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IS 2020

Zbornik 23. mednarodne multikonference

INFORMACIJSKA DRUŽBA

Zvezek B

Proceedings of the 23rd International Multiconference

INFORMATION SOCIETY

Volume B

Kognitivna znanost

Cognitive Science

Uredili / Edited by

Toma Strle, Jaša Černe, Olga Markič

8. oktober 2020 / 8 October 2020
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PREDGOVOR MULTIKONFERENCI INFORMACIJSKA DRUŽBA 2020

Triindvajseta multikonferenca Informacijska družba (http://is.ijs.si) je doživela polovično zmanjšanje zaradi korone. Zahvala za preživetje gre tistim predsednikom konferenc, ki so se kljub prvi pandemiji modernega sveta pogumno odločili, da bodo izpeljali konferenco na svojem področju.

Korona pa skoraj v ničemer ni omejila neverjetne rasti IKTja, informacijske družbe, umetne inteligence in znanosti nasploh, ampak nasprotno – kar naenkrat je bilo večino aktivnosti potrebno opraviti elektronsko in IKT so dokazale, da je elektronsko marsikdaj celo bolje kot fizično. Po drugi strani pa se je pospešil razpad družbenih vrednot, zaupanje v znanost in razvoj. Celo Flynnov učinek – merjenje IQ na svetovni populaciji – kaže, da ljudje ne postajajo čedalje bolj pametni. Nasprotno - čedalje več ljudi verjame, da je Zemlja ploščata, da bo cepivo za korono škodljivo, ali da je korona škodljiva kot navadna gripa (v resnici je desetkrat bolj). Razkorak med rastočim znanjem in vraževerjem se povečuje.

Letos smo v multikonferenco povezali osem odličnih neodvisnih konferenc. Zajema okoli 160 večinoma spletnih predstavitev, povzetkov in referatov v okviru samostojnih konferenc in delavnic in 300 obiskovalcev. Prireditev bodo spremljale okrogle mize in razprave ter posebni dogodki, kot je svečana podelitev nagrad – seveda večinoma preko spleta. Izbrani prispevki bodo izšli tudi v posebni številki revije Informatica (http://www.informatica.si/), ki se ponaša s 44-letno tradicijo odlične znanstvene revije.

Multikonferenco Informacijska družba 2020 sestavljajo naslednje samostojne konference:

- Etika in stroka
- Interakcija človek računalnik v informacijski družbi
- Izkopavanje znanja in podatkovna skladišča
- Kognitivna znanost
- Ljudje in okolje
- Mednarodna konferenca o prenosu tehnologij
- Slovenska konferenca o umetni inteligenci
- Vzgoja in izobraževanje v informacijski družbi

Soorganizatorji in podporniki konference so različne raziskovalne institucije in združenja, med njimi tudi ACM Slovenija, SLAIS, DKZ in druga slovenska nacionalna akademija, Inženirska akademija Slovenije (IAS). V imenu organizatorjev konference se zahvaljujemo združenjem in institucijam, še posebej pa udeležencem za njihove dragocene prispevke in priložnost, da z nami delijo svoje izkušnje o informacijski družbi. Zahvaljujemo se tudi recenzentom za njihovo pomoč pri recenziranju.

V 2020 bomo petnajstič podelili nagrado za življenjske dosežke v čast Donalda Michieja in Alana Turinga. Nagrado Michie-Turing za izjemen življenjski prispevek k razvoju in promociji informacijske družbe je prejela prof. dr. Lidija Zadnik Stirn. Priznanje za dosežek leta pripada Programskemu svetu tekmovanja ACM Bober. Podeljujemo tudi nagradi »informacijska limona« in »informacijska jagoda« za najbolj (ne)uspešne poteze v zvezi z informacijsko družbo. Limono je prejela »Neodzivnost pri razvoju elektronskega zdravstvenega kartona«, jagodo pa Laboratorij za bioinformatiko, Fakulteta za računalništvo in informatiko, Univerza v Ljubljani. Čestitke nagrajencem!

Mojca Ciglarič, predsednik programskega odbora
Matjaž Gams, predsednik organizacijskega odbora

FOREWORD
INFORMATION SOCIETY 2020

The 23rd Information Society Multiconference (http://is.ijs.si) was halved due to COVID-19. The multiconference survived due to the conference presidents that bravely decided to continue with their conference despite the first pandemics in the modern era.

The COVID-19 pandemics did not decrease the growth of ICT, information society, artificial intelligence and science overall, quite on the contrary – suddenly most of the activities had to be performed by ICT and often it was more efficient than in the old physical way. But COVID-19 did increase downfall of societal norms, trust in science and progress. Even the Flynn effect – measuring IQ all over the world – indicates that an average Earthling is becoming less smart and knowledgeable. Contrary to general belief of scientists, the number of people believing that the Earth is flat is growing. Large number of people are weary of the COVID-19 vaccine and consider the COVID-19 consequences to be similar to that of a common flu dispute empirically observed to be ten times worst.

The Multiconference is running parallel sessions with around 160 presentations of scientific papers at twelve conferences, many round tables, workshops and award ceremonies, and 300 attendees. Selected papers will be published in the Informatica journal with its 44-years tradition of excellent research publishing.

The Information Society 2020 Multiconference consists of the following conferences:

- Cognitive Science
- Data Mining and Data Warehouses
- Education in Information Society
- Human-Computer Interaction in Information Society
- International Technology Transfer Conference
- People and Environment
- Professional Ethics
- Slovenian Conference on Artificial Intelligence

The Multiconference is co-organized and supported by several major research institutions and societies, among them ACM Slovenia, i.e. the Slovenian chapter of the ACM, SLAIS, DKZ and the second national engineering academy, the Slovenian Engineering Academy. In the name of the conference organizers, we thank all the societies and institutions, and particularly all the participants for their valuable contribution and their interest in this event, and the reviewers for their thorough reviews.

For the fifteenth year, the award for life-long outstanding contributions will be presented in memory of Donald Michie and Alan Turing. The Michie-Turing award was given to Prof. Dr. Lidija Zadnik Stirn for her life-long outstanding contribution to the development and promotion of information society in our country. In addition, a recognition for current achievements was awarded to the Program Council of the competition ACM Bober. The information lemon goes to the "Unresponsiveness in the development of the electronic health record", and the information strawberry to the Bioinformatics Laboratory, Faculty of Computer and Information Science, University of Ljubljana. Congratulations!

Mojca Ciglarič, Programme Committee Chair
Matjaž Gams, Organizing Committee Chair

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KAZALO / TABLE OF CONTENTS

Zbornik 23. mednarodne multikonference

INFORMACIJSKA DRUŽBA – IS 2020
Zvezek B

Proceedings of the 23rd International Multiconference

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PREDGOVOR

Na letošnji konferenci Kognitivna znanost sodelujejo avtorice in avtorji z različnih disciplinarnih področij in predstavljajo tako empirične rezultate svojih raziskav kot tudi teoretska raziskovanja z najrazličnejših področji – od kognitivne nevroznanosti in psihologije do empirične fenomenologije, filozofije in umetne inteligence.

Upamo, da bo letošnja disciplinarno in metodološko bogata konferenca odprla prostor za izmenjavo zanimivih raziskovalnih idej ter povezala znanstvenice in znanstvenike z različnih disciplinarnih področij, ki se ukvarjajo z vprašanji kognicije.

Toma Strle
Jaša Černe
Olga Markič

FOREWORD

At this year's Cognitive Science conference, the authors present their empirical studies as well as theoretical research from a diverse range of disciplinary backgrounds – from cognitive neuroscience and psychology to empirical phenomenology, phiosophy and artificial intelligence.

We hope that this year's cognitive science conference – rich in disciplinary approaches and methodologies – will open space for exchanging intriguing research ideas and will bring together scientists from a diverse range of areas related to the exploration of the human mind.

Toma Strle
Jaša Černe
Olga Markič

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Phenomenology of Dissolution Experiences:
An Exploratory Study

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ABSTRACT

We report on an exploratory empirical phenomenological study investigating the so-called *dissolution experiences* (DEs), characterized by the subject experiencing a) a dissolution of her psychological or sensory boundaries and/or a fading of the sense of the self as a separate entity, and/or b) a feeling of unity or identification with (elements of) the surrounding environment. We conducted nine phenomenological interviews investigating seven DEs. The qualitative analysis of collected descriptions of experience elucidated the temporal unfolding of each DE episode, identified typical experiential elements characterizing (specific phases of) DEs, and inquired into the differences and similarities of DEs across different contexts. This study is considered a pilot for a more extensive investigation of DEs. Our findings provide grounds for making the first step towards the phenomenological and conceptual clarification of DEs, which have recently become an object of growing interest in the scientific community, consequently enabling further research.

KEYWORDS

Empirical phenomenology, Dissolution of the sense of boundaries, Sense of self, Altered states of consciousness

1 INTRODUCTION

Various strands of scientific [e.g., 1–11] and non-scientific [e.g., 12–19] literature report on experiential episodes during which "the subjective sense of one's self as an isolated entity can temporarily fade into an experience of unity with other people or one's surroundings, involving the dissolution of boundaries between the sense of self and 'other'" [1:1]. In autobiographical accounts, experiences of this kind are typically (albeit not always; see for instance [20]) described as "positively transformative moments that rank among the most meaningful of one's life" [1:6]. Most frequently, they are reported in association with religious and mystical traditions (e.g., *Atman Brahman* union in the traditional Indian philosophy of *Advaita Vedanta* [13], the meditative state of *Samadhi* in Classical Yoga and Buddhist meditation systems [14], the phenomenon of *unio mystica* in the Christian Tradition [15]; for an overview, see [1, 2]).

The sciences of the mind have lately shown an increased interest in this kind of experiences. The loss or decrease of the sense of boundaries between the 'self' and 'world' (also described as 'other' or 'nonself', cf. [1, 4]), brought about in the context of meditative practice, has been recently explored in studies using both third-person [3] and first-person [4] approaches. Apart from meditation, similar experiential phenomena have long been associated with the use of psychedelic substances such as LSD and psilocybin [5], and have been, in this context, observed and investigated in several recent studies [e.g., 6–8]. Changes in the habitual sense of being a separated entity have also been reported in contexts related to the engagement with art [9] or nature (cf. [10]). Finally, one can find a myriad of descriptions of similar experiences in prose and poetry, for instance in the literary and philosophical movement of transcendentalism [16], in Walt Whitman's poetry [17], in the cultural and literary movement of the Beats [18], and in the poetic tradition of *haiku* [19]; these sources frequently describe such experiences as arising from contact with nature.

Despite their apparent abundance, experiences of this kind seem to lack a common phenomenological and conceptual description, with reports frequently expressed in language specific to the particular context in which they occurred, or in which they are described. This makes it difficult to compare instances of potentially similar experiences reported in different traditions and situations, or by different subjects. Depending on the particular text, these might be described under a variety of names, including *dissolution of the sense of boundaries* (see for example [3–4]), *self-transcendent experiences* (e.g., [1]), *ego death* (e.g., [2]), *ego dissolution* [6–8], and *oceanic feelings* [11]. In one of the few available overviews of such phenomena, the article titled *The varieties of self-transcendent experiences* [1], such experiences are characterized by "transient mental states marked by decreased self-salience and increased feelings of connectedness" [1:1] (cf. also [19]).

We refer to these and similar phenomena as *dissolution experiences* (DEs). In line with the above-mentioned characterizations [1, 11], we define DEs as experiential episodes marked by (a) a feeling of a dissolution of one's psychological and/or sensory boundaries or a fading of one's sense of self as an isolated entity, separated from 'world', 'other' or 'nonself', and/or (b) a feeling of one's unity and/or identification with the surrounding environment, with other people or objects, or with something perceived as larger than oneself.

