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Article

Three Principles, 2 Sub-principles and One Magic Wand for Harm Minimization and Prevention of Technological Addiction in Human Children

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Abstract: Departing from the definition of techno-addiction in terms of technology-assisted behavior with probable detrimental consequences, we propose following guidelines could direct design of harm-reducing technologies: gradual use-constraining, circadianity, offline preferentiality, environmental referentiality and mono-tasking. These guidelines can serve as criteria according to which digital technologies can be evaluated. Also, these principles can direct design of post-smartphone digital technologies which will, hopefully, reduce the cognitive and physiological harm caused by unreflected deployment of current technologies. As a concrete example of such harm-reducing technologies, we provide first insights into structure and function of a "magic wand", a make-your-own-device digital artifact satisfying the above-mentioned guidelines.

Keywords: Digital education artifacts, Mono-tasking, Environmental referentiality, Gradual use-constraining, Harm reduction, Technological addiction

1. Introduction

Digital technologies permeate our every day life in an uncontrollable and accelerating manner. As of 2020, techno-addiction is already a global fact which concerns all generations, with youngest generation predicted to pay the highest cognitive price. It is impossible to stop this development but principles can be established and applied which are to minimize the strength of technological addiction in human children.

It was already in 2016—i.e., less than 10 years after introduction of the first iPhone on the market—that investigators working for a U.S. non-governmental organization Common Sense ringed the bell with their observation that 50 percent of teenagers feel like they are addicted to their mobile devices and 59 percent of their parents feel like their child is addicted to their mobile device (Common Sense Media, 2018).

Four years later, at the outset of first year with SARS-COV-2, techno-addiction becomes a mainstream topic. As indicated by Figure 1., around year 2016, number of occurrences of expression "internet addiction" in the public discourse got to comparable levels with "nicotine addiction" and "cocaine addiction". Only three years later the expression "internet addiction" has been attested, in English-language texts published in 2019 more than twice as often as is the case for nicotine or cocaine addiction. Also, a strong upwards trend for expression "smartphone addiction" makes it highly probable that no later than 2021, dependency of humans on their smartphones is to be thematized at least as often as is the case for two selected substance-based dependencies.

Indeed, a surprisingly swift lifestyle revolution is underway with consequences which are difficult to predict. With estimated 5.2 milliard of mobile phone users, 4.66 milliard of internet users and 4.14 milliard of social media users—i.e., 67%, 60% resp 53% of global population—(Kemp, 2020) it is no surprise that terms like "internet addiction disorder", "online gambling addiction", "digital communication addiction disorder", "no-mobile-phobia" become an evermore important topic of a public health debate.

With "gaming disorder", defined as "a pattern of gaming behavior ("digital-gaming" or "video-gaming") characterized by impaired control over gaming, increasing priority given to gaming over other activities to the extent that gaming takes precedence over other interests and daily activities" (World Health Organisation, 2019) being already included in 11th Revision of International Classification of Diseases (ICD-11), it seems to be only matter of time when syndromes, behaviors and diseases related to or induced by more generic forms of technology overuse will enter ICD's future revisions.

It is important to realize that the amount of people who use digital technologies is not the only variable whose value increases. The amount of devices owned by a single person increases as well—in 2016 reported circa 5 connected devices per U.S. household (Pew Research Center, 2017), a 2020 study "shows that the average household has 11 connected devices, including 7 smart screens on which to view content" (Deloitte, 2020). Hand in hand with these increases also the screen-time variable, i.e., the amount of time people spend with "on" their digital devices.

All these phenomena taken together mark a paradigm shift in human activity which does not have parallel at least since neolithic revolution when people decided to start investing their time into sedentary lifestyle. More concretely: contrary to zero screen-time hundred years ago, the amount of screen time which an average US teenager spends using a device with a screen consumes more than 7 hours within a 24-hour circadian cycle (Rideout & Robb, 2019).

