Psychological Perspectives and Challenges towards Information Technology and Digital Health Interventions

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Abstract: Psychology is a quite young discipline in the field of medicine. Established from Wilhelm Wundt in the second half of the 19th century it very soon got its first contacts to information technology. This keynote outlines the relationship of psychology and information technology from the very beginning in the fields of clinical and educational applications and human interaction aspects and illustrates the current development towards a field of digital mental health. In particular, the use of Virtual Reality as a an approach in the treatment mental disorders and diseases such as Anxiety disorders or Parkinson's disease, the therapeutic use of AVATARS in patients with auditory verbal hallucinations, the predictive power of digital drawing applications i.e. to detect Alzheimer's disease, or the attitude to robots in the health care system are spotlights illustrating the growing interaction of these domains which are addressed in this keynote. But also critical questions on the impact of digitalization on human identity i.e. in child development, working environment or in the increased use of wearables and smart applications in leisure time fostering a need of quantification of life are touched.

1 INTRODUCTION

The terms "Telemedicine", "E-health" and "M-health" have become an integral part of almost all health care systems with the advent of modern information technology. While telemedicine refers to the diagnosis and therapy by bridging a spatial or temporal distance between doctor, therapist, pharmacist and patient or between two doctors who consult each other by means of telecommunication, E-Health describes the integrated use of information and communication technology for the design, support and networking of all processes and participants in the health care system. The term M-Health defines the support of medical procedures and health care measures through mobile devices such as smartphones, tablets or other mobile technology such as body sensors (Ostermann, 2017).

A recent bibliometric analysis of worldwide scientific literature in m-health from 2006–2016 found a noticeable increase in publications in the period under review (Sweileh et al., 2017). Today these approaches are summarized under the umbrella "digital health interventions" (Allgaier et al., 2020).

2 HISTORY OF DIGITAL HEALTH INTERVENTIONS

2.1 A Forgotten Pioneer

From the historical perspective the first step into digitalisation in health care was done by Semen Nikolaevich Korsakov, an officer in the Department of Statistics in Russia. In 1832, he invented mechanical instruments he called "Machines for the Comparison of Philosophical Ideas" (Shilov & Silantiev, 2015) which very much resembles the concept of Karl Steinbuch's "Learning Matrix" from the early years of biological cybernetics almost 130 years later (Steinbuch, 1961). Based on the method of information storage in punch cards, he was the first to apply them in patient care almost a century before the first punch card systems were used. Although his idea was a more general one, he adopted it against the background of the cholera epidemic of that time: to find a suitable (homeopathic) drug for patients quickly and efficiently (Ostermann, 2015).

In principle his idea can be described as follows: Every drug is characterized by a number of symptoms. These are marked on a wooden board by

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perforations or holes at an appropriate point, so that each drug receives its binary code on a wooden board. If a patient now describes his symptoms, a comb is created with needles at the corresponding points of the symptoms. If this comb is stroked over the wooden plate, the comb clicks into place exactly where a medicine is provided with the corresponding "symptom holes": the machine "stops" and the medicine can be identified (Fig.1). This process is repeated until all drugs have been "combed through". The principle is graphically illustrated again in Fig. 1.

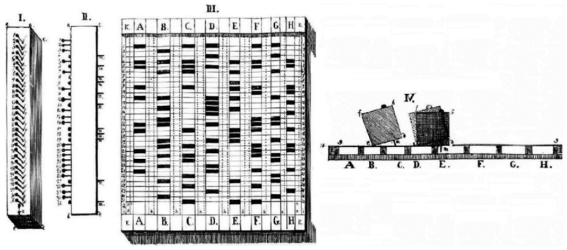

Figure 1: Semen Korsakoff's “Homeoscope” (adapted from Velminski & Ernst (2008)). The comb has needles at points 4, 5, ... representing the patient's symptoms and correspond to the drug “E”, which has perforations at the corresponding points.

However, his idea was forgotten and it took almost 90 years before punch-card systems patented by Hollerith in 1889 (Wahl, 2018) were introduced in health science and in particular in psychology.

2.2 Early Psychological Use of Digital Health Interventions: Punch-cards

Psychological research very early took advantage of the punch-card system they quite early were used to analyse census or opinion poll data as documented in (Bingham, 1922) or (Gage & Remmers, 1948). While these approaches mainly focussed on data procession and counting, psychological research also used this technique for automated calculation of statistical measures such as correlations. between the age of imprisoned persons in relationship to test scores of the Rorschach test in which the perceptions of inkblots (i.e. “it looks like a bat”) were analysed using psychological interpretation (Pescor, 1938).

