommendations

In conclusion, conspiracy beliefs can be easily spread via social media platforms and people who have conspiracy beliefs are more likely to get information from social media – the latter is crucial knowledge as to break this vicious circle of misinformation. Recent studies provide indications that believing in conspiracy theories has a negative impact on preventive health measures. Both future research and public health prevention policy should consider that different specific conspiracy beliefs may lead to different consequences (e.g. in behavior, compliance, or health consequences) in relation to controlling the spread of a pandemic virus. Preventive measures should, therefore, consider these differences and be tailored towards them. This may, however, prove strenuous as echo chambers in online spaces, and the algorithms by used social media companies, produce an environment which can inculcate certain belief systems among social media users. Social media companies are called upon to revise their presentation of news feeds and cooperate with researchers as well as authorities to incorporate scientific evidence gathered during the current crisis into their procedures. A consequential (and thoroughly funded) strategy needs to be implemented to fight the viral spread of misinformation and conspiracies in social media (c.f. Garrett, 2020). Public health campaigns on social media implementing referenced information and providing psychological inoculation might offer useful tools to fight misinformation. Therefore, it is important to strengthen awareness regarding fake news and conspiracy beliefs about COVID-19 in society, and curtail the spread of misinformation to reduce uncertainty in public.

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Opinion Letter

On the Need for Digital Phenotyping to Obtain Insights into Mental States in the COVID-19 Pandemic

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Highlights

Digital phenotyping provides real-time insight into population mental health in a crisis such as COVID-19.

Digital phenotyping empowers policy makers with population level information to help fight a pandemic like COVID-19.

User privacy and informed consent is paramount in building trust with digital phenotyping.

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Coronavirus Disease 2019 (COVID-19) has caused a worldwide pandemic. Respiratory failure is among the most common causes of death related to COVID-19 (Mehta et al., 2020). Beyond the current debate on developing vaccines and appropriate treatments for COVID-19 (Lurie et al., 2020; Matthay et al., 2020), discussions have emerged on how the pandemic can be successfully controlled by technological means (Mayor, 2020; McCall, 2020). Beyond the widespread recommendations to control the virus by washing hands regularly, wearing respiratory masks, and practicing social distancing (perhaps more appropriately called physical distancing because it is also possible to socially interact virtually; for effects of travel restrictions see (Matthay et al., 2020)), there is interest in using mobile phone data to better understand how COVID-19 spreads in a given population (Oliver et al., 2020).

Various tracking technologies have been proposed, with different levels of privacy issues (Cho et al., 2020; Ienca & Vayena, 2020). Perhaps the least invasive method to track the spread of COVID-19 uses Bluetooth technology, where one's smartphone logs the identity of other smartphone users with whom the person interacted for specific periods of time (Abeler et al., 2020). The data are stored on the smartphone and are only transferred to a server if the user decides to share this information, for example if they learn that they have been infected. This approach is expected to be effective only if a minimum of 60% of a population install such an application (Hurtz, 2020). Current statistics from countries such as Austria (3%) and Singapore (20%) show that typically the minimum threshold is not reached (Rosenbach et al., 2020), perhaps due to privacy concerns.

Beyond the question of whether smartphone-tracking procedures can adequately minimize the spread of COVID-19 in a population, use of smartphone tracking might have additional benefits in the context of a pandemic. The data derived from smartphones can be used to obtain insights on changes in psychological variables, such as the current mental state of a person, that are induced by a pandemic (Baumeister & Montag, 2019; Dagum, 2018). For instance, smartphone call behavior is robustly associated with extraversion (Montag et al., 2014, 2019). Detecting psychological states and traits from digital traces logged on smartphones and other connected devices is called digital phenotyping (Insel, 2017, 2018). It has shown promise in longitudinally assessing affective states (Messner et al., 2019; Zulueta et al., 2018), including providing insights into affective disorders such as major depression (Saeb et al., 2015, 2017). In principle, app tracking technologies could be used to track the spread of COVID-19 and further assess its adverse effects. For example, such tracking could be used to assess the increase of mental disorders that are a consequence of the effects of the COVID-19 pandemic. This includes the effects of loneliness and social isolation (Armitage & Nellums, 2020), and concerns about job losses and related financial duress (Coibion et al., 2020). At the moment it is difficult to obtain insights into the potential rise of mental disorders related to COVID-19. Social distancing prevents many people from obtaining access to mental health professionals. Digital phenotyping via smartphone tracking tech-

nologies could help reveal those who may benefit from access to health support and services.

Insight into population mental health in the COVID-19 pandemic is relevant to policy makers whose decisions on restricting social interactions, closing economic sectors, and imposing self-quarantine measures, need to reflect the indirect societal costs and health implications of depression and addiction. In this domain, Schimmenti et al. identified four areas, which might be among the causal factors for psychiatric disorders triggered by COVID-19. Here, the authors discuss the components: "(1) fear of the body/fear for the body, (2) fear of significant others/fear for significant others, (3) fear of not knowing/fear of knowing, and (4) fear of taking action/fear of inaction" (Schimmenti et al., 2020. p. 41).

The negative psychological impact of COVID-19, including adverse effects directly attributable to COVID-19 itself, and also indirect effects due to isolation or heightened anxiety/fear from constant media coverage, has already received empirical support in the literature. A nationwide survey from China reported that approximately 35% of the investigated population showed signs of significant psychological distress (Qiu et al., 2020). In Iran it has been reported that fear of COVID-19 correlates with elevated depression and anxiety symptoms (Ahorsu et al., 2020), and in Bangladesh the first case of suicide (of a 36 year old man) due to fear of infection by COVID-19 has been recorded (Mamun & Griffiths, 2020). COVID-19 could result in a higher risk of increased alcohol use disorders over time (Clay & Parker, 2020). In March 2020, Germans bought 12% more beer and 31% more high alcohol-content drinks compared to the same period the year before (Bartel, 2020). Such elevated alcohol consumption could be a consequence of isolation and/or fear of COVID-19. A recent paper also discussed the potential negative consequences of COVID-19 in the area of problematic Internet use, in the context of prolonged screen time sessions that are a result of governmental requests to stay at home (Király et al., 2020).

We need to pay greater attention to the negative mental health and social implications of the COVID-19 crisis and related policies. Population scale digital phenotyping can provide important insights on changes in population mental health and the impact of government policy. We must balance this potential benefit with ethical issues arising from the use of tracking technologies, perhaps the most problematic being privacy violations in the age of surveillance capitalism (Dagum & Montag, 2019; Martinez-Martin et al., 2018; Montag et al., 2020; Zuboff, 2019). Therefore, we stress the importance of protecting personal privacy while developing tracking solutions that can provide authorities with real time information on mental health in large populations during the COVID-19 pandemic.

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Conflict of Interest

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