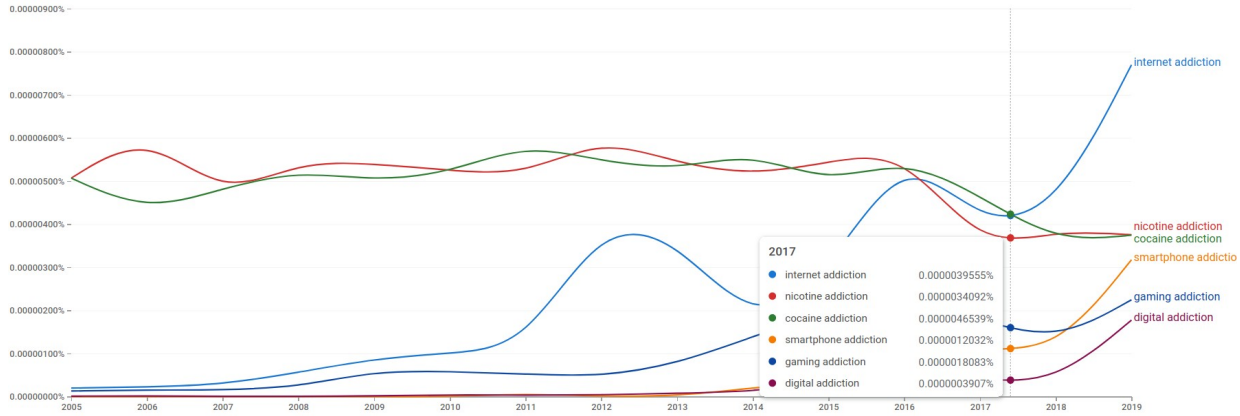

Figure 1. Diachronic development of relative frequencies of occurrence of expressions like "internet addiction" in English-language corpora contained in Google n-grams dataset.

Given such evidence, one would be obliged to conclude that in fact the only variable which is decreasing instead of increasing is the average age when children are start using given their first own smartphone. In 2015 census of U.S. NGO Common Sense, 19% of 10-year olds reported ownership of a smartphone; in 2019, 19% of 8-year old children owned1 one (Rideout & Robb, 2019) .

A 2013 survey of digital habits of preschool children one observed that 10% of 2-year olds used mobile devices in 2011 and 38% in 2013 (Common Sense Media, 2013). A more recent study from the Turkey reports the median age of the first time use of mobile device to be located at 12 months of age (Kılıç *et al.*, 2019).

Thus, it seems that during less than half of a generation, devices which were supposed to make humans "smart" already managed to break into the sacred realm of that highly neuro-plastic stage of human development which Piaget used to label with an attribute "sensori-motric". That is, the fundamental base for development of all later cognitive functions and faculties whose violent and unreflected tampering could result in neural, psychic and potentially somatic damage of an extent which research community is only starting to assess.

Bibliography of books like that of Newport (2019), Spitzer (2018) or (Alter, 2017) and articles like that of Bozzola *et al.* (2018) or Hromada (2019) provide introductory references for more profound exploration.

Knowing that the situation is critical and for children born between 2005 and 2020 potentially irreversible; assuming that market forces involved are so massive (Zuboff, 2015) and forces of intentionally engineered, media-induced, dopamine-releasing intermittent rewarding mechanisms so subtle and pervasive that it is impossible for any single individual or community to stop them nor significantly influence their course, we adopt a realistic pragmatic attitude, propose to fight fire with fire and ask a question:

"*How can we construct technologies which minimize harm caused by addiction-inducing technologies ?*"

Sections 3, 4 and 5 aim to provide some concrete, constructive and even tangible answers to this question. More concretely, section 3 enumerates a list of guidelines which, when followed, could lead to emergence of technologies whose very design and operational principles reduce harm caused by other more addictive technologies. Section 4 addresses the importance of assessment of addictive, resp. addiction-reducing potential of current and future technologies and section 5 provides an exemplar evaluation of an existing prototype of a digital, outdoor online learning "Magic Wand 0" artifact whose design is compliant with principles and sub-principles enumerated in Section 3.