In this contribution, we present the method and results of an exploratory empirical phenomenological study in which we investigated seven experiential episodes that, according to the above-specified criteria, qualify as DEs. The findings of this study will serve as guidelines for specifying the focus and methodology to be adopted in a more extensive study, currently in its early stages of development, whose final aim will be to provide a detailed phenomenological description of DEs.

The research questions we attempted to answer were: (1) What is it like to experience DEs; what are the typical experiential elements that can be found in DEs? (2) What are the potential similarities and differences between DEs occurring in different contexts?

2 METHOD

Between October 2019 and January 2020, six co-researchers (three females) participated in the study. Their average age was 31,2 (SD = 12,6) and they had, on average, 17,7 years of education (SD = 3,0). Five of our co-researchers were current postgraduate students of cognitive science; three among them had basic experience in phenomenological reporting and one of them was trained in the micro-phenomenological method. One co-researcher was not familiar with either cognitive science or phenomenological inquiry prior to the interview.

We conducted nine interviews about seven experiential episodes (two episodes being an object of an interview twice) satisfying the above-specified criteria of DEs. We selected co-researchers who reported having experienced a (candidate) DE at any point in their life, and expressed interest in its phenomenological exploration. The to-be-explored DEs were identified by the co-researchers themselves in a conversation with the principal investigator prior to the interview.

In line with the breadth of our definition of DEs, the investigated episodes varied with regard to their approximate duration (ranging from a few moments to several minutes), the time since their occurrence (ranging from five days to 25 years prior to the interview), as well as the context and activity within which they arose. All investigated DEs occurred in an ecological setting: three in the course of meditative practice, three during the use of psychedelic substances, and one in the course of engaging with art.

To assist co-researchers in producing phenomenologically rich descriptions of their experience, rather than (as appears to often be the case in describing DEs) relying on experientially ungrounded conceptualizations, we chose to base our interviewing approach on the guidelines of the micro-phenomenological interview method [21]. When the generated description was phenomenologically too coarse, or when co-researchers resorted to explaining, judging, or conceptualizing their experience, the interviewer re-directed their focus back to describing experience as it was concretely and actually lived.

For illustration, consider the following excerpt from the interview about DE6 (i.e., the sixth investigated experience), showing a back-and-forth exchange between the interviewer and the co-researcher Marco, aiming to describe his experience without falling back on phenomenologically imprecise notions and metaphors:

> Marco: It's kind of impersonal and like not being in a body […] Like part of something that's a lot bigger than yourself. […] Like I'm not aware of a body anymore. The sense of my body, like being here at a certain point in the world, is gone.
>
> Interviewer: Okay. And *how do you know* that the sense of being in your body is gone?
>
> Marco: Hm. It feels like I'm the universe. [Laughs.] I feel like I'm the universe. I feel like I'm the void. […] It's a void feeling.
>
> Interviewer: Okay, and *how does it feel* like to be the void?
>
> Marco: At first, it's cool! I think there is a first aspect of awe, like a positive aspect of awe…
>
> Interviewer: Okay, but how do you feel, how do you know that you are the void?

The interviews were conducted in English and Italian; they lasted from 56 to 78 minutes. Each interview focused on detailing the diachronic and synchronic dimension of the selected DE. We started each interview by first asking the co-researcher to describe the selected experience in its full temporal unfolding; we then inquired in more detail into the structure – rather than the content – of the experience within specific temporal phases (of variable duration) that were characterized by the same experiential elements; we also focused on the transitions between different phases. The *peak phase*, i.e., the phase during which the elements characterizing DEs – a dissolved sense boundaries and/or a feeling of unity or identification with (elements of) the surrounding environment – were present to the largest extent, was identified already during the interview; the synchronic structure of this phase was investigated in more detail.

All interviews were recorded on audio or video and transcribed verbatim. Our analysis process was informed by general guidelines of qualitative analysis [22]. Transcripts were chronologically ordered, eliminating or marking the so-called "satellite dimensions" [23], so that further analysis focused on the parts containing phenomenological descriptions. Descriptions of experience were divided into temporally distinct phases (extraction of the diachronic structure), with this process being guided by the prior identification of the peak phase. For each phase, we identified and described different experiential elements present (extraction of the synchronic structure). Interview excerpts used in the present contribution have been edited for clarity by removing the interviewer's interventions and less relevant parts of the transcripts.

3 RESULTS

In accordance with the exploratory character of the study, its findings are not conclusive, but present preliminary insights

that will guide our further research into DEs. Due to the nature of our results and the space limitations of the present contribution, we decided to refrain from laying out an exhaustive list of constructed experiential categories. Instead, this section presents a limited selection of identified experiential elements and characteristics that we find particularly interesting and/or illustrative of the investigated DEs.

Specific aspects of DEs are presented in subsections 3.1–3.3. We would, however, like to start this section by first giving the reader a general impression of the studied experiences by presenting a typical description of a peak phase, taken from the interview about DE7. Co-researcher Lev experienced DE7 while attending a concert, standing in a crowd of people in front of the stage, with the band playing a specific song. The initial phases of the experience, in line with the unfolding of the song, were characterized by a crescendo of feelings of connectedness, while Lev's sense of self, sense of time, and sense of space were gradually diminishing. At a certain point, however, there was a sudden "break in the song" in which only the singer was performing, with the rest of the band remaining silent; during this phase, Lev reported having briefly regained the type of awareness (of himself, his body, and the surrounding space) that he described as similar to that which he habitually experiences in the context of his everyday life. When the band suddenly started playing again, Lev rapidly entered the peak phase of the experience:

> This contrast [between the "break" and the band playing again] really made me lose all my sense of self […] it's like the feeling where it feels like it is exploding and it's just big, all the borders are gone […] it's like a huge euphoria. But it feels like it's everywhere. It doesn't feel that it's in my body or… It just feels that *everything* is very euphoric.

This feeling was accompanied by a decrease of the sense of being a separate self:

> It feels like everything is one, so like I'm aware that [the other people] are there but it feels like they are the same as me and we are the same as the music, and […] just everything appears to be one, everything. So before, it seems like we're connected, we're two different things that are connected, but in the end [i.e., when the peak phase begins] it doesn't seem like [we] are two different things anymore. […] This sense of connection changes into a sense of unity. [This sense of unity] cannot really tie to my experience, it just seems like a big experience, *one big experience*. Not like me feeling these things, just like […] this kind of feelings [that] float in the room, it's not like me feeling it in my chest or in my whatever, but it just seems to be there, everywhere. […] It's not something that I do or that I perceive […] it's just… *I'm part of everything else* […] If it's my behavior or someone else's, it doesn't really make a difference […] I'm out there somewhere. I don't really know [where], but I also don't really care.

Before presenting specific experiential aspects of DEs, it is important to stress that the investigated DEs presented high variability with regard to their diachronic as well as synchronic structure.

Variability in the diachronic structure. While the above excerpt from DE7 serves as a good illustration of the peak phase, its diachronic unfolding differed from that of the majority of investigated experiences. Namely, DE7 started with a gradual diminishment of Lev's sense of boundaries, which was then regained during the "break" in the song, only to be abruptly lost again with the beginning of the peak phase. By contrast, all other experiences (6/7) were characterized by a continuous, uninterrupted climax of defining elements of DEs towards the peak phase; in the phases following the peak phase, these elements would then gradually or abruptly disappear.

In line with this more typical temporal unfolding is, for example, DE2, during which co-researcher Claire perceived a progressive lessening of – as she called them during the interview – the "lines of her body". In the initial phase of the experience, Claire was feeling the freshness of the air touching her skin, and a straight "line" between the skin and the space around it; then, starting from the lower left part of her face and gradually encompassing all of her body, all the "lines" of her face and body began feeling "wobbly" at first and then altogether absent from experience. In the last phase of the experience, the "lines" separating her body from the outside world "entered into focus" again.

Variability in the synchronic structure. The seven investigated DEs highly varied with respect to the particular experiential elements present in (specific phases of) the described experience. The most notable difference refers to which of two above-specified criteria for DEs – (a) and/or (b) – were satisfied during their peak phase, and in what way.

Co-researcher Nadja, for example, described an experience (DE1) she had while meditating with her eyes closed, sitting with her legs crossed on the floor of her room. As she was focusing on her breathing (visualizing wood while exhaling, and imagining being part of this wood while inhaling), she started experiencing a gradual dissolution of the boundaries separating her body from her surroundings. Just before the peak phase, Nadja reported feeling a "hole" in the middle of her chest; in the peak phase, she described a sense of not having a frontal part of her torso at all. Here, a dissolution of bodily boundaries (criterion a) was reported without any sense of identification or unity with (elements of) the surrounding environment (criterion b).

In DE3, on the contrary, co-researcher Andrea was experiencing strong identification with objects present in her physical surroundings (criterion b); however, she did not report on any sense of boundary dissolution (criterion a). The experience arose after Andrea consumed LSD and inhaled laughing gas, starting then to recognize the reflection of her own face in various objects in her surroundings that she would look at. She reported feeling that the reflections she was seeing were "also part of who [she was]", and while she described "extend[ing] a little bit outwards, into what [she was seeing] and touching", she stressed she never stopped feeling "in [her] body".

When involving a sense of boundary dissolution, the investigated DEs also varied with regard to the described mode of experiencing this dissolution: while in some cases, the dissolution was described as an emphatically bodily experience or even had a very specific bodily location (as in

the above-described DE1), in other cases (for example in DE7), the co-researcher described the dissolution largely without referring to the bodily feelings.

In what follows, we list a subset of some interesting or illustrative experiential elements and characteristics that featured in particular temporal stages of the investigated DEs: (1) the peak phase, (2) the phases preceding the peak phase, and (3) the phases following the peak phase.

3.1 Elements present during the peak phase

Identification of the action of feeling and the object felt. Peak phases of four investigated DEs (in particular, three from the context of using psychedelic substances, and one from engaging with art) were characterized by instances where the co-researcher could not distinguish between the *action* of feeling and the *object* of feeling, or was experiencing the two as identical. For example, co-researcher Andrea, who experienced DE3 while she was sitting on a couch, reported:

> There was a certain awe. With the insight of everything being me [...] It was not like there was a world out there... There's just my perceptions of the world, which are part of *me* because they are *my perceptions*, and this extended to tactile feelings [as well as visual]. So, when I was feeling the couch, the feeling of the couch was part of me. [...] It's difficult to distinguish my perceptions of things from the actual things. [...] I could feel the softness of the couch, that softness was part of me, or just the pressure against me was part of me.

Lev, in describing DE7, similarly remarked:

> I cannot really tell what's the difference between me feeling something and me seeing something, or like... what the rest of the world does, it's like it's the same for me [...] what is going on on the stage and what is going on in my head, I cannot really tell the difference.

Transmodality. Two DE descriptions (one from the context of using psychedelics, and one from engaging with art) reported on the unification of different sensory modalities. Marco, who experienced DE6 while being in the forest under the influence of mescaline, thus described the merging of senses accompanying the onset of his sense of boundary dissolution:

> ... it might be hard to separate different aspects of the visual and the feeling and the thinking because it might have all been into one. Like the visual part was also the feeling, like my sense of self was encompassed by this visual aspect, like this broad universal view, and then the feeling, like it might have all been wrapped into one.

Similarly, in describing the beginning of the peak phase in DE7, Lev reported:

> Then, when everything else comes in again, it just loses the separation between the sound and colors and different sensory perceptions.

