What works in the Digital Age? VR and smartphone applications for forensic psychology

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What Works in the Digital Age? VR and Smartphone Applications for Forensic Psychology

Forensic psychology lies at the intersection of criminal justice and mental health care (Vollm et al., 2018). Its main goal is to reduce the chance of recidivism and address treatment targets in relation to offence-related factors and psychiatric disorders (Kip et al., 2018; Vollm et al., 2018). The forensic population is characterised by various risk factors for recidivism, such as high psychiatric comorbidity (Fazel & Danesh, 2002; Van der Veeken et al., 2018), relatively low treatment motivation (Drieschner & Boomsma, 2008; Kip et al., 2019b) and low cognitive abilities (Kip et al., 2019b). The combination of these risk factors makes the forensic population both hard to reach and difficult to treat, which is reflected in high reoffending rates (Bengtson et al., 2019). As risk factors are diverse, the use of individualised therapy is essential for treatment efficacy (Bonta & Andrews, 2007). Implementing technology in treatment can support individualised therapy (Kip et al., 2019b). Furthermore, when applied in the right way, technology could reduce bias and increase inclusivity. Therefore, technologies could enhance the forensic field in the main elements of care: risk assessment, offender rehabilitation, and reintegration (Bonta & Andrews, 2007; Vollm et al., 2018). Two forms of eHealth with the potential for application with a forensic population include Virtual Reality (VR) and applications for mobile devices ("smartphone apps"). Both are discussed in this chapter.

VR has several features that can make it a valuable addition to the forensic psychology toolkit. In this chapter, we focus on immersive VR (also referred to as IVR) which is generally experienced through a head-mounted display (HMD) (Fox et al., 2009). For research and assessment purposes VR provides advantages over current methods. Among others, VR enables objective data gathering and standardised treatment, resulting in less biased and more individualised assessment. Consider roleplay exercises, which generally take place with real actors. Confederates or trained actors' verbal and non-verbal behaviour may cause unintentional variation in the treatment and they may vary in terms of

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appearance and physique, dress, non-verbal cues, et cetera. All these aspects can be standardised using VR. Additionally, in VR, an avatar's or participant's characteristics (e.g., gender, age, skin colour, weight) can be experimentally changed and tailored to the needs of the specific target population.

Furthermore, clinical VR where simulated interactive learning environments are created that are difficult to realise in real life has been shown to be a powerful therapeutic tool (Hamilton et al., 2021). In these virtual settings, behaviour change can be supported without endangering others (Cornet & Van Gelder, 2020; Farley, 2018). Since VR environments are adaptive and do not require well-developed imaginative, verbal and cognitive skills, they can be tailored to the needs of diverse populations. Hence, they are an inclusive and engaging form of treatment compared to more conventional approaches and have the potential to be accepted by offenders (Kip et al., 2019b).

Smartphones have their own set of unique features. In the previous two decades smartphones have become an accessible and user-friendly form of technology with potential for research and intervention. Smartphone devices contain cameras, have GPS, internet connectivity, and various sensors (Miller, 2012). In addition, many different kinds of software applications can be run on these devices. Such features allow for efficient and individualised data collection, for example by registering participants' real-time location anywhere in the world, and administering interactive tests at any time of day (Kuntsche & Labhart, 2013; Miller, 2012). Furthermore, the potential of smartphones for forensic psychology extends to new possibilities for interventions, for example through serious gaming and via "portable" therapy (Bakker et al., 2016; Linardon et al., 2019). In addition, smartphones offer novel possibilities to engage with individuals living in remote areas or residential settings and provide opportunities to bring help and assistance within easier reach for a broader, and therefore more diverse, audience.

To summarise, both VR and apps can enhance treatment engagement and motivation (Kip et al., 2019b; Klein Tuente et al., 2020; Ticknor, 2019) and be tailored to individual user needs. Furthermore, both allow for objective data collection, which can reduce implicit bias in assessment. In addition, for an incarcerated population, VR and apps can support digital resocialisation. Yet, despite their potential, forensic psychology has not yet fully embraced the possibilities that these technologies offer (Cornet & Van Gelder, 2020; Kip et al., 2018; Ross, 2018; Ticknor, 2018). Our goal is twofold. First, we aim to provide a state-of-the-art review of smartphone and VR applications in forensic science. This updates the review for VR by Cornet and colleagues (2019). Second, we show the potential of these technologies beyond the current state of the art. Below, we start out with presenting the findings of our review.

Results

This review yielded 18 VR applications and 18 smartphone apps (see Tables 8.1 and 8.2 for details on the literature search). Based on these results, we conclude

Table 8.1 Search methods and eligibility criteria

The literature search included the databases of Web of Science, PsycINFO, PubMed, and Scopus in June 2021.
For VR, we replicated the search used in a previous review with the same keywords and databases (Cornet et al., 2019). We then conducted a similar search for apps. We used the following search terms: ("virtual reality" OR "augmented reality") / ("mobile app*") AND (judicial*, forensic*, crim*, delinquen*, aggress*, antisocial*, externali?ing, impuls*, violen*, prison*, "conduct disorder", psychopath*, offend*, detention, jail, parole, probation, victim*, police, "offender assessment", "offender correction", "offender rehabilitation").
To include VR and smartphone applications that were not reported on in scientific publications, we also conducted a web search with the Google Search Engine with keywords related to technology ("virtual reality" / "mobile app") in combination with a simpler search string of keywords related to a forensic population (e.g., "prison"/ "offender"/ "delinquent"). Finally, additional applications were located through browsing the reference sections of relevant articles.
Studies were selected if they were published in English or Dutch, and researched or described either VR or smartphone applications developed for or validated by a forensic population.