2. Definitions

This section provides some basic definitions which facilitate the entry to the core part of this article present in the Section 3.

2.1. Human Being

Definition: Holistic union of a spatiotemporally constrained primate body and meta-sapient social cognition.

2.2. Human Child

Definition: A playful human being in initial stage of its development endowed with environment-assimilating brain with increased neural plasticity.

2.3. Technology

Definition: Product of organized human activity.

Commentary: For the rest of this article, we use the term technology to denote what is in fact a very specific subset of "products of organized human activity" characterized by presence of following features:

- exhibits activity
- consumes energy
- processes information and performs computation
- is designed to interact with humans by means of interfaces adapted to one or multiple human senses (audio, video, tactile, olphactoric or gustative)

Thus, the notion of "technology" as used in the rest of this article is very close to notion of "digital media" defined as "*Digital media collect, process and transmit quantized information in order to actualize certain contents within the mind of the human observer*" in (Hromada, 2020b).

2.4. Techno-addiction (TA)

Definition: Technological addiction is a condition in which an organism engages in technology-assisted behavior in which the rewarding effects provide a compelling incentive to repeatedly and/or compulsively pursue the behavior despite of possibility of detrimental consequences.

Commentary: This definition is in great part inspired by a mainstream definition of addiction (Psychology Today, 2020.). However, to underline the organic base of addiction we speak of "organism" instead of "person" and instead of vague notion of "use", the expression "technology-assisted behavior" is used which allows to account for addictions whereby technology is involved but the classical hierarchical model "human H uses technology T" is absent. Key notions of "rewarding effects providing a compelling incentive", "repeatedly pursue of the behavior" and "detrimental consequences" are left intact.

2.5. Techno-Addiction Harm-Minimization (TAHM)

Definition: Set of pedagogical, cognitive, medical, techno-engineering or legal measures, actions and policies aiming for gradual reduction of impact of technology-assisted behaviors with demonstrably detrimental consequences.

Commentary: Expression "detrimental consequences" used both in definition of TA as well as in that of TAHM are synonymous, for all practical purposes, to a more common term "harm". Note, however, contrary to a quasi "clinical" definition of TAHM which puts greater focus on an individual subject and behavioral aspects of technological addiction is the definition of TAHM more collective and systemic.

3. Pragmatic Problem of TAHM

3.1. Statement of the Pragmatic Problem

Having defined the notion of harm minimization of technological addiction, let's now start focusing on techno-engineering subset of harm-reducing measures, actions and policies. Our focus on this particular subset is motivated by a question:

How can we engineer technologies which will minimize harm caused by addiction on technologies ?

The approach to use technologies for the purpose of TAHM is pragmatic in a sense that it realistically assumes that in order to successfully address TAHM, not only a method and a technique will be necessary, but also a technology or a device of some particular kind. For this reason, we shall label the problem posed by the above question with expression “Pragmatic problem of TAHM”.

3.2. Pathways to Solution of the Pragmatic Problem

We conjecture that the pragmatic problem of harm-minimization of technological addiction can be solved by compliance with set of principles which includes, but is not restricted to:

3.2.1. Principle P1: Gradual Use-constraining

At the core of a pragmatic problem lies a paradox. One one hand, we strive to develop and deploy digital technology T, on the other hand, the technology T should be such that its use allows the human user H – or, in particular a child C - to liberate onself from dependency on any kind of digital medium or technology, including T itself.

The principle of gradual use-constraining offers the way how the paradox can be solved and can be described as follows:

P1-compliance: *Technology T is P1 compliant if and only if T tends to gradually decrease availability of all or some of its functions.*

A smartphone which shuts itself down first for an hour, then for a day and later even for a week; a social network which locks its users out for a weekend, Christmas or even a whole year; a WiFi-router explicitly configured to reject all packets coming from Netflix on Friday, Netflix and YouTube on Saturday and from all addresses on Sunday – such are some trivial examples which comes to one’s mind when thinking about implementation of P1 in practice.