3.2 Elements present before the peak phase

"Feeling" that passes through the bodily boundaries. In four investigated DEs (two from the meditation context, one from the psychedelics context, and one from engaging with art), co-researchers reported a *feeling* (a term all four spontaneously used in all four occasions to refer to different sensations, e.g., a pulsating or a movement) that they perceived as "passing through their bodily boundaries", usually without encountering obstacles in doing so (or encountering them less and less). This feeling was felt as moving either from the outside inwards or from the inside outwards, and was sometimes experientially related to the loosening of the sense of boundaries. For example, Claire described an experience (DE2) that she had while lying on her bed and following a guided meditation. Throughout the experience, she felt a pulsating sensation spreading from her chest that was loosening the "lines of her body":

> [A]s this pulsates, I don't feel any... block in a way. [...] Nothing slows the feeling down in this area. [...] It goes everywhere, sort of just spreads over the body and then goes out into space. [...] Makes my, like this separation of my body, it makes it sort of thinner and lessens it.

Another example can be found in DE1, in which the peak phase (already mentioned above) was preceded by Nadja experiencing the movement of air freely passing between the space in front of her chest and the inside of her chest:

> I inhaled, and I was surprised by this stream of air entering clearly and directly into my chest. As if the air passes directly from here [pointing to space in front of her chest] towards the inside, and there is nothing that it has to go through. [...] I just observe this sensation, I continue inhaling and exhaling, until I really [...] notice that this air is not stopped by anything. [...] At a certain point I really feel like there is a hole in my body that makes the air going through it. At the beginning, just a hole. Then, after a while, I just feel there's no frontal area [...] So the frontal part is really just this exchange of air, there's nothing else [...] and in this way there's no separation between what is actually the area inside my body and what is outside, because the exchange of air is happening in the same space. I'm just a shape in which this exchange of air can take place, but nothing else.

3.3 Elements present after the peak phase

Need to go back to the habitual way of experiencing. In two of the investigated DEs (one from the meditation context and the other from the psychedelics context), the end of the peak phase was accompanied by a need to go back to the "habitual" way of experiencing. In describing DE2, Claire described it as

> a wish, like this nag or a need to come back, to not stay in this because it's really pleasant [...], something that urges to come back and then colors the entire space.

Marco reported on the need to "pull away" from what he was experiencing in DE6 (i.e., losing of sense of time and space, accompanied by visual hallucinations of "weird creatures"):

> And then there's a sense that I don't want to, I don't want that, it's too scary. (...) Well, I don't know if I can control it or not, but when I get scared [...] then I pull out of it.

Returning to the body/moment/location. In several analyzed DEs, we noted changes, throughout the experience, of the sense of body (5/7), time (4/7), space/location (4/7), or of what the co-researcher was doing (2/7). Usually, the awareness of these aspects was at its lowest during the peak phase, and returned towards the end of the DE. For example, Claire reported that at the end of her DE,

> [t]here is a sense of coming back to the body. [...] The body comes into focus again and the room [...] the sense of the

room, where I am positioned, that there is a bed underneath my legs and my body and then there is a drawer next to me and stuff like that, all that sort of comes back, […] it brings to focus the body and where I am and what I'm doing. […] So it's like *making* the room and the world in a way.

4 FUTURE DIRECTIONS

Despite most co-researchers being familiar with the basic guidelines for phenomenological reporting, the generated descriptions of experience have often failed to reach the desired phenomenological depth and precision, instead frequently staying at the level of general remarks and conceptualizations. It might well be that at least some aspects of DEs are particularly difficult – or perhaps impossible – to be put into words. Marco, for instance, emphasizes that a part of his experience of boundary dissolution (DE6) is better describable as an "*absence* … of what you thought was always there, rather than a *presence*". Our co-researchers often mentioned that their experience was difficult to describe, and further sometimes expressed concern that any words they could find were too metaphoric or esoteric to do justice to the DE as it was actually lived. For example, Jan, describing DE5 experienced while meditating on a hill with other meditators, commented:

But what can I say, "ah what a good vibration" – I don't mean to say this as those "ah I've been to India"! I mean, you were really feeling it, you were feeling that there was… That something was vibrating, no?

In describing the peak phase of DE7, Lev similarly remarked:

Everything is just really like on the same, I don't know – that sounds esoteric – but like everything is on the same frequency, everything is like coherent, everything shakes together.

Setting aside the question of whether the defiance to verbal description might present an inherent feature of DEs, we believe that the quality of phenomenological reports could be nevertheless substantially improved by (a) increasing the number of interviews dedicated to the exploration of a particular DE; (b) training co-researchers in phenomenological reporting in the context of everyday lives.

The results found in this study will enable us to refine the research design to be implemented in our further inquiry into DEs. In the course of the larger study based on this pilot, we are planning to collect a sample of approximately thirty DEs, experienced in different context; however, each co-researcher will, prior to exploring their DE, undergo a period of training in a technique similar to *descriptive experience sampling* [24]. This will enable co-researchers to learn to better observe and describe their experience, as well as provide descriptions of aspects of co-researchers' everyday experience that can be later on compared to characteristic experiential aspects of their DEs.

ACKNOWLEDGMENTS

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Primerjava rezultatov analize funkcijske magnetne resonance z različnimi programskimi orodji

Results of Functional Magnetic Resonance Imaging Analysis with Different Software Tools: A Comparison

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POVZETEK

Funkcijska magnetna resonanca (fMR) je metoda slikanja aktivnosti možganov, ki temelji na kompleksni analizi podatkov, ki jo omogočajo različna programska orodja. Med temi so najbolj pogosto uporabljeni AFNI, FSL in SPM. Želeli smo preveriti, če dobimo enake rezultate, ko podatke analiziramo z različnimi orodji. Naloga, ki so jo udeleženci opravljali, je bila osnovana na blok eksperimentalnem načrtu; opazovali smo čustven odziv na slike nezdrave hrane v primerjavi v nevtralnimi slikami, ki niso povezane s hrano. Pokazala se je velika variabilnost rezultatov med programskimi orodji, tako v viških aktivacij, kot v samih področjih teh razlik. Obstaja veliko možnih razlag za te rezultate; največji pomen pripisujemo različnim pristopom registracije in normalizacije, ki so onemogočili direktno primerjavo. Ta študija je šele začetek eksploracije tega področja in nakazuje potrebo po večji refleksiji fMR znotraj nevroznanosti.*

KLJUČNE BESEDE

funkcijska magnetna resonanca, statistična analiza, metodologija, programska orodja, nevrofilozofija

ABSTRACT

Functional magnetic resonance imaging (fMRI) is a method of capturing brain activity, which is based on a complex analysis of data. This is done in one of the available software packages, out of which AFNI, FSL and SPM are most commonly used. We wished to check if we got the same results, if they were analyzed with different packages. The task that the participants were given was based on a block experimental design; we observed the emotional response to images of unhealthy food compared to neutral images not related to food. The results showed a large variability of the peaks of activation, as well as areas associated with them between the packages. There are many explanations for these results; we would put the main emphasis on the different approaches to registration and normalization, which meant that a direct comparison was not possible. This study is only the beginning of the exploration of this area and shows a need for more reflection on fMRI in neuroscience.

KEYWORDS

functional magnetic resonance, statistical analysis, methodology, software packages, neurophilosophy

*Tekst je v celoti osnovan na magistrskem delu z istim naslovom.

1 UVOD

Funkcijska magnetna resonanca (fMR) je raziskovalno najpogosteje uporabljena metoda slikanja možganske aktivnosti [1]. Končni prikaz aktivnosti določenih predelov možganov nastane s kompleksno analizo podatkov. Za analizo teh podatkov obstaja več programskih orodij, med katerimi so najpogosteje uporabljeni Analysis of Functional Images (AFNI), FMRIB Software Library (FSL) in Statistical Parametric Mapping (SPM). Celoten postopek analize vključuje dolg niz odločitev glede zaporedja izvedbe posamičnih korakov ter specifičnih vrednosti parametrov [2]. Ker vsako orodje uporablja nekoliko drugačne nastavitve in drugačno programsko kodo za procesiranje signala, obstaja možnost, da pri uporabi različnih orodij ne dobimo enakih rezultatov. Primerjava rezultatov teh orodij je pomembna, da ugotovimo, ali so rezultati fMR analize skladni pri uporabi različnih orodij ali so odvisni od specifične izbire programskega orodja za analizo. V slednjem primeru je to potrebno ustrezno upoštevati pri vrednotenju in interpretaciji rezultatov.

Za končno oceno aktivnosti možganov morajo biti zbrani podatki obdelani v kompleksnem procesu analize, ki vključuje kontrolo kakovosti, popravo prostorskega popačenja, popravo premikov glave, popravo časa zajema posamičnih rezin možganov, prostorsko normalizacijo, prostorsko glajenje, časovno filtriranje, statistično modeliranje, statistično analizo in vizualizacijo [2].

Carp [3] poudarja, da je v fMR eksperimentih prisotna velika variabilnost v metodoloških odločitvah. Po pregledu 241 fMR študij je Carp [3] poročal o uporabi 32 različnih programskih orodij in 207 kombinacij korakov analize. Zaradi velikega števila kombinacij korakov pride do analitične fleksibilnosti, t.j. večji spekter zaključkov analiz z uporabo sprejemljivih metod. Iz analitične fleksibilnosti sledita dve negativni posledici: povečano število lažnih pozitivnih rezultatov in selektivno poročanje.

Le nekaj raziskav je do sedaj primerjalo rezultate analiz z različnimi programskimi orodji. Bowring idr. [4] so opazili veliko variabilnost v vrednosti t-statistik in lokacijah statistično značilnih aktivacij, vendar to ni bilo konsistentno pri vseh eksperimentih. Glede na splošni vzorec aktivacij ni bilo opaznih večjih razlik. Medtem ko so pri tej študiji analizo prilagajali eksperimentom, so Pauli idr. [5] primerjali analize s programskimi orodji AFNI, FSL in SPM, pri katerih so uporabili najpogosteje uporabljene nastavitve za vsako programsko orodje. Rezultati so pokazali podoben splošen vzorec aktivacije,

kjer je bilo pri AFNI-ju nekaj manj aktiviranih vokslov. Študija lažnih pozitivnih rezultatov [6], ki je spet primerjala AFNI, FSL in SPM, je pokazala, da vsa orodja kljub nadzoru večkratnega testiranja kažejo inflacijo statistične značilnosti. Podobno je pokazala študija, ki je primerjala rezultate analiz na ravni posameznikov (in ne na ravni skupin), kjer so razlog za povišano število lažnih pozitivnih rezultatov pri SPM-ju pripisali preveč enostavnemu modelu za šum, pri FSL-ju pa podcenjevanju prostorskega glajenja [7].

Temelj vsakega znanstvenega pristopa je zanesljivost. Ta je bistvenega pomena, če je naš cilj odkrivanje resnice in če želimo metodo aplicirati v praksi in če želimo sodelovati z raziskovalci z istega in drugih področij. Bennett in Miller [8] sta poudarila, da se raziskovalci, ki uporabljajo fMR metodo, premalo zavedajo (ne)zanesljivosti svojih raziskav. Zaradi številnih korakov v predprocesiranju pri izločanju šuma, in metodoloških odločitev, ki sledijo iz tega, je zanesljivost težko doseči. Iz tega sledi indirektnost opazovanja [9] in vprašljivost spadanja v paradigmo realizma [10].

Zanimalo nas je, ali s programskimi orodji AFNI, FSL in SPM dobimo enake rezultate pri analizi fMR podatkov in posledično, ali današnje stanje fMR raziskav odraža resničnost ali metodološko pristranskost. Cilj raziskave je bil, da s primerjavo rezultatov, pridobljenih s programskimi orodji AFNI, SPM in FSL, dobimo pregled nad razlikami in podobnostmi med rezultati. Zanimala nas je razlika v moči aktivnosti, vzorcu aktivnih predelov in deležu vokslov nad določeno mejo.

2 METODE

Raziskava je zajela kontrolno skupino 16 zdravih otrok in mladostnikov (10 ženskega spola) iz študije debelih mladostnikov. Povprečna starost udeležencev je bila 14,1 let (*SD* = 2,7 let, min = 10 let, max = 19 let).