But also more complex statistical procedures at the time like computing biserial correlation coefficients (DuBois, 1942) or sorting and scoring of questionnaire inventories i.e. the Minnesota Multiphasic Personality Inventory (Manson & Grayson, 1946) were performed using punched coding cards. An illustration from the original publication of Manson & Grayson (1946) in displayed in Fig. 2.

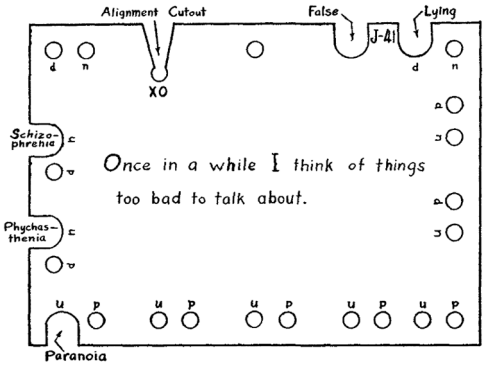

Figure 2: “XO card (front view)” for the item “Once in a while I think of things too bad to talk about” of the Minnesota Multiphasic Personality Inventory from (Manson & Grayson, 1946).

2.3 Mainframe Computers in Psychology

With the emergence of mainframe computers in science starting from the 1950th, psychological research also made use of this new technology.

Figure 3: IBM 701 operator's console. Retrieved from https://commons.wikimedia.org/w/index.php?curid=13301780. Dan-Flickr: IBM 701.

According to a survey of computer usage in 109 Departments of Psychology and 26 Departments of Sociology in the United States in 1960, 83 Psychology departments (76.1%) and 25 Sociology Departments (96.2%) reported to have a computer installation at their departments. They estimated a mean of 75.4 hours of machine time within the last 12 month for the psychology departments and 156.0 hours for the sociology departments. In most of the cases an IBM 650 (n=81; 75.0%) or an IBM 701 (n=25; 23.1%) was used (Fig. 3).

According to a summary on computer use at that time (Newell & Simon, 1963), most of the procedures, the mainframes were used for were large-scale statistical and numerical analyses, such as cluster or factor analyses i.e. determining the factor analytic structure of the House-Tree-Person-Test (Digiammo 1962) where an IBM 650 was used to perform a complete centroid method for the extraction of factors.

2.4 Microcomputers in Psychology: Clinical and Experimental Applications

With the first emergence of microcomputers in the 1970th the costs for using computational applications decreased together with an easier handling in their operation. Thus popularity during the late 1970s and early 1980s exploded and as a consequence digital applications also went into the field of clinical psychology by means of decision support systems, databases for documentation of patient records (Hayward, 1981; Reynolds et al., 1985). Even the idea of performing "online" patient interviews in a man-machine interaction in a way that an emulated "friendly doctor [is] asking questions requiring simple YES or NO answers" was realized at that time (Bevan et al., 1981) using a conventional BASIC program.

But also in the field of experimental psychology, computers were used i.e. for computer-controlled arithmetic problem solving tasks (Fig. 4) (Aaronson et al., 1976) or the visual display and eye-movement recording systems (Loftus et al., 1975).

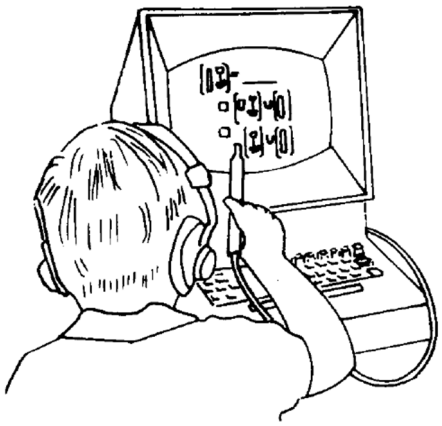

Figure 4: A pupil solving arithmetic problems in a computer-aided instruction project displayed in (Aaronson et al., 1976).

2.5 Internet and Psychology: From USENET to Online Therapy

At the same time when microcomputers found their way into psychology, first ideas of connecting networks shifted more and more into the centre of interest (Schwartz, 1985). A first guide of psychological resources was summarized in (Quinn, 1995) ranging from Online-Journals such as *"Psycoloquy"*, a peer reviewed open access journal published online from 1990 to 2002 by the American Psychological Association (APA) to electronic news- and discussion-groups like "*sci. cognitive*", a newsgroup for cognitive psychology, or "*psyart*", a discussion group for the psychological study of the arts.

But also therapeutic electronic networks and data sharing in the field of mental health using "Bulletin Board Systems" were topics discussed (Miller, 1991) very early.

Similarly concepts like virtual reality, in which the computer serves "as a as mediator or imagination enhancer" were introduced (Reid, 1994) alongside of first case reports in the field of clinical psychology, i.e. in the field of exposure treatment of acrophobia (Rothbaum et al, 1995) using "a head-mounted display (VR Flight Helmet) and an electromagnetic sensor […] to track the head and right hand (Ascension Technology Flock System)" or in the construction of a virtual sand box for the diagnosis and treatment of autistic patients (Kijima et al., 1994).