Table 8.2 Study selection

For VR, 3426 references were initially identified in the scientific databases. After duplicates were removed, this number was reduced to 2593. All references were screened by title and abstracts, which excluded a further 2542 articles. After selection, the remaining full-length articles were retrieved for further analysis resulting in the exclusion of another 41 studies. In total ten studies met the criteria to be included in this review. The web search yielded an additional eight VR applications, leading to final selection of 18 VR applications. For a schematic overview of the VR search, see Figure 8.1.
For smartphone apps, 1492 references were initially retrieved through the databases, which was reduced to 1204 after removing duplicates. After titles and abstracts were screened for eligibility, 39 articles were selected for further consideration. A total of six studies met the inclusion criteria and were included in this review. The web search yielded an additional 12 smartphone applications, leading to a total of 18 smartphone apps. For a schematic overview of the search see Figure 8.2.

that (1) the development and implementation of VR and smartphone applications for forensic populations are still in their infancy, but interest is increasing; (2) most VR applications have been developed for rehabilitation, whereas most smartphone apps have been developed for reintegration; and (3) scientific research investigating the effectiveness, feasibility and usability of VR and smartphone applications is scarce. Below we present an overview of the opportunities these technologies offer for supporting risk assessment, offender rehabilitation, and reintegration.

Method

Risk Assessment

VR for Risk Assessment

Forensic risk assessment refers to the process of predicting and evaluating the likelihood of future offending (Brown & Singh, 2014; Singh & Fazel, 2010). This involves the routine examination of individual, social, or contextual factors (Bogaerts et al., 2017; Brown & Singh, 2014).

VR offers several opportunities for forensic risk assessment. Firstly, exposing an individual to a virtual risk scenario does not pose actual risk to others or the user. Secondly, VR can provide insight into criminal decision-making processes which are usually covert due to the illegal nature of crime (Cornet & Van Gelder, 2020; Fromberger et al., 2018; Kip et al., 2019b). Thirdly, the lack of restrictions as to the kinds of different environments that can be developed allows for a wide

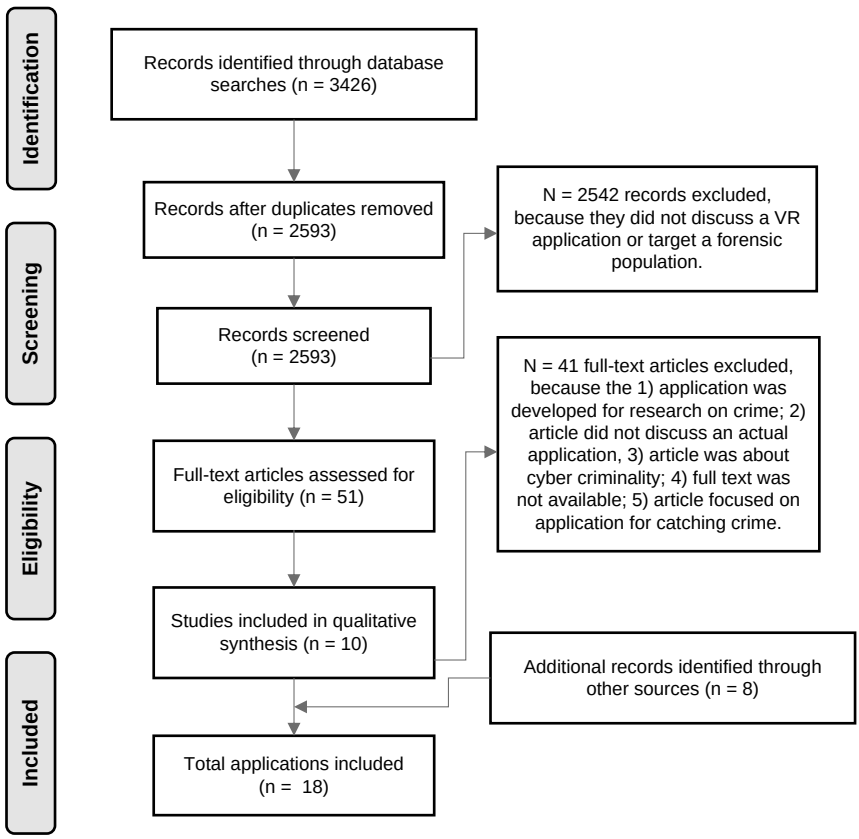

Figure 8.1 Schematic overview of the VR search.