Študija je bila sestavljena iz dveh nalog čustvene nasičenosti dražljajev, povezanih s hrano. Dražljaji pri blok načrtu so bile slike, ki smo jih razdelili v dve kategoriji: kategorija nezdrave hrane in kategorija nevtralnih slik, ki niso prikazovale hrane.
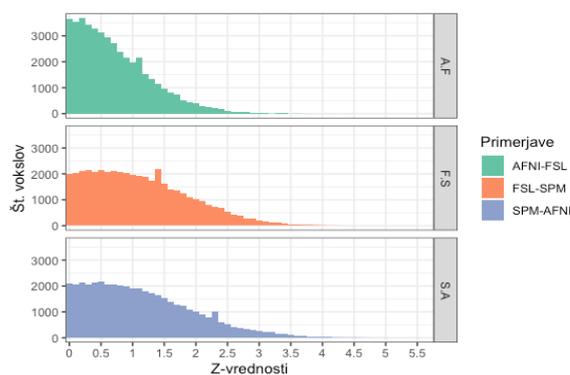
Podatki so bili analizirani ločeno za blok in z dogodkom povezan načrt v vsakem od treh programskih orodij AFNI, FSL in SPM. Najprej je bila narejena povprečna strukturna slika vseh udeležencev, ki smo jo uporabili za predlogo. Vsaka analiza je bila izvedena po postopku in s parametri, ki so privzeti ali priporočeni za vsakega izmed programskih orodij; pri FSL-ju in SPM-ju smo uporabili privzete nastavitve, pri AFNI-ju pa te možnosti ni, tako da smo uporabili priporočene. Zaradi tega je prišlo do razlike v analizi: pri AFNI-ju smo vključili korak poprave časa zajema posamičnih rezin možganov, pri drugih dveh orodjih pa ne. Po predprocesiranju, prvostopenjski in drugostopenjski analizi smo dobljene rezultate primerjali na več načinov. Variabilnost moči razlik med aktivacijami pod različnimi pogoji med programskimi orodji smo pokazali z razlikami med Z-vrednostmi. Položaj aktivnosti smo primerjali s splošnim vzorcem aktivnosti ter določanjem aktivnega predela s pomočjo različnih atlasov. Razlike med statistično značilnostjo rezultatov smo pokazali z deležem vokslov, ki presegajo izbrano mejno vrednost.

3 REZULTATI

3.1 Variabilnost moči aktivnosti

Variabilnost moči aktivnosti pri programskih orodjih smo prikazali s primerjavo razlik med Z-vrednostmi v vsakem vokslu končnih slik. Zaradi nekaterih razlik v končnih funkcijskih slikah med orodji, ki se pojavijo zaradi različnih pristopov registracije in normalizacije, smo za to primerjavo naredili masko in upoštevali le voksle, ki so prisotni pri vseh orodjih.

Kot je razvidno s histograma na sliki 1, je največ vokslov z minimalnim razponom Z-vrednosti pri primerjavi AFNI-ja in FSL-ja. Drugi dve primerjavi imata bolj podobno porazdelitev, pri vseh pa je razpon manjši od 1 pri vsaj polovici vokslov.

Slika 1: Porazdelitev razponov Z-vrednosti pri vseh primerjavah. med programskimi orodji

3.2 Variabilnost položaja in vzorca aktivnosti

Položaj aktivnosti smo primerjali z lociranjem področij aktivnosti in opisom splošnega vzorca. Rezultati aktivnih področij so se izkazali za zelo različne.

Največji delež vokslov s prepoznanimi razlikami med aktivacijami pod pogoma nezdrava hrana - nevtralni dražljaj je bilo pri analizi v FSL-ju, kjer je 1,14 % vseh možganskih vokslov prišlo nad mejno vrednost. Sledil je AFNI, kjer je bilo 0,48 % vseh možganskih vokslov nad mejno vrednostjo, pri SPM-ju pa je 0 % vokslov preseglo mejo.

Analiza v FSL-ju je pokazala pet skupkov, kjer se največji nahaja v levem fusiformnem korteksu. Sledita pozitivna razlika med aktivacijama pod pogojema nezdrava hrana - nevtralni dražljaj v desnem superiornem parietalnem režnju in desnem inferiornem okcipitalnem režnju. Dve negativni razliki med aktivacijama sta se pokazali v bilateralnem parahipokampalnem girusu in lingualnem girusu, kot je razvidno na sliki 2.
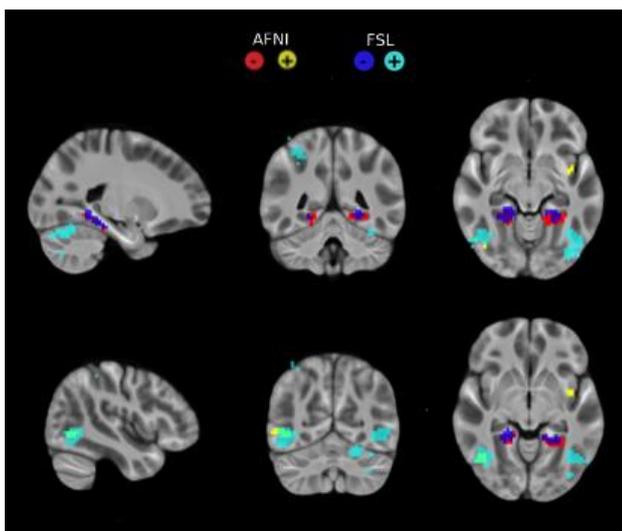

Slika 2: Rezultat analize v FSL-ju (koordinate: 24L 40P 10I)

Analiza naloge z blok načrtom je v AFNI-ju pokazala šest skupkov: dve negativni razliki med aktivacijama pod pogojema F - C v bilateralnem lingualnem in fusiformnem girusu, ena pozitivna razlika v levi insuli, dve pozitivni razliki v bilateralnem lateralnem okcipitalnem korteksu in ena v srednjem frontalnem girusu (slika 3).

Slika 3: Rezultat analize v AFNI-ju (koordinate zgornjih treh rezin: 23L 49P 5I, koordinate spodnjih dveh rezin: 43R 12A 44S)

Pri primerjavi vzorca aktivnosti najbolj izstopa analiza v SPM-ju, ki ni pokazala nobenega aktivnega področja. AFNI in FSL sta delno pokazala različna aktivna področja, razen negativne razlike med aktivacijama pod pogojema F - C v lingualnem girusu in pozitivne razlike med aktivacijama v desnem lateralnem okcipitalnem korteksu, kjer je prišlo do bistvenega pokrivanja. To vidimo na sliki 4, kjer + nakazuje aktivacije in - nakazuje deaktivacije.

Slika 4: Področja aktivnih predelov glede na različna programska orodja (koordinate zgornjih rezin: 21L 47P 10I, koordinate spodnjih rezin: 43R 61P 61)

4 DISKUSIJA IN SKLEPI

V pridobljenih rezultatih se je pokazala velika variabilnost področja in moči aktivacije med programskimi orodji. Ena izmed možnih razlag, zakaj je prišlo do te variabilnosti, je razlika v metodah analize pri različnih programskih orodjih. Vsako orodje ima drugačno ozadje, različne pristope ter drugačno zaporedje postopkov.

4.1 Primerjava postopkov

Privzete ali priporočene nastavitve za vsako orodje so se razlikovale na vsakem koraku, sami koraki pa so se razlikovali v vrstnem redu. Pri vsakem orodju smo za popravo premikov glave uporabili drugačno referenčno sliko (sredinski volumen, povprečje vseh volumnov ali volumen z najmanj odstopanji v signalu) pri registraciji na strukturno in standardno sliko pa smo uporabili drugačne transformacije. Glede na bistvene razlike v maskah rezultatov vsakega orodja lahko sklepamo, da je ta korak bistven za razlike v naših rezultatih. Z AFNI-jem smo opravili najbolj konservativno glajenje, z SPM-jem pa najbolj liberalno. Razlika se je pokazala že pri rezultatih, ki niso statistično značilni, a je še bolj očitna po popravkih za multiple primerjave. Ker obstaja veliko pristopov k temu problemu – kot poudarijo Poldrack idr. [2], je meja arbitrarno določena – ima vsako orodje drugačen priporočen način popravkov na ravni skupkov. Veliko korakov (predvsem pri predprocesiranju in pri postavljanju končne meje) pri metodah je torej lahko pripomoglo k variabilnosti rezulatov, veliko sprejemljivih možnosti v metodoloških odločitvah pa pomeni tudi veliko analitično fleksibilnost [3].

4.2 Primerjava rezultatov

Glede na velike razlike v rezultatih je potrebno izpostaviti, da primerjava vrednosti vokslov temelji na predpostavki, da so slike prostorsko poravnane. V našem primeru niso bile, kar vidimo v različnih oblikah končih slik možganov. To je zato, ker smo želeli uporabiti privzete nastavitve, te pa so se pri registraciji in normalizaciji tako razlikovale, da so ustvarile končne slike različnih oblik. V manjši meri razlike opazimo pri Z-vrednostih pred postavitvijo meje. Kljub visokem maksimalnem razponu se pri vseh primerjavah vsaj polovica vokslov razlikuje za eno standardno deviacijo ali manj.

Variabilnost viškov se je pokazala že v drugih študijah [11] [12], medtem ko je aktivnost na različnih področjih bolj nepričakovana (napram [4] [5] [11][12]). Pri raziskavi, ki so jo opravili Pauli idr. [5], se je AFNI izkazal za programsko orodje z najbolj konservativno analizo, medtem ko je v našem primeru glede na delež aktivnih vokslov to bil SPM. Medtem ko pri SPM-ju ni bilo aktivnega področja, smo z AFNI-jem našli šest skupkov velikosti med 16 in 64 vokslov, s FSL-jem pa kar pet skupkov velikosti med 56 in 406 vokslov.

Glede na to, da eno orodje (SPM) ni pokazalo nobene aktivnosti, se postavi vprašanje lažnih pozitivnih rezultatov. Prejšnje raziskave so pokazale, da vsa orodja lahko povzročijo inflacijo statistične značilnosti [6], pri čemer je je pri SPM-ju vzrok enostaven model za šum, pri FSL-ju pa podcenjevanje prostorskega glajenja [7]. Ker smo dobili tri različne slike, bi glede na našo študijo morali potrditi izjavo Ionnadisa [13], da je več raziskovalnih zaključkov napačnih kot pravilnih. Pomembno

pa je poudariti, da naši zaključki veljajo le za privzete oz. priporočene nastavitve vsakega programskega orodja.

4.3 Pomanjkljivosti študije

Za bolj trdne zaključke bi lahko študijo izvedli z določenimi popravki. Obstaja vprašanje, ali s takim eksperimentom sploh opazimo čustveni odziv na nezdravo hrano. Ker smo za to raziskavo uporabili le osebe iz kontrolne skupine, je še posebej vprašljivo, če nam rezultati kaj povejo. Izstopa tudi majhno število udeležencev. Dodatno je treba izpostaviti, da so bili udeleženci otroci različnih starosti, kjer prihaja do velikih razlik v razvoju možganov, zato težje dobimo dokončne zaključke. Na tej točki razvoja takšnih raziskav bi bilo bolj primerno primerjati slike odraslih možganov, saj je pri pediatričnih slikah več komplikacij [14].