As of 2020, some software-based use-constraining solutions already exist, e.g. apps like AntiSocial or Freedom (Newport, 2019). However, all these are additional and optional features which can be activated or deactivated with a click, as such they are of fairly little use in more serious cases of techno-addiction. Deeper, potentially hardware-based mechanisms combined with subtle inhibiting mechanisms based on deeper knowledge of human cognition and addiction 1 are to be deployed to prohibit an addicted Ulysses to unbind himself from the harm-reducing mast.

3.2.2. Sub-Principle P1.1: Circadianity

Sub-principle 1.1 is a most salient case of time-based constrainment of use.

P1.1-compliance: *Technology T is P1.1 compliant if and only if it obliges T to function or non-function in synchrony with 24-hour-cycle rhythms of a modal healthy child.*

One of the most harmful aspects of current media devices is their ability to disrupt bodily circadian rhythms, including very important phases of sleep and transition into it. There is very little hope that the problem of techno-addiction will be solved in cases where the very last thing the child does before she, finally, falls asleep is a swiping on here light-emitting touchscreen. In this sense, following recommendations of diverse pediatric societies (Bozzola *et al.*, 2018) not to expose children to screens at least one hour before going to bed, has very strong harm-minimizing potential.

A simple but fairly effective means of enforcing circadianity is turning on and off home’s grid-connected digital infrastructure (e.g. LAN router) by a mechanical time switch. Also, some variants of Android operating system allow user to set up automatic turn on and turn off cycles. However, such “lock-out” measures are still weak in a sense that they allow the user to easily bypass or deactivate them.

A more sophisticated means of harnessing the maximum of harm-reducing potential is to endow devices or services with hard” circadian rhythms (Hromada, 2019a; Hromada, 2019b). Such circadian devices would prohibit use outside of specific times and enforce execution of some task-specific activities to some well-defined time intervals (e.g. doing home-works between 14:00 – 15:00). Consistently with the use-constraining principle of which the circadian principle is an extension, one could gradually reduce the length of such “digital time slots” or shift them from more detrimental (e.g. night) to less detrimental period of a 24-hour cycle (e.g. late afternoon).

3.2.3. Sub-Principle P1.2: Offline Preferentiality

Sub-principle P1.2 is a most salient case of function-based constrainment of use and enforces frequent deactivation of network connectivity.

P1.2-compliance: *Technology T is said to be fully P1.2 compliant if and only if it connects to infosphere only when the current task cannot be solved by local means.*

As of 2020, the "always online" mindset, fueled by diverse marketing campaigns (e.g. cloud, 5G) leads one to conclusion that no sophisticated technology can run on a local device and that instant and non-interrupted connection to the info-sphere (i.e. Internet) is a *conditio sine qua non* of any useful digital experience.

Such conclusion is false. With current technologies (e.g. edge computing, micro-controllers, TensorFlow Lite) one can run sophisticated AI assistant systems in one's pocket without communicating a single bit of information to a so-called "cloud". Indeed, in a situation where the biggest compendium of human knowledge ever compiled by humanity2 can be stored on a 20-eur 128 GB SD card and still leave enough space to store a complete map of Europe - with all its cities, playgrounds and streets 3 - aside it, an uninterrupted info-sphere connectivity – with its botnets, malware and endless streams of attention-demanding notifications – may be considered more an obstacle than assistance.

3.2.4. Principle P2: Environmental Referentiality

An important factor in establishment and continuation of a technological or media addiction is the attractiveness of content provided by such media. Sequences of moving bright colored images appeal to senses of adults and children alike and the fact that in a simulated world one can do the impossible – e.g. jump from one roof to another – or prohibited – e.g. cut somebody's head of - without getting injured or punished appeals to a curious brain.