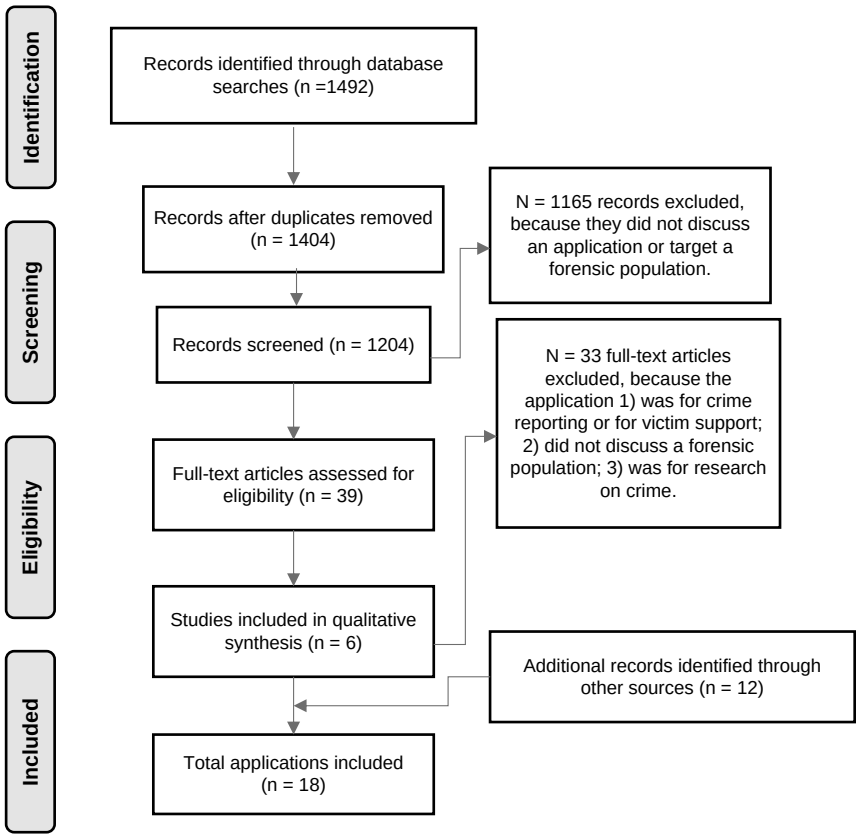

Figure 8.2 Schematic overview of the app search.

range of criminogenic situations to be assessed. Fourthly, VR offers high levels of researcher control. Besides the ability to test individualised scenarios, this enables exposing participants to the same virtual environment (VE) thus enabling highly standardised observation. Fifthly, VR allows for the measurement of physiological responses, which facilitates detailed measurement of behaviour (e.g., movement, eye gaze; see Nee et al. (2019) and Park & Lee (2021). Therefore, VR can provide a more thorough evaluation of behaviour, physiological processes and criminal decision-making processes (Parsey & Schmitter-Edgecombe, 2013). This may improve ecological validity of risk assessment and reduce implicit bias (Fromberger et al., 2014; Parsey & Schmitter-Edgecombe, 2013; Rizzo et al., 2000), because physiological measurements do not require data linked to individual factors as race or socioeconomic status (Haarsma et al., 2020).

Despite these advantages, the use of VR for risk assessment is still in its infancy. The located VR risk assessment tools and applications (see Table 8.3) make use of the advantages of VR in different ways. They share the aim to gain

Table 8.3 VR applications for risk assessment

Application/ authors	*Target population*	*Goal*	*Description*
(Renaud et al., 2014)	Sex offenders	Study the capacity of VR for the assessment of sexual profiles.	The erectile response of 22 sex offenders and 42 controls was measured with supplementary physiological measurements (penile plethysmography [PPG]) while they listened to audio stimuli and while immersed in a VE watching computer-generated avatars of males, females, boys and girls.
(Fromberger et al., 2018)	Sexual offenders against children (SOCs)	Study to investigate whether monitoring SOCs in virtual risk situations will yield additional information for risk assessment.	SOCs and non-offender controls walked through three VEs and were confronted with a virtual child character. They could choose to engage in approach or avoidance behaviour.
What's up? (Creemers, 2020)	Juveniles that enter residential youth institutions	Improve screening of juveniles in forensic care, optimise receiving the right treatment and test if VR can support forensic risk assessment among juveniles.	Neurobiological measurements are assessed in a VE to evaluate among others cognitive flexibility, pro-social behaviour, dealing with authority and pro-active aggression.
Virtual Reality Aggression Assessment (VRAA) (Sappelli et al., n.d.)	People with reactive aggression	Develop a VR assessment tool for reactive aggression.	Provoking scenarios are presented to people in order to reliably assess reactive aggression.

insight into decision-making processes but differ in the type of criminogenic environment they use for that purpose. These range from neutral environments like a supermarket (Fromberger et al., 2018), to provoking scenarios intended to trigger delinquent behaviour (Klein Tuente et al., 2020; Sappelli et al., n.d.; Smeijers & Koole, 2019). Furthermore, most of the located VR assessments only use virtual environments (VEs) to observe behaviour rather than supplementing VR with physiological measurements for objectively measuring behaviour. For example, to date only one research group used additional measurement equipment in their VR assessment of those convicted of sexual offences (Renaud et al., 2014).

VR offers a wide range of untapped opportunities for supporting forensic risk assessment. For example, supplementing VR assessment with additional equipment (e.g., to measure brain activity, heart rate, and/or skin conductance) may provide a more comprehensive image of behaviour and decision-making processes. Additionally, gamification can be used to make the assessment more interactive, attractive, and engaging. However, methods to quantify observed behaviour must be developed in order to be able to use VR for assessment purposes. In addition, even though research has shown that behaviour displayed in VR seems to correlate with how participants would behave in real-life (Fromberger et al., 2018; Nee et al., 2019; Renaud et al., 2013; Renaud et al., 2014), it is important to remain cautious about the generalisability of virtual forensic risk assessment to the real world. This generalisability depends on a series of factors, including the type of risk factor involved, the quality and character of the VR instrument, and the type of behaviour and offender under study. Until the external validity and diagnostic value of a specific risk assessment instrument has been unambiguously assessed, no claims towards generalisability can be made.