Ker smo za analizo uporabili privzete nastavitve programskih orodij, se je pokazala velika razlika med analizami. Zato je to ena izmed odločitev, ki bi jo lahko premislili. Ena izmed rešitev bi bila poskus izvedbe analiz z različnimi programskimi orodji, ki so si čim bolj podobne. To pa je težko izvedljivo zaradi različnih filozofij orodij, ki so sicer odprta, ko se uporabi ukazna vrstica, vendar je za približevanje drugim orodjem potrebno vzpostaviti veliko sprememb. Predvsem bi bilo potrebno večjo pozornost posvetiti registraciji in normalizaciji, da bi bile slike dejansko poravnane in bi jih lahko primerjali.

Za bolj jasno primerjavo bi morali uporabiti večji vzorec, naloga za analizo pa bi morala biti bolj enostavna ter – na tej točki našega poznavanja nevroslikovnih metod – zelo skladna s prejšnjimi študijami (na primer premikanje prsta). Glede na to, da so se razlike pri nalogi z blok eksperimentalnim načrtom kazale v aktivnih področjih, ne pa toliko v vrednostih vokslov, bi bilo verjetno relevantno pri vseh analizah postaviti isto mejo in primerjati te rezultate

4.4 Implikacije za nevroznanost

Variabilnost korakov analize postavi pod vprašaj direktnost opazovanja možganske aktivnosti. Poleg indirektnega merjenja živčne aktivnosti, ki je v sami osnovi metode fMR, različni koraki analize vzpostavijo še večjo distanco s predmetom opazovanja. Če uporabimo metaforo fotografije, ki je pogosta pri opisu fMR [15], dobimo tri različne fotografije istega učinka; torej ena analiza ne daje popolnega razumevanja možganske aktivnosti. To še posebej postavi pod vprašaj paradigmo realizma, ki velja v slikanju s fMR.

Ti podatki kažejo na problem fMR, ki sta ga poudarila Bennett in Miller [8]: nezanesljivost metode. Eden izmed temeljev znanstvene metode je zanesljivost in če dobimo različne rezultate pri isti nalogi, to močno izpodkoplje glavno nevroslikovno metodo. Pomembnost zanesljivosti in veljavnosti metode je jasna tako za raziskovalno delo kot za aplikacijo teh ugotovitev v kliniki. Na tej točki bi radi poudarili različne rešitve, ki so jih predlagali že drugi: izboljševanje trenutnih metod [6], odprto deljenje podatkov [16] ter ustvarjanje standardnega formata korakov analize [17] [18]. Nadaljevanje na kritičnem raziskovanju delovanja metode fMR je torej ključnega pomena za nevroznanost.

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What Anime to Watch Next? The Effect of Personality on Anime Genre Selection

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ABSTRACT

Personality can affect people's entertainment preferences. This has been shown with TV shows, movies, books, and music. This study tries to see if there is also a connection between personality and anime watching patterns and preferences. The analysis was done on the reviews posted on the MyAnimeList website. The study shows, that personality has a small connection with what people watch and a somehow bigger connection with what they like to watch as shown by higher ratings.

KEYWORDS

personality, genre, anime, LIWC

1 INTRODUCTION

People use different media, to satisfy different psychological and social needs [7]. But since different people can have different needs, these can also mean, that they choose different media to satisfy their needs. One of the ways to conceptualizes differences in people is through personality.

1.1 Personality

Personality can be defined as differences in how people think, feel, and behave in general [3]. The most popular personality model in science is currently the Big Five model. The model includes five traits [11]:

- Extraversion is defined by the frequency and intensity of positive feelings. These people are positively oriented, social, and assertive, as opposed to quiet.
- Neuroticism is defined by the frequency and intensity of negative feelings. These people are less resilient and more sensitive and nervous.
- Agreeableness is defined by the relative importance people place on other people when compared to themselves. These people are more cooperative, empathic, and likable, instead of competitive.
- Conscientiousness is defined by the need to follow a system and defined rules. These people are more efficient and organized, as opposed to spontaneous.
- Openness is defined by the number of associations with different ideas and concepts. These people are more curious and creative, as not as consistent as people on the other end of the trait.

1.2 Entertainment preferences

Personality can affect interests. Even an indirect indication of interest, for example, Facebook likes, can predict personality [9]. There are some studies, showing the connection between personality and entertainment that people choose.

The entertainment preferences were found to correlate with personality. When measured by questionnaires, Communal genre preference was positively correlated with agreeableness factors. Aesthetic genre preference was positively correlated with openness and agreeableness factors. Dark genre preference was negatively correlated with agreeableness and conscientiousness factors. And cerebral genre preference was positively correlated with openness factors [13].

The specific genres were also connected to personality when the later was measured with Facebook likes. For example, in books, openness predicted liking poetry and science fiction, while disliking drama, scary, and crime books. Conscientiousness predicted liking education books and disliking comics, fantasy, and poetry. Extraversion predicted liking scary and humor books and disliking fantasy, science fiction, and war books. Agreeableness predicted liking drama and education books and disliking war and crime books. And on the end, neuroticism predicted liking crime and poetry books, while disliking non-fiction, thriller, and mystery books [4].

Because of the size of the market, focus on mass media, and different levels of tolerance for foreign media, most of the media exports in the world comes from the USA [6]. But Japan held the primary role in the cartoon segment for decades. With animes popularity increasing outside Japan [10], this allows for study the mass media from a country that differs from the USA [2]. Since there is a lack of studies connecting personality and anime, I would like to see, if there is a connection there. For this purpose, I am going to try to answer two research questions.

Research question 1 Is personality connected with the anime genres people choose to watch?

Research question 2 Is personality connected with how much people like the anime genres they watch?

2 METHODOLOGY

Data were collected by scraping the reviews and anime metadata from the myanimelist.net website in August 2020. There were 138335 reviews for 7570 anime series written by 52235 users. Users were differentiated by their user name, there was no attempt made to figure out if one user is using multiple accounts. More than half of the users wrote only one review, while the user with the most reviews wrote 554 reviews.

By scraping the genre metadata for each anime, there were 43 different genres. Each anime can be in multiple different genres. The genres are comedy, school, shounen, supernatural, hentai, romance, seinen, dementia, a slice of life, kids, adventure, space, mecha, military, sci-fi, action, fantasy, magic, music, game, drama,

shounen-ai, harem, horror, historical, sports, mystery, cars, parody, shoujo, demons, martial arts, yaoi, superpower, ecchi, thriller, vampire, samurai, psychological, police, yuri, josei, shoujo-ai.

To get the personality scores of the people, I analyzed the content of the reviews with the LIWC [14, 12]. This is a program intended to study texts with the help of the word counts in different categories. The categories include function categories, like the number of pronouns, and the content categories, like social processes.

I concatenated all the reviews for each person in a separate file. I analyzed these files with the LIWC program. The commercial version also includes the Big Five scores, which is the most frequent way of how to use LIWC to get personality. But in the academic version, these are not available. So the personality was computed based on the correlations between LIWC categories and personality found in previous studies. Some studies used this method before [1].

I used the correlations from the Yarkoni study [15], where over 600 people's blogs were analyzed with LIWC and correlated with the Big Five traits from the questionnaire. I used only the categories, that were significant at the p=.001. Since the blogs were analyzed with the earlier version of the LIWC (version 2001) program, the equivalent groups from LIWC 2015 were used. If the category no longer existed, then it was dropped. The values were summed together to get the composite value.

Based on this method, the traits were calculated in the following way: Conscientiousness was calculated by summing achievement, anger (negative), negative emotions (negative), and negations (negative). Agreeableness was calculated by summing the words connected with home, leisure, motions, space, positive emotions, anger (negative), negative emotions (negative), and swear words (negative). Openness was calculated by summing the propositions, articles, words connected to death, home (negative), leisure (negative), motion (negative), time (negative), family (negative), social processes (negative), positive emotions (negative), first-person singular pronouns and all pronouns. Extroversion was calculated by summing words connected to sexualization, friends, social processes, and second-person pronouns. Neuroticism was calculated by summing anxiety, negative emotions, and second-person pronouns (negative).

The problem with this method is, that the result does not represent the real values, but only the rankings of the people. This is why the analysis will be done by comparing the highest 1/3 of the review authors with the lowest 1/3 of the review authors on each dimension.

3 RESULTS

3.1 Analysis of Review Presence

The first analysis is for the percentage of the reviews that each group wrote for each genre. If there are differences in the watching patterns of people with different personalities, then this would be reflected in the number of reviews that people write. The people usually only write reviews for the shows that they watched. So if there is a difference in ratios of reviews for different genres, this can be indicative of different watching patterns. The ratio of the reviews was analyzed with chi-square, while the effect size was calculated with ϕ.

Below are presented the results, where the p-value was lower than the threshold corrected with Bonferroni correction (1.136^{-56}). The results are also presented in a table, where for each trait, the average power for statistically significant results is presented, as well as the genre with the highest power among statistical results for both low and high levels of the trait. If there are more than three results, only the three strongest are presented.

Table 1: The summary of power results for review presence

trait	N	average	highest	high trait	low trait
A	11	0.00272	.02019	Slice of Life	Action
E	8	0.00170	.00864	Hentai	Action
N	6	0.00157	.01036	Action	Comedy
C	5	0.00143	.01108	Slice of Life	Action
O	10	0.00239	.01668	Sci-Fi	Shoujo

3.1.1 Agreeableness. People with higher agreeableness wrote more reviews for slice of life $(\chi^2 = 1087, p = .000, \phi = .014)$, comedy $(\chi^2 = 931, p = .000, \phi = .012)$ and music $(\chi^2 = 432, p = .000, \phi = .005)$. On the other hand, people with lower agreeableness wrote more reviews for action $(\chi^2 = 1524, p = .000, \phi = .020)$, horror $(\chi^2 = 623, p = .000, \phi = .008)$ and psychological $(\chi^2 = 473, p = .000, \phi = .006)$.

3.1.2 Extraversion. People with higher extroversion wrote more reviews for hentai $(\chi^2 = 673, p = .000, \phi = .008)$, romance $(\chi^2 = 605, p = .000, \phi = .007)$ and harem $(\chi^2 = 467, p = .000, \phi = .005)$. On the other hand, people with lower extroversion wrote more reviews for action $(\chi^2 = 576, p = .000, \phi = .007)$ and sci-fi $(\chi^2 = 455, p = .000, \phi = .005)$.

3.1.3 Neuroticism. People with higher neuroticism wrote more reviews for action $(\chi^2 = 818, p = .000, \phi = .010)$ and horror $(\chi^2 = 420, p = .000, \phi = .005)$. People with lower levels of neuroticism wrote more reviews for comedy $(\chi^2 = 679, p = .000, \phi = .008)$, slice of life $(\chi^2 = 572, p = .000, \phi = .007)$ and romance $(\chi^2 = 438, p = .000, \phi = .005)$.

3.1.4 Conscientiousness. People with higher level of conscientiousness write more reviews for slice of life $(\chi^2 = 817, p = .000, \phi = .010)$, comedy $(\chi^2 = 348, p = .000, \phi = .004)$ and sports $(\chi^2 = 341, p = .000, \phi = .004)$. While people with lower conscientiousness wrote more reviews for action $(\chi^2 = 837, p = .000, \phi = .011)$ and horror $(\chi^2 = 460, p = .000, \phi = .006)$.

3.1.5 Openness. People with higher level of openness write more reviews for sci-fi $(\chi^2 = 1008, p = .000, \phi = .011)$, action $(\chi^2 = 662, p = .000, \phi = .007)$ and mecha $(\chi^2 = 369, p = .000, \phi = .004)$. People with lower level of openness write more reviews for shoujo $(\chi^2 = 1450, p = .000, \phi = .016)$, romance $(\chi^2 = 1302, p = .000, \phi = .014)$ and school $(\chi^2 = 752, p = .000, \phi = .008)$.

3.2 Analysis of Review Scores

In the next section, the scores of the reviews will be analyzed. For this analysis, only the main score will be used. The analysis will be done with a t-test, and the effect size will be calculated with Cohen d statistics. The results for five genres with the highest effect size are presented below. The results were presented, only if the p was higher than the corrected value mentioned in the previous section. If there were more than 3 results with p-value like that, only the 3 with the highest power were shown.