However, in spite of ingenuosity of all game studios and social network marketing departments, the world out there, the world behind and below and above and around the screen is much more rich and fascinating than the screen world will ever be. And children are eager and curious to discover that richness full of tangible forms, materials, forces and counter-forces, smells and tastes. Hence the environmental referentiality:

P2-compliance: *Technology T is said to be P2-compliant if it tends to focus child's attention to diverse aspects of her physical / natural environment.*

Thus, tasks and apps helping a child to recognize a plant and potentially – in case of plants recognized as non-poisonous – inviting the child to smell it; programs helping a child to locate a star constellation and explaining her how to focus a telescope in its direction; or a musical artificial mentoring intelligence (AMI) inviting the pupil to create a rhythmic tune by recommending to apply a wooden stick on a metallic fence: all such implementations are consistent with P2.

By steady and consistent focusing child's attention to surrounding natural context, such environmentally referential technology not only increases amount of child's learning about the world – which is the goal of education – but also weakens child's techno-addiction by means of shifting attention away from technology. In this sense, environmentally referential technologies provide two advantages of non-negligible importance.

3.2.5. Principle P3: Mono-tasking

In year 1995, Microsoft released the Windows 95 operating system which introduced the idea of preemptive multitasking to Personal Computer (PC) user community. From the perspective of a human user, preemptive multitasking led to an experience of multiple programs running in parallel. A generation later, multi-tasking is the main paradigm behind all dominant operating systems and their user interfaces.

Human cognition, however, has difficulties with performing multiple tasks in parallel – switching between tasks brings about errors and comes at a cost (Rogers & Monsell, 1995). Thus, it is little surprising that constant interaction with multi-tasking interfaces disrupts one's attentional processes and may lead to a condition of Attentional Deficit Trait (Hallowell, 2005).

Additionally, each among multiple tasks (e.g. apps) is apt to provide its own intermittent reinforcement mechanisms. Therefore, multitasking devices have by design a higher addictive potential compared to a device which runs a single task. For this reasons, we propose the mono-tasking principle:

P3-compliance: *Technology T is said to be P3-compliant when it provides and exposes - in any single moment - the human user to one single task and does not allow the user to switch to another task until the task is finished.*

Note that the attribute of mono-tasking relates solely to the user experience and to the front-end interface with which the human interacts. Thus, the mono-tasking principle does not exclude that there will be many parallel processes running on device's back-end. An AMI running in the back- end, for example, can be composed of a process for speech recognition and another process for recognition of facial expressions. However, from the perspective of a child interacting with such AMI, in every moment there will always be one and only one task to be dealt with (e.g. conversation about the relevant study topic or homework problem solving) and only after the task is ended, child could be allowed to proceed to another task. For example consult a list of telephone calls which were automatically dismissed as the child was focused on a previous activity.

3.3. Additional Pathways to TAHM

It is obvious that the list of principles and sub-principles in the previous section is far from being exhaustive. One can imagine many technological means for techno-addiction harm-minimization: habit inhibition, inconvenient and auto-poietic interfaces, slowing-down media, technological demystification, conversation-instead-of-communication, corporal/spatial referentiality, tech-supported cognitive enrichment, empowerment, mindfulness.

Before presenting these, however, we propose to stop here and start joining forces with research and therapist communities. The extent of the undergoing TA-epidemy (Spitzer, 2018) may seem overwhelming but there is little doubt that well applied science may provde paths to an effective antidote.

4. Evaluation of Harm-reductive Potential of Present and Future Technologies

Above-mentioned principles are first and foremost techno-engineering design principles. That is, principles which – so we hope - should guide those computer scientists, electrical, hardware and software engineers, programmers, IT-specialists, UI/UX/HCI designers aware of importance of techno-addiction prevention and harm minimization.

However, above-mentioned principles can serve not only as criteria according to which future harm-reducing technologies of the future could be designed. These very principles can also be interpreted as set of criteria according to which present technologies – be it hardware, software or combination of the two – could be evaluated and/or certified. More concretely, fulfillment or non-fulfillment of each principles or sub-principle can be assessed in a qualitative or – preferably – quantitative manner and each technology thus assessed could be characterized by a vector of values describing the level of compliance of technology and the relevant principle.