Smartphone Apps for Risk Assessment

In general, existing forensic risk assessment methods will occur in a clinical setting and are often dependent on retrospective self-reports. As retrospective self-reports cannot reliably capture fluctuations in behaviour, current methods appear restricted in how well they measure real-world behaviour (Parsey & Schmitter-Edgecombe, 2013). Compared to traditional forensic risk assessments, and also VR-based assessment, smartphones carry a number of advantages. Firstly, smartphones are an accessible and user-friendly technology that most people carry with them throughout the day. Secondly, smartphones have an extensive research potential, because they are equipped with a set of sensors (e.g., GPS, microphone, accelerometer, gyroscope) and features that can collect information about their user and their environment (Miller, 2012). The combination of these two characteristics enables efficient and frequent (even continuous) data collection in real time (e.g., ecological momentary assessments (EMA); Shiffman et al., 2008). These data can be collected in the user's natural living environment without temporal or spatial restrictions (Van Gelder, 2020), which reduces bias and increases ecological validity (Russell & Gajos, 2020; Shiffman et al., 2008).

However, developing apps for risk assessment and testing their effectiveness is challenging considering data can be affected by smartphones changing hands, and privacy and ethical issues (Keusch et al., 2019; Nicholas et al., 2019). In addition, even though computerised measurements make people feel more anonymous and therefore seem to reduce social desirability bias (Richman et al., 1999), a certain risk of social desirability when collecting data unsupervised cannot be excluded. The challenges in developing apps for forensic risk assessment are reflected in the limited number of apps for this specific purpose. There also seems to be a lack of apps targeted at the forensic population that use EMA methods to passively collect data through smartphone sensors.

Two of the forensic risk assessment apps that our review identified, QoL-ME and The *Zelfscore App* (see Table 8.4), have been developed to facilitate self-management for service users who wish to gain more insight into themselves and their progress. Therefore, these apps are self-report-based and require active user input.

Additionally, to actively collect self-report data, apps offer wider opportunities for forensic risk assessment (Areàn et al., 2016; Bush et al., 2019). Firstly, apps can include tasks or games which assess behaviour (e.g., neurological tasks or serious games) (Sobolev et al., 2021). Preliminary results even suggest that app-based serious games can predict reoffending or psychiatric relapse with predictive accuracy similar to commonly used risk assessments. Haarsma et al. (2020) developed a gamified set of neurocognitive tests administered on a tablet. To predict the chance of reoffending, test results were analysed with machine learning methods. Due to only neurocognitive input being required to predict recidivism levels, implicit bias and confounds of static factors (e.g., criminal history) are limited (Haarsma et al., 2020; Ormachea et al., 2016). Secondly, apps can collect data in an unobtrusive and highly individualised way (Parsey & Schmitter-Edgecombe, 2013). For example, smartphones can collect data on physical activity (accelerometers and pedometers), social network (Bluetooth, messaging services, or number of phone calls), sleep patterns (screen interaction), stress levels (additional wearables such as breast or wrist bands), and psychological well-being (facial emotion recognition through the front camera). Passively collecting such data enables evaluating the connection between measured factors (Russell & Gajos, 2020).

Offender Rehabilitation

VR for Rehabilitation

Treatment of patients in forensic settings focuses both on reducing criminogenic factors and treating psychiatric problems related to antisocial behaviour (Bonta & Andrews, 2007). For the efficacy of offender rehabilitation, it is essential to engage service users in their treatment and to support the transfer of cognitive skills to behaviour (Andrews & Bonta, 2010; Bonta & Andrews, 2007).

VEs have several characteristics that render them well-suited for training self-regulation skills and learning prosocial behaviour. Firstly, in VEs a situation can

Table 8.4 Smartphone applications for risk assessment

Application/ authors	*Target population*	*Goal*	*Description*
(McLoughlin et al., 2021)	Nursing staff on an all-male inpatient acute forensic psychiatry unit	Assess the internal and predictive validity of a mobile app risk assessment tool.	Developed for staff to assess risk of aggression. The app is based on the dynamic appraisal of situational aggression (DASA) risk assessment tool.
QoL-ME (Buitenweg et al., 2019)	People with severe mental health problems	Develop an app for quality of life (QoL) assessment.	An innovative, personalised, and visual app for QoL assessment. People treated in forensic psychiatry were involved in the development of the app.
Zelfscore App [self-score app] (Ter Horst et al., 2016)	Adult forensic inpatients	Make clients more aware of treatment goals and progress, and support shared decision making between inpatients and therapists.	Inpatients answer a combination of questions about different risk factors for reoffending. The results are visualised to map on in which domain progress has been made and which domain continues to carry risks.

be experienced that would otherwise involve risk, contain prohibitive ethical implications, or be impossible to create in real-life (Cornet & Van Gelder, 2020). Secondly, VEs can realistically reflect the real world, thus they do not pose high demands on imaginative skills, which may support transfer of skills learned in treatment to real life. In addition, it is important to consider that for VEs to realistically reflect the world of a diverse population as the forensic population, they must allow for a high level of customisation (e.g., VEs reflecting different kind of neighbourhoods, body types, gender identities, and skin colours). Thirdly, VR seems to provide higher self-reflectiveness compared to memory or imagination (Riva et al., 2016; Ventura et al., 2021). For example, individuals can embody another avatar in VR to increase perspective taking abilities (Ventura et al., 2021) and empathy levels (Schutte & Stilinović, 2017; Seinfeld et al., 2018; Ventura et al., 2021). Fourthly, the immersive character of VR and the possibilities of interaction and gamification are likely to be experienced as engaging (Klein Tuente et al., 2020; Ticknor, 2019), which supports therapy adherence and may reduce treatment drop-out (Andersson et al., 2018; Evans et al., 2009).