Table 2: The summary of power results for review scores

trait	N	average	highest	high trait	low trait
A	23	.61509	.86056	Harem	/
E	/	.14158	.34974	/	/
N	28	.71882	.83250	/	Game
C	28	.68101	.88185	Shoujo	/
O	17	.39967	.52882	/	Thriller

3.2.1 Agreeableness. People with higher level of agreeableness rate higher the genres of harem ($t = 31.1, df = 5424, p = .000, d = .860$), shoujo ($t = 29.0, df = 4467, p = .000, d = .851$) and school ($t = 53.1, df = 19349, p = .000, d = .753$). There were no genres, where people with a lower level of agreeableness would rate higher than people with a higher level of agreeableness.

3.2.2 Extroversion. There were no genres, that trait extraversion would be connected with at the corrected p level.

3.2.3 Neuroticism. There were no genres, that people with a higher level of neuroticism would rate higher than people with a lower level of neuroticism. People with lower level of neuroticism rate higher the genres of game ($t = −20.2, df = 2523, p = .000, d = .832$), harem ($t = −29.1, df = 5427, p = .000, d = .798$) and vampire ($t = −16.5, df = 2069, p = .000, d = .778$).

3.2.4 Conscientiousness. People with higher level of conscientiousness rate higher shoujo ($t = 29.1, df = 4345, p = .000, d = .881$), vampire ($t = 17.3, df = 2033, p = .000, d = .814$) and harem ($t = 26.1, df = 5303, p = .000, d = .740$). There were no genres, that people with a lower level of conscientiousness would rate higher than people with a higher level of conscientiousness.

3.2.5 Openness. There are no anime genres, that people with a higher level of openness would rate higher. But there are genres, that people with a lower level of openness would rate higher. Among these are thriller ($t = −16.5, df = 4565, p = .000, d = .528$) superpower ($t = −22.8, df = 8270, p = .000, d = .519$) and shounen ($t = −32.5, df = 19118, p = .000, d = .480$).

4 DISCUSSION

One can see in the results above, that personality is connected with both what the people are watching and how much do they like what they watch. But the statistical power with the former is much smaller than with the later. So this would mean that that personality does show some connections with the people's watching selection and a bit more connection to how much they like the genre.

When it comes to the anime series that people watch, the effect sizes are small. The averages are only approaching the cut-off for the small effect, while the strongest are all, sans extroversion, in the small effect size territory. There seems to be a bit higher for openness and agreeableness. But overall, none of them are big. So there seem to be other explanations for the selection of which show to watch, that would need to be discovered.

On the other hand, the effect sizes for liking the genres based on their personality are bigger. While the extraversion average effect size is approaching the small effect size, the rest are all

above it. With agreeableness, neuroticism, and conscientiousness being in the middle effect size territory. The genres with the highest effect sizes for these traits reach the high effect size territory.

Interestingly, that openness and extroversion have less connection to which genres the person likes compared to the other three traits. I don't know the reason, why this would be so.

Taking the more general picture of the results, there seems to be some possible connection between the groups of genres and personality. The agreeableness seems to be connected to positive social relationships, and negatively connected to conflict and negative emotions. The extraversion seems to be connected with more thrilling and positive genres along with relationship-based genres, while negatively connected to plot-driven genres. Neuroticism is connected to negative themes and conflicts and less connected with positive genres. The conscientiousness was connected to more positive, relationship-based, and supernatural genres. The interesting finding here was that some of the genres they enjoyed, they watched less of. This is unlike the finding for the former three traits. The openness also has this gap. They prefer to watch more ideas and plot-driven genres and less positive genres. But the people with a lower level of this trait seems to enjoy the genres with conflict and competition more.

The general results are more or less in line with what would be expected based on personality theory. Agreeableness' connection to empathy, extraversion's connection to positive emotions and sensation seeking, neuroticism's connection to negative emotions, and openness' connection to the creativity can explain a lot of the group genre preferences described above. Just conscientiousness does not have a very easy explanation for it.

There are a couple of things that I could do to improve the study. One of them is shown in the one-sidedness of the results for linking the different genres of the anime. While looking at all results, there are some results for low and high levels of traits, the results are still very biased in one direction. So agreeableness and conscientiousness are positively connected to liking most genres, just as openness and neuroticism are negatively connected to liking most genres. One interpretation of the results would be, that people that are higher on agreeableness and conscientiousness and lower on openness and neuroticism prefer anime. The other possible explanation, that I did not test, would be that different personalities are connected to different actions on the internet. In one study, the agreeableness and extroversion were connected with more frequent positive writing, conscientiousness with less frequent negative writing, and neuroticism and extroversion with more frequent negative writing [5]. And additional studies should try to separate the effect of personality on writing from the results.

This also leads to the second improvement. The results should be triangulated with data from different sources or, even better, with a different method. The users of one internet site are not always representative of even the whole sub-community on the internet. For example, some studies show, that websites people visit are correlated with personality [8]. So the caution should be exercised in trying to generalize the results.

The third way to improve this study would be to use multiple ways to measure personality. In this study, the correlation between LIWC categories and personality traits found in an unrelated study was used. But the correlations might not be the same if the study would be done on this dataset, so the results could be biased because of this. Confirming the personality of

a subset with questionnaires or using multiple methods would allow for a greater show of confidence in the results.

In conclusion, the personality seems to have a mostly predictable connection what people watch and how much they like it. With a stronger connection to the linking than general watching patterns.

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A   ONLINE RESOURCES

The files with all statistical results and the code that I used can be found on https://sarajaksa.eu/IS2020.

Zaznavanje lastnosti zdravil brez recepta

Perception of OTC medicine attributes

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POVZETEK

Pri zdravljenju ima pomembno vlogo jemanje zdravil brez recepta. Pacienti lahko dobijo informacije o teh zdravilih iz več virov. Poleg nasvetov strokovnjakov s področja zdravja je na razpolago tudi več pisnih virov. Razumevanje informacij o zdravilih vpliva na odločanje in vedenje pacientov in posredno na rezultate medikamentoznega zdravljenja. Raziskovali smo zaznavanje pomembnosti lastnosti zdravil brez recepta, ki so del uradnih dokumentov. Posamezne lastnosti smo sistematično združili v več skupin. V sedanjem razširjenem povzetku smo se osredotočili na zaznavanje učinkovitosti in možnih neželenih učinkov zdravil brez recepta. Za analizo podatkov smo uporabili »conjoint« metodo. V vprašalniku so respondenti z odgovori na vprašanja izrazili preference do posameznih lastnosti. Potrdili smo, da pacienti skupini lastnosti, ki opisuje tveganja, posebej resnejša, pripisujejo primerjalno večjo pomembnost kot skupini lastnosti z opisom prednosti zdravil brez recepta. Pripisovanje pomembnosti je del procesa odločanja, ki vodi v nakupno vedenje. Osnovni namen raziskave je določitev relativne pomembnosti, ki jih respondenti pripisujejo posameznim lastnostim oziroma skupinam lastnosti zdravil brez recepta. Na osnovi ugotovitev, katerim lastnostim pacienti pripisujejo prednost oziroma pomembnost, lahko strokovnjaki s področja zdravja z njimi bolj učinkovito komunicirajo. V več znanstvenih delih so opisane teorije, ki poudarjajo pretežno racionalno ali pretežno emocionalno odločanje pacientov. Odziv na tveganja je opisan kot emocionalen. Čeprav smo v raziskavi ugotavljali pripisano pomembnost tveganj in drugih lastnosti zdravil brez recepta, pa je potrebno nadaljnje raziskovanje, da bi potrdili odziv nanje kot racionalen ali emocionalen.

KLJUČNE BESEDE

Zdravila brez recepta, lastnosti, preference, pripisovanje pomembnosti, učinkovitost, tveganja

ABSTRACT

Taking OTC medicines has an important role in the treatment. Patients can obtain the OTC medicines' information from several sources. Besides the health experts' advices also several written sources are available. Comprehension of medicine information affects decision-making and patients' behavior and indirectly influences the results of the treatment with the medicines. We researched a perception of the importance related to the OTC medicine attributes, included in the official documents. Individual attributes were systematized into several groups. In the present extended abstract a focus is given to the perception of efficacy and possible side effects of the OTC medicines. A conjoint method was used for analyzing the data. The responders expressed the preferences toward individual attributes, by answering the questions in the questionnaire. It was confirmed that patients ascribe a higher importance to the attributes' group, encompassing the risks, especially the serious ones, in comparison with the group of attributes which describes the advantages of the OTC medicines. Ascribing an importance is a part of making decisions, leading to the consumer behavior. The main purpose of the research study is determining of the importance, assigned to the individual attributes and the groups of the attributes of the OTC medicines. On he basis of the findings regarding the attributes to which the preferences and the importance are assigned, more efficient communication between the healthcare experts and the patients is enabled. Several scientific publications describe the theories which emphasize mainly rational or mainly emotional decision-making by the patients. The response to the risk is described as an emotional one. Although an assigned importance of the risks and other attributes of the OTC medicines were determined, an additional research is needed in order to confirm the related response as a rational or an emotional one.

KEYWORDS

OTC medicines, attributes, preferences, ascribing an importance, efficacy, risks

1 UVOD

Zdravila brez recepta so pomemben del zdravljenja pacientov. Odločitev za nakup teh zdravil lahko temelji na nasvetu strokovnjakov, na primer zdravnika ali farmacevta v lekarni. Informacije o zdravilu brez recepta pacient lahko pridobiva tudi iz različnih pisnih virov. Poleg uradnih, odobrenih pisnih virov so razpoložljivi različna promocijska gradiva, s katerimi proizvajalci nameravajo vplivati na odločanje in nakupno vedenje pacientov. Za razliko od zdravil, ki se predpisujejo na recept, je dovoljena promocija oziroma oglaševanje zdravil brez

recepta splošni javnosti, ob upoštevanju zakonskih določil. Oglaševanje zdravil brez recepta pa mora biti skladno z določili Pravilnika o oglaševanju zdravil [1]. Pravilnik določa, kateri podatki o zdravilu brez recepta morajo biti zajeti v oglaševalskem sporočilu in katerih informacij sporočilo ne sme zajemati.

Pomembni uradni dokumenti, ki spremljajo zdravila brez recepta, na primer navodilo za uporabo zdravila in ovojnina zdravil, so v Sloveniji regulatorno urejeni. Vprašljivo pa je, ali je nadzor promocije zdravil brez recepta zagotovljen v zadostni meri, da nima negativnega vpliva na odločanje in vedenje pacientov, z verjetnim vplivom na rezultate zdravljenja. Ustrezno jemanje zdravil brez recepta je bistveno za doseganje pričakovanih rezultatov medikamentoznega zdravljenja. Zdravila, ki se ne predpisujejo na recept, imajo prav tako kot zdravila na recept pogosto močne učinke, pa tudi možne neželene učinke. Določene učinkovine v zdravilih brez recepta medsebojno učinkujejo z učinkovinami z zdravili na recept, ki jih pacienti sočasno jemljejo, pa tudi drugimi snovmi. Raziskovalci [2] so pokazali, da trditve o učinkovitosti niso v ravnotežju s trditvami o tveganjih v promocijskih materialih, ki opisujejo značilnosti zdravil brez recepta. Ustrezno ravnotežje trditev pa je pomembno za razumevanje in odločanje pacientov. Dobro razumevanje informacij o zdravilih vodi v pravilno jemanje in ravnanje z zdravili. Posebej na področju zdravil brez recepta odločanje pacientov in njihovo razumevanje informacij še ni dovolj raziskano.