Based on such vectors, a harm-minimizing index (HMI) is to be calculated with value 0 denoting complete absence of addiction-minimization features in the device and value 1 denoting an idealized – and potentially impossible - technology whose implementation would lead to dissolution of techno-addiction in all human subjects, independently from extent and intensity of their addiction.

As an example, let's imagine two hypothetical devices. On one hand, an active screen running 24-hours a day in child's bedroom: a device without a power switch, providing activated, non-removable, notification-enabled accounts for all major existing social networks. On the other hand, a circadian digital education artifact – an AMI-endowed primer (Hromada *et al.*, 2020a; Hromada, 2019) of a sort – gradually teaching the child how to understand and master her environment, her own nature as well as nature of surrounding technologies.

It is clear that the harm-minimizing index of the first device would be fairly close to zero while the HMI of the second hypothetical device could be expected to be significantly above 0.5.

5. A 0th Magic Wand for the Solar Era

Figure 2 provides a first public display of a "magic wand 0", (MW0) a digital artifact built at Berlin University of the Arts, Einstein Center Digital Future and Berlin Open Lab consistently with the precepts of make-Your-own-device (Hromada *et al.*, 2020) philosophy and Solarpunk (Reina-Rozo, 2021) artistic movement . Even more importantly, design choices which have emerged and still emerge during design of the artifact are principally addressed by means of three principles and two sub-principles of the three principles of technological harm-reduction enumerated above.

Hardware-wise, MW0 is built on top of well established off-the-shelf technologies like Raspberry Pi and Arduino. MW0 is endowed with LTE7600 modem for 4G/GSM communication, 4 microphones, Google Coral Edge Tensor Processing Unit (TPU) for machine-learned inferences, high-resolution camera with physically adjustable objective. Additional sensorics includes GPS/Galileou/GLONAS, sound, light, temperature, humidity, moisture, air pressure, acceleration, 8 gesture-class recognition sensor, and multiple external capacitive touch sensors attachable to arbitrary surfaces. Output modality is currently restricted to minimalist OLED screen and sound (resp. speech) output by means of optionally attachable shakers/transducers and/or Bluetooth.

All is attached with common replaceable consumables (e.g., screws, rubber bands) on a piece of unprocessed, raw, easy-to-carry wood of unknown age and origin. MW0 is powered by solar energy, with a 26Wh power-bank serving the role of an intermediate energy-storing buffer.

Software-wise, the main computational component of the MW0 runs the newest version of Raspbian operating system, configured in a way that it provides—should the need arise—following functionality:

- local WLAN access point
- connectivity to the info-sphere with a fixed IPv4 address so that MW0 can - whenever connected to a 2G/3G/4G cellular network - fulfill the role of a full-fledged publicly accessible internet server
- running Matrix 4homeserver service matrix-synapse for asynchronous federated chat rooms
- running instances of a teacher.js (Brodbeck & Hromada, 2021) system for outdoor online teaching and Knowledge Management System Kastalia

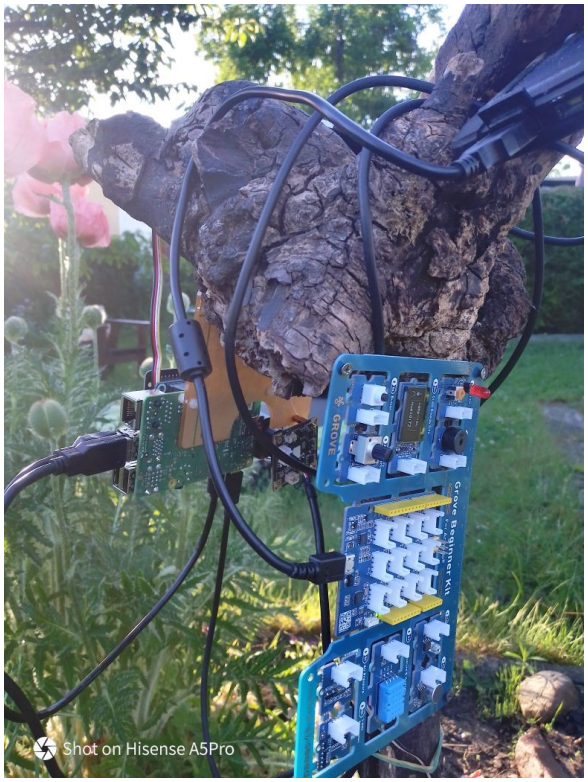

Fig. 2. MW0 in process of providing necessary network & content services for an environmentally referential outdoor on-line course.