3 ACTUAL TRENDS

Twenty-five years later, most of the ideas and concepts presented in the last chapters have been enhanced and tested by means of clinical studies and meta analyses.

Immersive virtual reality has become an accepted treatment i.e. in the treatment of schizophrenia spectrum diseases, where it has shown "safe, tolerable, and long-term persistent" effects in the treatment of "delusions, hallucinations or cognitive and social skills" (Bisso et al., 2020). But also in other fields like Parkinson's disease (Dockx et al., 2016) or traumatic brain injury rehabilitation (Aida et al., 2018) reviews have shown its effectiveness.

The same holds for online-therapy. Current clinical research i.e. found electronically delivered cognitive behavioural therapy "at least as effective" as face to face cognitive behavioural therapy in the field of depressive disorders (Luo et al., 2020). Also other psychotherapies like mindfulness based

interventions have been adopted into online formats and shown its usefulness in particular in cases of immobile or hard to reach patients (Jayawardene et al., 2017).

However apart from optimising already known concepts, recent trends in psychotherapy include new forms of digital health interventions i.e. AVATAR therapy for auditory verbal hallucinations in people with psychosis (Craig et al., 2018) or the digital analysis of bodily sensation maps (Volynets et al., 2020). In the clinical context of the latter, Lyons et al. (2020) were able to show, that depressive subject showed distinctly reduced bodily sensation maps for different emotions than healthy controls.

Another aspect is given by mobile devices like smartphones, tablets and wearables, which are currently used in clinical psychological diagnoses. According to a position paper of Torous et al. (2017), "new digital technologies […] can now explore new dimensions of pathology largely inaccessible only a few years before".

One example is given by the digital tree drawing test (dTDT). In this test, patients draw a tree with a digital pen on a Microsoft Surface Pro 3 digitizer (Fig. 5).

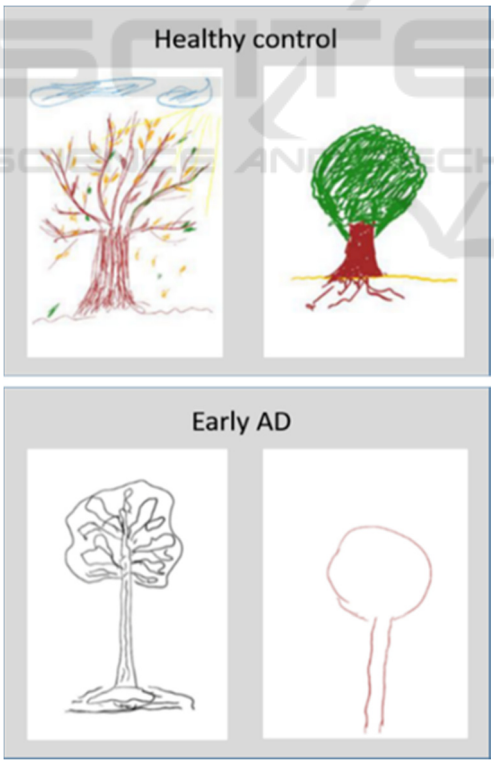

Figure 5: Examples of digital tree drawings of two healthy controls and two early AD participants from (Ostermann et al., 2020).

Statistical models identified the average painting velocity in combination with the variation in the use of colours and line widths as significant predictors for early Alzheimer's disease (Robens et al., 2019).

However, new technologies are not useful for diagnosis but also for monitoring tasks. A recent systematic review on the application of wearable devices for Parkinson's disease found that wearbales were efficient in the analysis of body motion, motor fluctuations and home-based long-term monitoring (Rovini et al., 2017).

Finally, due to demographic changes and aging society, the use of human like robots to support older adults in everyday activities is another emerging field of research. Although recent surveys have demonstrated, that people across age groups though of robots as being "useful" and disagreed that robots were dangerous (Backonja et al., 2018), research on attitudes towards robots is still at the very beginning.

4 CONCLUSIONS

Information technology nowadays has reached almost every part of patient care. Although this overview is far away from being exhaustive in terms of having found all information technology applications in psychological research and patient care, it nevertheless was able to show, that psychology has always been on the cutting edge of information technology making use of the most innovative technology available.

However, critical questions on the impact of digitalization on human identity i.e. in child development, working environment or the increased use of wearables and smart applications in leisure time fostering a need of quantification in life should also be recognized in this rapidly growing area of research (Meschner, 2020; Nagy & Koles, 2014).

Thus, a mindful integration and cautious adoption of further developments in the field of information technology in psychological research should be encouraged.

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