V opisani raziskavi nas je posebej zanimal vidik zaznavanja pomembnosti posameznih lastnosti, ki se pojavljajo v uradnih dokumentih o zdravilih brez recepta. Medtem ko se z običajnimi raziskavami o ocenjevanju izdelkov ovrednoti celoten izdelek, pa smo v tej raziskavi ugotavljali pripisano pomembnost določenih lastnosti. To je bistveno tudi s praktičnega vidika komuniciranja strokovnjakov s področja zdravja s pacienti. Če se ugotovi primerjalno velika pripisana pomembnost neželenih učinkov zdravil brez recepta, je koristno, da strokovnjaki naslavljajo te lastnosti tekom svetovanja pacientom, prav tako pa v pisnih gradivih.

Pregled literature kaže več objavljenih znanstvenih prispevkov, ki pa se razlikujejo glede na to, ali poudarjajo vlogo razuma ali čustev pri odločanju. Proces odločanja je zapleten in natančnejšo povezavo zaznavanja lastnosti z emocionalnega oziroma racionalnega vidika bi lahko ugotavljali tekom nadaljnjega raziskovanja. Joffe (2003) pa v objavljenem delu (3) poroča o čustveni vsebini odziva na tveganja, vključno z zdravstvenimi tveganji.

Osnovni raziskovalni problem je bil, da zaznavanje posameznih lastnosti zdravil brez recepta ni dovolj raziskano, čeprav vpliva na vedenje pacientov in lahko posredno vpliva na izide zdravljenja. Rezultati ugotovitev lahko pripomorejo pri komuniciranju strokovnjakov s področja zdravja s splošno javnostjo. Zavedanje o čustvenih in racionalnih vidikih zaznavanja lastnosti zdravil in poznavanje pripisane pomembnosti posameznih lastnosti zdravil brez recepta bi pripomoglo k učinkovitemu komuniciranja in posredno k uspešnosti zdravljenja.

Hipoteza: Neželenim učinkom zdravil brez recepta se pripisuje večja relativna pomembnost kot prednostim zdravil. Resnejši neželeni učinki se v primerjavi z drugimi neželenimi učinki zaznavajo kot bolj tvegani.

2 RACIONALNE IN EMOCIONALNE TEORIJE O ODLOČITVAH GLEDE ZDRAVLJENJA

Medtem ko nekatere objavljene teorije pripisujejo bistveno vlogo racionalnemu vedenju, pa druge teorije poudarjajo pomen emocionalnega vedenja. Sprva so se v večji meri uveljavljale teorije, ki so poudarjale racionalno vedenje. Kasneje so raziskovalci spoznavali pomen čustev pri zaznavanju lastnosti izdelkov, razvoj znanstvenih metod pa je omogočil tudi boljše spremljanje odziva organizma na lastnosti izdelka.

Raziskovalci [4] so ugotovili, da čustveni odzivi lahko povzročijo vedenje oseb, ki ne vodi v njihovo dobrobit. Avtorji trdijo, da se zaradi vpliva čustev zaznavanje tveganja ne sklada z racionalnimi, na znanstvenih ugotovitvah temelječimi analizami. Zaradi čustvene obdelave informacij osebe zaznavajo negativne strani kot bolj pomembne od prednosti. V raziskavi [4] je tudi opisano, da vedenje pod vplivom čustev povzroči slabše predvidevanje prihodnjih preferenc ter neustrezno oceno preteklih izkušenj in dejanskega tveganja.

Večina teorij torej odločanje opredeljuje s kognitivnega vidika. Avtorji teh teorij razlagajo, da odločitve temeljijo na ocenah prihodnjih izidov različnih možnosti, s pomočjo vrste analiz, kjer se tehtajo stroški in koristi. Določene teorije upoštevajo čustva, a le kot posledico neke odločitve in je ne povezujejo neposredno z odločitvijo. Vendar pa avtorji teorije, ki temelji tudi na fizioloških meritvah, čustvom pripisujejo večjo težo [5]. Osebe se odločajo ne le z ocenjevanjem resnosti izidov in verjetnosti njihovega pojava, ampak predvsem zaradi njihove čustvene vrednosti.

V raziskavi [6] so ugotavljali, kako osebe zaznavajo vsebino sporočila. Ko pacienti zdravljenje zaznavajo kot tvegano, so sporočila s poudarjenim vplivom tveganj bolj učinkovita. Ko pa neko zdravstveno obravnavo osebe zaznavajo kot varno, so sporočila s poudarjenimi prednostmi bolj učinkovita, saj osebe prednost namenijo pozitivnim informacijam, pred informacijam o tveganjih.

Raziskovalci [7] so preučevali sposobnost za odločanje (*decision-making capacity or competence, DMC*). Izhajali so iz že objavljenih ugotovitev ki sta jih zapisala Grisso in Applebaum [8] pri opredelitvi štirih poglavitnih dejavnikov. Razumevanje pomeni sposobnost dojemanja z zdravljenjem povezanih informacij. Ocenjevanje je povezano s sposobnostjo razpoznavanja posledic bolezni in koristi zdravljenja. Presojanje pomeni sposobnost racionalne obdelave informacij, tudi pri primerjavi tveganj in koristi zdravljenja. Dokazovanje pa se povezuje s sposobnostjo za komuniciranje. Hermann idr. [7] pa so poudarili tudi pomen čustev in vrednote v procesu odločanja o zdravju.

Hermann idr. [7] so prikazali drugačen vidik vloge čustev, posebej bolj intenzivnega čustvenega odziva oziroma neustrezne čustvene reakcije. Raziskovalci soglašajo s trditvijo, da je pri odločanju prevladujoč proces čustvovanja. Posamezniki morajo upoštevati čustva, jih priznavati kot pomembne informacije, jih povezovati s preteklimi izkušnjami in opredeliti, ali bo vedenje na osnovi takih izkušenj v prihodnje omogočalo dobro počutje. Če pa je čustven odziv intenziven, se zmanjša zmožnost za razumevanje in posvetovanje. Sposobnost za odločanje je povezano s primerno

stopnjo vključitve čustev. Pomanjkanje ali presežek čustev pa predstavlja težavo.

Raziskovalci upoštevajo različne nevrološke mehanizme v organizmu, ki vplivajo na čustvene oziroma racionalne procese ter sodelujejo pri odločanju o zdravju oziroma zdravilih. Prav tako pripisujejo različen pomen in vpliv racionalnih oziroma emocionalnih procesov na odločanje. Iz določenih raziskav [3, 4] je razvidno, da se odločanje o tveganjih v večji meri povezuje z emocionalnimi procesi.

3 ZASNOVA IN METODA RAZISKAVE O ZAZNAVANJU LASTNOSTI ZDRAVIL BREZ RECEPTA

3.1 Izhodišča

Odločanje pacientov o medikamentoznem zdravljenju je področje, ki je še premalo raziskano. Ne le pravilna struktura besedila o zdravju in zdravilih, ampak tudi ustrezno razumevanje teh informacij pomembno prispeva k pričakovanim rezultatom zdravljenja.

V tej raziskavi smo preučevali preference respondentov o lastnostih zdravil brez recepta. Skupine lastnosti so bile povezane s prednostmi zdravila, neželenimi učinki in ceno zdravil. Določili smo, katerim lastnostim so respondenti pripisali največjo pomembnost – učinkovitosti, komplianci, neželenim učinkom oziroma ceni.

3.2 Conjoint analiza

Conjoint analiza je sodobna metoda z zanesljivimi rezultati. S conjoint analizo raziskovalci ugotavljajo odločanje respondentov. V vprašalniku so navedeni različni scenariji, na osnovi katerih respondenti tehtajo med posameznimi nivoji lastnosti glede na preference. Respondenti z odgovori ovrednotijo različne značilnosti oziroma lastnosti izdelka po pripisani pomembnosti. V vedno večji meri se ta metoda uporablja na področju raziskovanja informacij o zdravilih. Conjoint analiza je vrsta evalvacije, pri kateri se uporablja vprašalnik, da bi določili tehtanje med lastnostmi in nivoji lastnosti in ugotovili preference pacientov za določene izdelke oziroma lastnosti izdelkov [9]. Tekom odgovarjanja na vprašanja se respondentu prikažejo različne kombinacije vprašanj z lastnostmi, med katerimi izbira. Računalniška obdelava podatkov omogoča določitev preferenc in določitev zaznane pomembnosti lastnosti izdelka.

3.3 Izvedba raziskave

V raziskavo je bilo vključenih 85 respondentov. 68 žensk in 17 moških. Starostna struktura respondentov kaže, da je bilo 40,0 % respondentov mlajših od 30 let, 38,8 % starejših od 50 let, 21,2 % oseb pa je imelo med 30 in 50 let.

Izbrali smo navodili za uporabo dveh zdravil brez recepta, ki sta na slovenskem tržišču. Navodila za uporabo zdravil brez recepta so uradni dokument, ki jih odobri JAZMP (Javna agencija Republike Slovenije za zdravila in medicinske pripomočke). Učinkovina v enem izmed zdravil je paracetamol. Zdravilo se uporablja za lajšanje bolečine in znižanje povišane telesne temperature, ki sta simptoma bakterijskega ali virusnega obolenja ali drugih bolezni. Drugo zdravilo brez recepta pa vsebuje tri učinkovine, to so paracetamol, psevdoefedrinijev hidroklorid in dekstrometorfan hidrobromid. To zdravilo ima širše indikacijsko območje od prvega, poleg znižanja povišane telesne in lajšanja bolečin izboljša simptomov bakterijske ali virusne infekcije v nosu ter za olajša kašelj.

V navodilih za uporabo smo kodirali trditve, ki smo jih umestili v tri skupine lastnosti. Skupina lastnosti, ki opisuje učinkovitost zdravljenja. zajema tri nivoje lastnosti in sicer olajšanje bolečine, lajšanje dihanja in zamašenega nosu ter lajšanje kašlja. Druga skupina lastnosti prav tako zajema prednosti zdravljenja, poleg znižanja povišane telesne temperature tudi dve lastnosti, ki sta povezani s komplianco zdravil: zdravila se zlahka zaužijejo in enkrat dnevno odmerjanje. V skupini lastnosti, ki zajema možne neželene učinke, je prva lastnost izpuščaj, srbenje in omotičnost. Druga lastnost so težave s srcem, tretja pa težave z dihanjem. Naslednja skupina lastnosti vključuje tri nivoje cene, ki temeljijo na realnih cenah izbranih zdravil.

4 POGLAVITNI REZULTATI RAZISKAVE

Z analizo smo dobili več rezultatov. S pomočjo računalniškega programa smo določili pogostnost izbire posameznih lastnosti in pomembnost, ki so jo respondenti pripisali lastnostim oziroma skupinam lastnosti.

4.1 Izbira lastnosti

Sprva smo določili delež izbire posamezne lastnosti s strani respondentov. V skupini z učinkovitostjo zdravila brez recepta so respondenti v povprečju največkrat (v 22 %) izbrali olajšanje bolečine in lajšanje dihanje pri zamašenem nosu [10]. To pomeni, da so izmed vseh prikazov tega nivoja lastnosti respondenti ti dve lastnosti izbrali v 22 % primerov. V manjši meri so respondenti izbrali olajšanje kašlja. V drugi skupini lastnosti je bila lastnost, ki opisuje znižanje povišane telesne temperature, izbrana v 25 % primerov, kar je presegalo izbiro lastnosti, ki so se povezovale s komplianco. Hi-kvadrat statistična analiza je pokazala, da je razlika med posameznimi lastnostmi v prvi in drugi skupini lastnosti signifikantna.