- various services like web-server (nginx), transactional database (PostgreSQL) and audiobridge / WebRTC server (Amirante *et al.*, 2014), etc.
- LAN & low-latency access to various datasets (Wikipedia, Open StreetMaps) stored on the SD Card

MW0 is P1 compliant because it implements gradual use constraining. In context of the sub-principle P1.1, the artifact is circadian because its energy circuitry prohibits it, by definition, to operate in night time. In context of the sub-principle P1.2, the artifact allows strong offline functionalities. For example, combination of local WLAN, stored content (maps, encyclopedia) and services (teacher.js, database, web-server, machine-learning inference) makes it possible to provide surrounding students and pupils with plethora of highly-sophisticated information-processing technologies without necessity to connect to wider Internet.

Also, MW0 is P2 compliant because its extensive sensorics allows the MW0's carrier to focus his attention to aspects of her/his natural environment like temperature, humidity, moisture, air pressure etc. Note that implementation of more sophisticated sensorics like microscopy or Geiger counter for radiation detection is also possible and could potentially be as easy as plugging a cable into appropriate Arduino or GPIO port.

Additionally, high-quality optics resp. multi-microphone array combined with ML-inferencing faculties of an attached Tensor Processing Unit allow for cloud-less, edge plant (resp. bird-song) recognition, provided that such classifiers would be made available by eco&bio- research communities.

At last but not least, MW0 aspires to fulfill the mono-tasking ideal by providing very little simultaneous output in the same-time. Thus, in spite of the fact that dozens of highly sophisticated, embedded-AI processes and services may run simultaneously on its four 1.5 GHz cores and/or the attached TPU(s), and in spite of the fact that MW0 may, indeed, synthetize speech in many languages and as a bot communicate its internal states within many different Matrix rooms, there is very little multi-media distraction which the MW0 may provide to its carrier or surrounding public. After all, a device cannot expose one's cognition with sequences of flashy images when the only visual output modality at its disposal is a 128 × 64 OLED Dotmatrix.

Given that MW0 satisfies TAHM principles P1, P2, P3 as well as sub-principles P1.1 and P1.2, we estimate its harm-minimization spectrum to lie above 0.5. More field-work, of course, is necessary to estimate MW0's HMI value in more precise and robust detail.

6. Discussion

This article started with an observation (c.f. Fig. 1) suggesting that within last few years, the notion of internet addiction was mentioned in English-language publications more often in English-language publications than serious substance-based addictions like cocaine or nicotine.