Multiple VR applications for offender rehabilitation have been developed (see Table 8.5). All of these focus on individual learning exercises, with aims ranging from learning practical skills (e.g., Virtual Mechanic) to aggression regulation skills (e.g., VR Aggression Prevention Training or VRAPT). Furthermore, there are differences in the methods used to achieve behaviour change. For example, VR-GAIME includes gamification, where Seinfeld et al. (2018) and FutureU include perspective changing exercises. Despite the variety in VR interventions for offender rehabilitation, only a limited number of efficacy studies have been undertaken. Two recent RCTs have been unable to prove the effectiveness of the VR interventions under study (Klein Tuente et al., 2020; Smeijers & Koole, 2019). More research is needed in different forensic settings (e.g., outpatient settings), with multiple research outcomes (e.g., behaviour and skills in social situations, treatment motivation, or emotion recognition) (Klein Tuente et al., 2020), different VEs, and with other behavioural change theories underlying the intervention. Furthermore, since technology as VR is suited for establishing virtual social connection, the potential of group learning could be explored. Especially for incarcerated populations the added value could be assessed of offering virtual group sessions, or virtually involving family members and peers to engage the offender's network in treatment.

Smartphone Apps for Rehabilitation

Whereas VR offers a safe environment for practicing skills and behaviour, this environment is generally physically bound to the treatment setting. To be able to continue the learning process beyond the treatment setting, smartphones could be used. Since these devices have become part of the daily routines of many, they offer unique advantages for delivering interventions (Stieger et al., 2018). They are accessible from almost anywhere and at any time. Therefore, they can reduce barriers to treatment adoption, increase acceptance of interventions, and

Table 8.5 VR applications for offender rehabilitation

Application/ authors	*Target population*	*Goal*	*Description*
Virtual reality aggression prevention training (VRAPT) (Klein Tuente et al., 2020)	Forensic psychiatric inpatients with low aggression regulation skills	Reduce reactive aggression.	In multiple guided interactive VE's forensic psychiatric inpatients are confronted with provocative social scenarios to practice aggression regulation skills.
"Vergeet mij niet" [Don't forget about me] (Enliven, n.d.)	Offenders of domestic violence	Enhance empathy, awareness, and behaviour change.	In 360° VR, domestic violence offenders take the perspective of a seven-year-old boy witnessing his parents arguing and physically fighting.
(Seinfeld et al., 2018)	Offenders of domestic violence	Test if changing perspective through immersive VR can change emotion recognition.	Participants take the perspective of a female and experience being a victim of domestic abuse.
Virtual Environment for the Treatment of Offenders (VETO) (Ticknor, 2017)	Juvenile offenders	Evaluate how VR can be deployed in juvenile correctional rehabilitation.	Juvenile offenders learn social coping skills in a cognitive behaviour-based VR group therapy, by controlling avatars in different VEs.
VR-Game for Aggression Impulse Management (VR-GAIME) (Smeijers & Koole, 2019)	Forensic psychiatric outpatients with aggression regulation problems	Reduce aggression.	This serious game targets implicit processes that are related to aggression. People have to avoid angry looking avatars and approach friendly looking avatars.
VR at De Waag (De Waag, 2020)	Forensic outpatients	Enhance social skills and regulation skills, get used to VR, practice meeting other people, and enhance perspective taking.	Three VR exercises are used in treatment: "Role plays" for enhancing social and regulation skills, "Walking around" to get used to VR, and "Changing perspectives" to enhance empathy and empathising skills (Hutten et al., 2021).

Virtual Mechanic (Collins et al., 2020; McLauchlan & Farley, 2019)	Prisoners with low literacy and numeracy skills	Improving learner engagement and progress with a VE.	A literacy and numeracy programme is contextualised within a virtual mechanic's workshop. Learners must identify various car parts, tools and features, manipulate components and follow instructions.
(Innovative Prison Systems, 2017)	Prisoners	Offender rehabilitation.	Various VR services, including formal education, vocational job training, and psychological rehabilitation.
FutureU (Van Gelder et al., 2022)	Young adult offenders	Enhance vividness of the future self and long-term thinking abilities, and reduce self-defeating behaviour.	Participants set goals and virtually travel through time to give advice from the perspective of their future self who had already achieved the goal.
Volver a Casa [Going Back Home] (Alarcón, 2020)	Inmates from different prisons	Give access to technology and to use VR as a bridge between the exterior and interior of prisons.	One of the work areas of Volver a Casa is connecting inmates with their family by having them virtually visit their homes in 360° VR.

enhance access to care (Zhang et al., 2015), either by providing stand-alone interventions, or by extending the reach of existing treatment methods (e.g., the My Companion App, see Table 8.6). Furthermore, app-based interventions can be highly individualised (Stieger et al., 2018) and offered at the right moment and place (ecological momentary interventions or EMIs; Heron & Smyth, 2010). Additionally, apps may improve transfer of skills acquired during treatment because interventions can be accessed and delivered in real time and in the natural living environment of the user (Heron & Smyth, 2010).

The apps that the current review yielded offer both EMIs that need to be actively accessed by users (e.g., chatting in the FutureU app), and EMIs that passively emerge (e.g., the GRiP app noticing heightened stress levels). However, even though smartphones contain sensors and features that can be used for EMA and EMI (e.g., accelerometers, GPS, and Bluetooth), the currently available apps only use a few of them. GPS is used in A-CHESS and BFO to locate the user and provide EMIs when the user enters a risk area. GRiP uses the microphone of the user's smartphone to capture their voice volume and external sensors (a heart or wrist band) to measure their heart rate variability. Furthermore, only a few apps offer educational and health care modules (e.g., A-CHESS and BFO), and they focus mostly on substance abuse.

To make better use of smartphones' potential for providing interventions for offender rehabilitation, intervention modules which focus on other aspects of behaviour change aside from addiction need to be developed. Another recommendation would be to further explore the possibilities of EMIs that use sensors and features to passively collect data. Offering support at the right moment and at the right place can assist a forensic population during stressful or risky situations. For example, through pre-programmed prompts or by offering the option of calling a therapist or peer. In such a manner, EMIs could afterwards support evaluating these risk situations to promote learning and support prevention. Therefore, it is worth looking into the possibilities of apps for offender rehabilitation and into the acceptance, feasibility, and usability of such interventions.

Reintegration

VR for Reintegration

Reintegration involves the process of re-entering society after having served a prison sentence or when released from a residential psychiatric institution. Empirical research into what elements and combinations of reintegration services prove most successful in reducing recidivism is scarce (Wormith et al., 2007). Since reintegration support and continuity of mental health treatment is often essential for preventing relapse and recidivism (Graffam et al., 2004; Ventura et al., 1998), support must necessarily enhance continuity of care and bridge the gap between life in prison and life on release. VR can reduce this gap in two ways. Firstly, VR can provide a realistic glimpse of the outside world while still in

Table 8.6 Smartphone applications for offender rehabilitation

Application/ authors	*Target population*	*Goal*	*Description*
Goede Reactie is Preventie [Good reaction is prevention] (Hoogsteder et al., 2018)	Adult forensic psychiatric patients with aggression regulation problems, a high amount of arousal or stress, and low control skills	Learn to recognise stress and anger, and learn to monitor and control these feelings.	Biomarkers (wrist bands, breast bands or smartwatches) can be connected to the app to measure heart rate variability. The microphone measures voice volume. When stress levels or voice volume above certain values that are measured, the app offers an intervention.
A-CHESS (Gustafson et al., 2014; Johnson et al., 2016)	People suffering with alcohol addiction	Achieve and maintain recovery and prevent relapse in people suffering with alcohol addiction.	People have access to different kind of educational modules, GPS locates risk areas and will provide a micro intervention when the user is near a risk area. Weekly surveys gain information regarding well-being.
Breaking Free Online (BFO) – My Companion App (Elison et al., 2016)	For substance addicts. The programme was adapted to an internet-based intervention for substance-involved offenders	Strengthen resilience and build tools for recovery.	Different kinds of modules in the app support the BFO programme and help the user desist from substance misuse by providing relaxation exercises and EMIs if users enter risk areas.
Self-Control Training (SCT) app (Kip et al., 2021)	Populations with aggression regulation problems	Study if self-control could be improved and aggression be decreased via an app.	Users are asked to perform daily activities with their non-dominant hand.
FutureU (Mertens et al., 2022)	Young adult offenders	Reduce self-defeating behaviour by enhancing future orientation.	Consists of various modules: a gamified chat conversation with an aged avatar of the user, a time travel portal to take the perspective of your future self, and an implementation intention exercise.

custody. By virtually being exposed to the outside world, prisoners might be better prepared for what life looks like on the outside. Secondly, VR can support preparation for re-entry into the community by providing opportunities for practicing common "all-round" skills (e.g., opening a bank account; Dolven & Fidel, 2017) and learning how to avoid potential risk situations (e.g., how to reject an offer of drugs; Teng & Gordon, 2021).

The use of VR to support reintegration is already being explored, as is reflected in the various types of VR applications that this review yielded. Various prisons have implemented VR programmes to prepare for life after release (see Table 8.7). They offer virtual practice environments, ranging from navigating public transportation to shopping at a self-scan supermarket (Dolven & Fidel, 2017). By practicing these skills in a realistic and individualised environment, digital resocialisation is supported and offenders are better prepared for life after release, therefore reducing the gap between prison and society.

However, research investigating the effectiveness of using VR during reintegration is lacking. Since immersion in realistic looking scenarios (e.g., when practicing how to deal with risk situations after release) could potentially trigger traumas (Teng & Gordon, 2021), research is needed to avoid counterproductive effects.

Smartphone Apps for Reintegration

Since apps can be accessed at any place and any time they can function as a useful tool for assisting reintegration by supporting service users on probation. The majority of apps that the current review has yielded have been developed for the purpose of reintegration (see Table 8.8). Two types of reintegration apps can be broadly distinguished. Firstly, apps exist that function as an extended form of probation supervision. These apps can replace electronic ankle bracelets and reduce the number of physical check-ins, for example, by offering mobile check-ins with the probation officer and by providing probationers with Bluetooth breathalysers to measure alcohol levels at a distance (e.g., Outreach Smartphone Monitoring or OSM). Secondly, apps have been developed with the specific aim to facilitate the reintegration process without active supervision. To achieve the latter goal, apps can offer various possibilities, for example, gamification (e.g., MyNeon), or by offering educational modules (e.g., StaySafe and Mobile-Enhanced Prevention Support or MEPS), mental health support and crisis support (e.g., Utsikt and Changing Lives).

The reintegration apps we identified mostly provide educational modules or mental health support, which need to be actively accessed in the app. Ideally, reintegration apps should also contain EMA and provide EMI based on these data to facilitate continuity of care during reintegration. In addition, research on the uptake, feasibility, usability, and effectiveness of reintegration apps is lacking. Therefore, it would be valuable to study if probation officers and service users perceive the apps as useful, and if the apps support reducing recidivism.