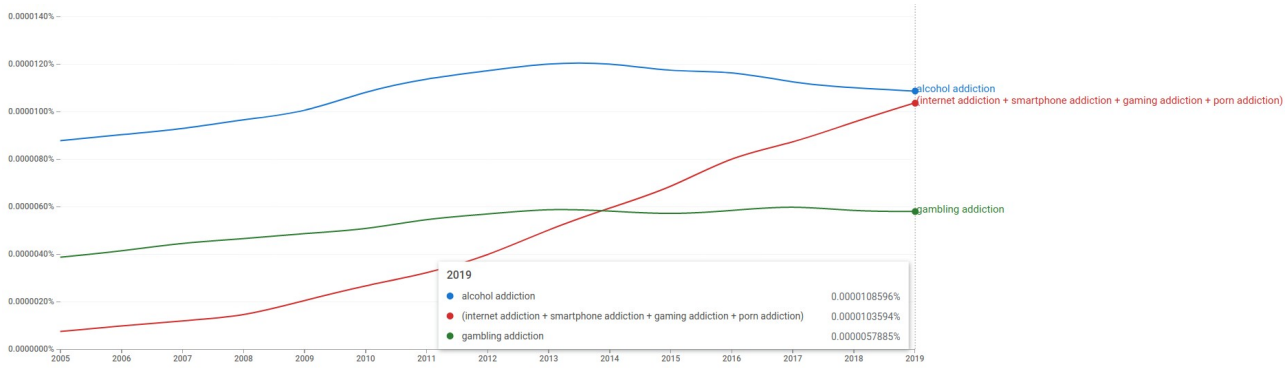

Fig. 3. Diachronic development of relative frequencies of occurence of expressions like “gambling addiction” and “alcohol addiction” compared with aggregated values for four forms of techno-addiction.

However, when one looks at Fig. 3. which aggregates four kind of activities which due to their presence of technology-assisted behaviors can all be understood as particular cases of techno-addiction (c.f. definition II d.) one sees even more disturbing picture.

Thus, it is already in 2014 that mentions of TA-quartet “internet / smartphone / gaming / porn addiction” surpassed “gambling addiction” and it seems to be quite probable that in data from the Covid-19 year 2020, one shall see TA-quartet dethroning also the tragic queen of all substance addictions: alcohol.

In spite of these observations, and in spite of ever-increasing amount of amassed clinical evidence, no parliament, government or regulatory body seems to be interested in putting prohibitory measures into practice. When it comes to preventive practices, they are more or less reduced to putting age recommendation labels on computer game packages or clauses into contractual agreement between user and the social network. In practice, such labels and clauses are often ignored and incomparably weaker in their effect than, for example, alcohol drinking age limitations.

Nonetheless, given the gravity of the situation, it is quite surprising that as of 2020, there was very little work done, if any, in the domain of TAHM. The objective behind this introductory text is to start filling the gap by proposing first definitions and asking first questions like, for example:

Nonetheless, given the gravity of the situation, it is quite surprising that as of 2020, there was very little work done, if any, in the domain of TAHM. The objective behind this introductory text is to start filling the gap by proposing first definitions and asking first questions like, for example:

- *Does deployment of technology T0 within the community C result in increased or decreased rates of techno-addiction in C?*
- *What is T0‘s harm-minimization index?*
- *Shall community C adopt new technology T1?*
- *Shall T1 substitute T0?*
- *Shall mass-scale sale or marketing of T0 be dismissed or even forbidden by Law or an international Treaty?*

It is our belief that posing and answering such questions in a calm, methodical and scientific way, followed by a subsequent design, creation of deployment of new kinds of digital artifacts like our and media like our MW0 may – as of 2021 – still reduce probability that the harm caused by unreflected, short-sighted planetary deployment of cognition-modifying technologies to present and future young generations will become chronic, ubiquitous and irreversible.

7. Conclusion

Note that the questions asked in section defining the "Pragmatic problem of H.M.T.A." starts with an interrogative adverb "how". Thus, even a more fundamental yes/no question :

"*Can we design technologies which minimize harm caused by overuse of technologies ?"*

has not been even asked.

For all along this article, it had been tacitly presumed that the answer is an affirmative "yes".

While - as of 2021 - we have no historic, empiric nor intuitional guarantees that giving such a "yes" answer is consistent with present and future state of things, our reasoning is based on a consideration that such a yes-based approach to be more optimist and constructive than a pessimistic, neo-Luddite, "no".

More constructive than the neo-Luddite "no" because answering "yes" makes us articulate the above-posed "how to" questions. And posing such questions makes us - philosophers, developmental psychologists, neuro-scientists, psychiatrists, computer scientists, engineers of 21st century, decision makers, investors as well as our students and children - turn up our sleeves and start cleaning up the decay caused by short-sighted greed of previous generations.

And more optimist, because the "yes" answer gives us – teachers, parents, humans, artists - at least some chance to harness forces which the *homo fabers* in us, in their ignorance, unleashed.

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