Table 8.7 VR applications for reintegration

Application/ authors	*Target population*	*Goal*	*Description*
Colorado Prison Programme	Inmates convicted as juveniles and served at least 20 years of their sentence	Support inmates preparing for community entry.	To qualify for early release, inmates enrol in a three-year programme in which they use virtual reality to practice skills they never learned as teens, like doing laundry, grocery shopping, and navigating in public transport (Clarke, 2019).
Education Justice Project	Men incarcerated at the Danville Correctional Center	Introduce people who will soon be released meet challenges they can encounter after release.	The University of Illinois created various immersive reality scenarios: how to navigate public transportation, pay at the pump at a gas station or order from a digital kiosk at a fast-food restaurant (Heckel, 2018).
(Teng & Gordon, 2021)	Incarcerated women prior to their release	Practice acting in high-stress re-entry situations.	Female offenders practice various risk scenarios that might occur after release (e.g., during a job interview the manager asks about your criminal record).
VR Job Interview Training (VR-JIT) (Smith et al., 2020)	Returning citizens	Enhance interview skills and confidence, and increase the chance of receiving job offers.	Incarcerated individuals can practice job interviews with a virtual hiring manager. People receive immediate feedback if certain answers are correct or incorrect and the scenarios become more challenging over time.

Table 8.8 Smartphone applications for reintegration

Application/ authors	*Target population*	*Goal*	*Description*
Mobile-Enhanced Prevention Support (MEPS) (Edwards et al., 2020)	Gay or bisexual men and transgender women leaving jail	Support engagement in preventive health care during reintegration and reduce recidivism.	Provides tools for tracking and meeting goals, locating services, tracking and distribution of rewards, and receiving assistance of peer mentors.
StaySafe (Lehman et al., 2021)	People under community supervision or in residential settings	Help people make better decisions regarding health risk behaviours, especially those linked to HIV, viral hepatitis and other STDs.	Includes 12 weekly sessions in which users are guided through a series of steps, questions, and exercises aimed at promoting critical thinking about health risks associated with substance use and unprotected sex.
Changing Lives, Probation service Ireland (McGreevy, 2019)	For probationers suffering with addiction or mental health problems	Increase desistance by enabling probationers to identify problems; find support, information, advice and services.	Includes multiple modules, among others a journal to keep track of progress; a probation module where expectations and requirements of probation supervision are found; a mental health and addiction module that provides information, resources and support to probationers struggling with mental health problems or substance related problems.
Socrates 360 (Socrates Software, 2018)	Offenders in prison or during reintegration	Facilitate continuous independent learning opportunities.	Provides engaging and interactive educational modules, and access to health and well-being resources. Staff can upload documents such as medical records, which improves continuity of care.
Outreach Smartphone Monitoring (OSM) (Outreach Smartphone Monitoring, n.d.)	People on probation or parole	Decrease recidivism.	Contains various features to monitor and support people on probation: GPS to monitor inclusion/exclusion zones and curfews, and a Bluetooth breathalyser for self-measurement of alcohol levels. Furthermore, the app includes rehabilitative resources, court and event reminders, and incentives for compliance.

Scram (SCRAM TouchPoint, n.d.)	Probationers	Make community corrections programmes more efficient and to increase compliance by helping service users successfully complete their supervision.	Involves text-like messaging between probationer and officer, mobile check-ins, appointment reminders, and the ability to share documents.
MyNeon, (Mossler & Blank, 2014)	Probationers in the United States	Provide support, assistance and supervision upon release.	Community leaders enter community events or goals into the app (e.g., job training classes, specific courses, or volunteer opportunities. App users can earn points by engaging in these activities.
Utsikt ["View"] (Kriminalvården, n.d.)	Probationers in Sweden	Increase appointment attendance, and supplement and strengthen the probation treatment programme.	Utsikt contains appointment reminders, tools for managing thoughts, emotions, and actions in risk situations; a diary for writing down daily emotions and notes; and a goal section where users keep track of their goals.
VerlofHulp 2.0 [Leave Support 2.0], (Transfore, University of Twente, & Minddistrict, 2019)	Patients who have been institutionalised in clinical settings	To support professionals and inpatients during leave of absence.	At set times the patients get certain questions and propositions regarding the leave. Depending on the answers, the app will provide advice for supporting a good leave of absence.
Mijn Leven, Mijn Risico's, Mijn contacten [My life, My risks, My contacts]	Juvenile probationers in the Netherlands	Extend the reach of current probation methods.	The Dutch probation office developed three apps in which juveniles map their risk factors, their lifeline and their network of peers (Stichting Verslavingsreclassering GGZ, n.d.)

Discussion

The current review has identified VR and smartphone applications for forensic populations, with the specific aim of illustrating the possibilities that these technologies offer for research and intervention. The results indicate that few VR and app interventions have thus far been developed for this domain and that research on their feasibility, usability, and effectiveness is scarce. After an extensive review of the literature and a general web search, 18 VR and an equal number of smartphone applications were identified. We argue that both VR and smartphone apps nevertheless have much potential for this specific target group by offering novel ways for targeting treatment needs and supplementing standard therapies (Linardon et al., 2019). VR enables observation and training of behaviour in various criminogenic environments that are safe, cost-efficient, and easy to control (Van Gelder et al., 2014). Smartphone apps can provide cost-effective, easily accessible interventions that enable access to individualised treatment anytime, anywhere (Linardon et al., 2019; Zhang et al., 2015). In addition, both VR and smartphone apps entail the possibility of objectively collecting data, which can reduce implicit bias (Haarsma et al., 2020; Renaud et al., 2014) and therefore add to a more inclusive practice.

Among the identified VR and smartphone applications, their complementary use was hardly considered. This is a missed opportunity because the specific characteristics of VR and smartphone applications make them uniquely suitable for complementing each other. Whereas VR provides realistic and safe practice environments (Botella et al., 2015; Fox et al., 2009), it is only available at places where the required hardware is available. Smartphones, on the other hand, offer less of an immersive experience, but the portable nature of these devices facilitates the access to intervention material at any time and place. Furthermore, smartphones can track their users' real-world behaviour and can collect ecologically valid behavioural data (Bush et al., 2019; Miller, 2012). VR enables the objective observation of behaviour in simulated environments (Fox et al., 2009), although the extent to which this environment evokes real-world behaviour is yet to be determined. The combination of VR and smartphone apps in forensic psychology has the potential to increase learning effects in rehabilitation and reintegration, and the combined data of VR and smartphone apps can enrich assessments and research and ultimately tell us more about how we can better manage risk – with multiple benefits to society.

One example of complementary use of VR and apps is the FutureU intervention that is currently under development. This intervention aims to reduce self-defeating behaviour by enhancing future orientation and identification with the future self. In FutureU VR, participants are introduced to an avatar of their future selves with whom they interact. Taking the perspective of this future-self enhances future self-continuity (Ganschow et al., 2021) and has proven to reduce self-defeating behaviours among a student population (Van Gelder et al., 2013), and in a sample of convicted offenders (Van Gelder et al., 2021). FutureU also includes a smartphone application in which participants

can interact with their future-self on a daily basis. An RCT to study the effectiveness of the FutureU smartphone application is currently underway (Mertens et al., 2022). Another RCT that will involve both VR and the smartphone application is planned for 2022.

Points of Attention Related to VR and Apps

The lack of development of VR and smartphone applications and their limited implementation in practice could be because of limitations related to the technology. The wearable nature of smartphones has the disadvantage that these devices can be lost, stolen, sold, or exchanged, leading to data loss or invalid data. Limitations related to software are high development costs and the expertise required for their development. In addition, once an application has been developed the involvement of software developers – and thus costs – does not necessarily stop, for example, because updates are required (Larsen et al., 2016). Therefore, VR and smartphone app development currently only seems available for research groups, forensic institutions, or individuals that have a certain amount of budget. That said, not too complex applications should be well within reach of the average research budget. Furthermore, this review also identified that for smartphone apps, research is scarce regarding what psychological mechanisms, behavioural change techniques, and features contribute to the application's efficacy (Bakker et al., 2016; Chib & Lin, 2018; Linardon et al., 2019). There is also a paucity of research on which features are essential to keep users engaged, preventing low uptake, and increasing retention rates (Bakker et al., 2016; Hennemann et al., 2017; Torous et al., 2018).

The implementation of VR and smartphone applications is a work in progress. Studies confirm that acceptance of eHealth among health care professionals is still limited (Hennemann et al., 2017; Kip et al., 2019a). It is therefore important to consider how the use of technology in forensic health practices is influenced by organisational culture, professional ideologies, values and working conditions (Graham & McIvor, 2017), and how increasing the use of technology will affect work within forensic health practices and the relationship between therapists and service users. Even though implementation is often only included in the final stages of intervention development, it is critical that the implementation process is carefully considered from the outset to ensure that VR and smartphone app interventions will be integrated in existing care (Kip et al., 2019a; Kip et al., 2021; Schueller & Torous, 2020).

Technologies like VR and smartphone applications have the potential to make the forensic field more inclusive. For example, VR and apps facilitate highly individualised data collection in real time that includes physiological measures. Such measurements are more objective compared to observations and questionnaire data. In addition, they can aid in explaining data from observations or questionnaires. Physiological measurements therefore have the potential to reduce the impact of blind spots and implicit bias in human judgement, which will support a more inclusive practice. To achieve inclusive design, it is important for

researchers and software developers to design VR and smartphone applications with diversity in mind. For example, virtual avatars and VEs must reflect different cultural and social realities. To accomplish this, it is important that service users are involved during the development phase of the design. Furthermore, it is necessary that future research investigates how technology can facilitate the forensic context to become more inclusive, but also in what way technology can create additional barriers.

A final reason for the lack of development and usage of VR and smartphone applications for forensic populations is the various ethical concerns and privacy related questions that their usage raises (Schueller & Torous, 2020; Zhang et al., 2015). Firstly, forensic residential settings may resist access to smartphones and the internet, because of the adverse impact technology can have (e.g., access to the dark web, or opportunities for engaging in illegal activities). Secondly, ethical standards and professional guidance around the use of these technologies within health care practices is lagging behind their implementation. This creates both a gap and a grey area that impacts both the willingness and the ability of organisations and individual practitioners to implement. Furthermore, current laws regarding data privacy and security in mobile application research are lacking (Ross, 2018; Tovino, 2020). Both VR hardware and smartphones are provided by major technological companies who collect user data. Media coverage about some of these companies in recent years in relation to data sensitivity and security is likely to create barriers around engagement with technology in this field of work. For smartphone apps that collect background data, it is questionable how ethical it is to track people continuously, and possibly threaten the privacy of third-party bystanders (Miller, 2012; Tovino, 2020). For forensic populations in particular, the most important ethical concern is how the collected data will inform decision making. Hypothetically, fluctuations in mental state that previously would not have been noticed could now trigger rehospitalisation or reincarceration (Resnick & Appelbaum, 2019). Therefore, guidelines and protocols on how VR and apps will be applied to forensic psychology must be developed. Until then, it is important to be aware of data privacy and security and for what reasons data is being collected.

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