V skupini lastnosti z možnimi neželenimi učinki je bila lastnost, ki opisuje izpuščaj, srbečico in omotičnost, izbrana v 35 % in so jo v povprečju torej respondenti zaznali kot manj tvegano kot težave z dihanjem, ki so jih respondenti izbrali v 17 % in težave s srcem, ki so jih respondenti izbrali le v 7 %. Razlika med izbirami posameznih lastnosti v tej skupini je bila prav tako statistično pomembna. V četrti skupini s ceno kot lastnostjo je bila pričakovano največkrat izbrana najnižja cena (4,5 EUR), v 22 %. V manjšem deležu (20 %) je bila izbrana cena 6,5 EUR, v najmanjšem deležu (18 %) pa je bila izbrana cena 8,5 EUR.

4.2 Zaznana pomembnost lastnosti

Ugotavljali smo tudi pomembnost, ki so jo respondenti pripisali posameznim skupinam lastnosti. Primerjalno največjo pomembnost so respondenti pripisali skupini lastnosti o možnih neželenih učinkih, ki je po pomembnosti presegala pripisano

pomembnost obeh skupin lastnosti, povezanih s prednostmi zdravila, torej učinkovitosti in komplianci zdravil. Primerjalno najmanjšo pomembnost so respondenti pripisali ceni.

Tabela 1: Povprečna pripisana pomembnost skupin lastnosti

Št. skupine lastnosti	Skupina lastnosti	Pripisana pomembnost lastnosti (%)
1	Prednost: učinkovitost zdravila	14,61
2	Prednost: komplianca, učinkovitost	17,12
3	Možni neželeni učinki	59,05
4	Cena	9,22
Skupaj		100,0

V raziskavi smo pridobili in analizirali še druge rezultate, ki bodo predvidoma v prihodnje objavljeni. Poleg navedenih lastnosti smo ugotavljali tudi preference z ozirom na posamezne blagovne znamke oziroma lastniška imena zdravil brez recepta, tudi na večjem vzorcu respondentov.

5 RAZPRAVA IN ZAKLJUČEK

Izhajali smo iz trditve, da neželenim učinkom respondenti pripisujejo večjo pomembnost kot učinkovitosti, Kot posebej tvegani se zaznavajo resni neželeni učinki. Rezultati raziskave postavljeni hipotezi pritrjujejo. Predvidevali smo, da bodo ceni respondenti pripisali večjo pomembnost, kar pa rezultati raziskave [10] niso potrdili.

V sorodni raziskavi [11] so raziskovali preference o lastnostih zdravil brez recepta, predvsem za lajšanje bolečin. Ugotovili so, da sta cena in blagovna znamka najpomembnejši lastnosti pri izbiri zdravila brez recepta. Ti rezultati se ne skladajo z našimi rezultati, kjer ceni respondenti niso pripisovali velike pomembnosti. Vendar so Halme idr. [11] ugotovili razlike med respondenti glede njihovih preferenc za lastnosti zdravil brez recepta in jih na osnovi tega razvrstili v pet skupin. Glede na to razvrstitev so določili, katera skupina respondentov ceni pripisuje večjo pomembnost. V skupine so respondente razvrstili glede na to, ali upoštevajo predvsem učinkovitost, primerjalno nižjo ceno, blagovno znamko, ali pa uravnotežene lastnosti; slednji skupini respondentov so raziskovalci pripisali racionalno odločanje. V peto skupino so raziskovalci uvrstili respondente, ki v veliki meri upoštevajo nasvet strokovnjaka, zdravnika ali farmacevta.

V isti raziskavi [11] so avtorji ugotovili večjo pripisano pomembnost lastnosti, ki se navezujejo na učinkovitost zdravil brez recepta (25 %) kot pri naši raziskavi, kjer je bila nekoliko manjša kot 15 %. Vendar pa se je izbor lastnosti med raziskavama razlikoval.

Guo idr. [12] so raziskovali preference in pripisano pomembnost izbranih lastnosti zdravil in ugotovili, da osebe niso naklonjene neželenim učinkom, kar posebej velja za resnejše neželene učinke. Ti rezultati se skladajo z rezultati naše raziskave

Osnovna ugotovitev naše raziskave je, da je bila skupini lastnosti, ki se povezujejo z neželenimi učinki, pripisana večja pomembnost kot skupini lastnosti, ki opisujejo prednosti zdravil brez recepta, to je učinkovitost in dobro komplianco teh zdravil. Kot posebej tvegane so respondenti zaznavali resnejše neželene učinke. Ceni zdravil pa, nasprotno s pričakovanji, respondenti niso pripisali velike pomembnosti, morda tudi zaradi razmeroma majhne razlike med cenovnimi nivoji in razmeroma majhnega stroška.

Na osnovi rezultatov naše raziskave zaključujemo, da bi bilo v ustni in pisni komunikaciji s pacienti koristno naslavljati neželene učinke zdravil brez recepta in ovrednotiti in racionalizirati njihovo dejansko tveganje, posebej glede na prednosti jemanja zdravil brez recepta.

Ne glede na objavljene teorije o prevladujočem racionalnem ali emocionalnem odločanju velja, da na odločanje vplivajo racionalni in emocionalni mehanizmi. Natančnejša določitev emocionalnega ali racionalnega vidika pripisane pomembnosti lastnosti pa bi bila izvedljiva tekom nadaljnjega raziskovanja. V tej fazi raziskovanja le predvidevamo, da se možna tveganja zaradi jemanja zdravil brez recepta v večji meri povezujejo z vplivom čustev, tudi na osnovi ugotovitev predhodnega raziskovanja [3, 4]. Odločanje pa je celovit proces, na katerega učinkuje več dejavnikov in koristilo bi nadaljnje raziskovanje.

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Kognitivno–motivacijski model čustvovanja v vsakdanjem življenju

Cognitive–motivational Model of Emotions in Everyday's Life

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POVZETEK

V prispevku se ukvarjamo z vprašanjema, kaj so čustva in kakšna je vloga čustev pri našem vsakdanjem funkcioniranju. Pri tem nas zanima, katere psihološke entitete sodelujejo pri čustvovanju in pripomorejo k učinkovitemu in pozitivnemu delovanju. Postavimo hipotetični kognitivno–motivacijski model čustvovanja v vsakdanjem življenju, ki predstavlja podlago za empirično raziskovanje tistih vidikov čustvovanja, ki pripomorejo k pozitivnemu vsakdanjemu delovanju.

KLJUČNE BESEDE

Čustva, kognicija, motivacija, cilj, hipotetični model.

ABSTRACT

In this article, we deal with the question of what emotions are and what the role of emotions is in our daily activities. In doing so, we are interested in which psychological entities are involved in our emotions and contribute to effective and positive functioning. We set up a hypothetical cognitive–motivational model of emotion in everyday life, which represents the basis for empirical research of those aspects of emotion that contribute to positive everyday functioning.

KEYWORDS

Emotions, cognition, motivation, goal, hypothetical model

1 UVOD

V literaturi obstajajo številne opredelitve čustev. Kompleksnost njihovega definiranja ponazarjajo najrazličnejši poskusi kategoriziranja različnih opredelitev, med katerimi naj omenimo le poskus Paula R. Kleininna in Anne M. Kleininna [1], v katerem sta avtorja zbrala več kot 100 različnih definicij čustev in jih klasificirala v 6 kategorij. To so definicije, ki poudarjajo: fiziološke vidike čustev, motivacijo in vedenje, funkcije čustev, razlikovanje med drugimi pojavi čustvovanja, kot npr. razpoloženje, preference, strast oz. hrepenenje, afekt itd., psihopatološke oblike čustvovanja ter različne klasifikacije, kot so npr. pozitivne nasproti negativnim čustvom, ciljno skladne nasproti ciljno neskladnim ipd.

Plutchik [2] opozarja, da je zmeda na področju definiranja čustev posledica več dejavnikov. Prvi je v močni prevladi behaviorizma, ki je dominiral tja do 60. let prejšnjega stoletja in čustva niso bila predmet obravnave. Drugi je v psihoanalizi, ki je pokazala, da subjektivni opisi čustev niso nujno relevantni oz. da to, kar človek opisuje, da doživlja, ni nujno res. Nekatera čustva so potlačena, druga modificirana in vprašanje je, kaj je pravo čustvo, ki ga posameznik doživlja. Tretji dejavnik je v besednjaku, kako opredeliti oz. s katerimi besedami opisati ustrezna čustva. Različne študije so poskušale prebroditi to vrzel s ti. vpeljavo »sodnikov«, največkrat študentov, ki so iskali najrazličnejše besede za opisovanje določenih čustev in skušali oblikovati nekakšen slovar čustev. Nobena klasifikacija se ni izkazala za bolj objektivno od druge. Četrti razlog je v različnih teoretskih pristopih, ki so se oblikovali skozi zgodovino psihologije, peti pa v nas samih, ki smo se s pomočjo vzgoje in težnje k prilagajanju okolju naučili potvarjati svoja čustva. Čeprav smo npr. žalostni, si v družbi »nadenemo« nasmeh, čeprav smo na nekoga jezni, zaradi neprimernosti izražanja jeze tej osebi, tega čustva ne izrazimo itd. [2].

Čustva opredelimo kot duševne procese in stanja, ki izražajo človekov vrednostni odnos do zunanjega sveta ali do samega sebe [3]. Posameznik spozna osebe, dogodke in situacije ter jih s čustvi ovrednoti, tako da jim subjektivno določi njihovo vrednost [3]. Čustva so torej kratkotrajni subjektivni, duševni, funkcionalni in ekspresivni pojavi, ki usmerjajo naše vedenje v smeri prilagajanja ali neprilagajanja danim okoliščinam [3, 4]. To pomeni, da so čustva evalvacije in se pojavljajo ob objektih, ki so za posameznika pomembni [4]. Funkcionalno imajo čustva adaptacijsko funkcijo, kar pomeni, da omogočajo učinkovito prilagajanje okolju, delujejo kot motivi, saj nas usmerjajo k objektom in situacijam, ki sprožajo pozitivna čustva, pomembno vlogo pa imajo tudi pri komunikaciji in uravnavanju socialnih odnosov [3].

Tudi na področju motivacije je razlag veliko, vendar se skladajo v opredelitvi, da je motivacija: občutena napetost, ki je usmerjena k ali proti nekemu cilju; notranji proces, ki vpliva na smer, vztrajnost in intenzivnost k cilju usmerjenega vedenja; specifična potreba, želja ali hotenje, ki spodbudi k cilju usmerjeno vedenje [5]. Motivacija je torej psihološki proces, ki spodbuja in usmerja naše vedenje [6].

Kognicija je izraz, ki se je v psihologiji pojavil razmeroma pozno, in sicer v 50. letih prejšnjega stoletja [7]. V nadaljnjih desetletjih pa je raziskovanje kognicije dobilo naslutene razsežnosti, še zlasti s pomočjo spoznanj iz nevropsihologije, kar so omogočile tudi kompleksne nevropsihološke tehnologije [4]. Kognitivni procesi so psihološki procesi, ki nam omogočajo odnos z okoljem, z njimi sprejemamo in predelujemo informacije, ki jih pridobimo s pomočjo različnih izvorov, kot npr. z zaznavo, izkušnjami, prepričanji ipd., nato pa jih pretvorimo v znanje. Kognitivni procesi so: občutenje, zaznavanje, učenje, spomin, mišljenje, jezik, govor in zavest [4].

V prispevku nas zanimata vlogi motivacije in kognicije pri našem čustvovanju. Pri tem izhajamo iz Reevovega [8] razumevanja povezanosti med čustvi, kognicijo in motivacijo, ki čustva in kognicijo razlaga kot sestavna člena motivacije, v čustvih samih pa vidi indikator prilagojenosti vedenja. Veselje npr. kaže na socialno vključenost in težnjo po doseganju ciljev, žalost pa, nasprotno, napotuje na socialno izolacijo in odmik od ciljev. Pozitivna čustva odsevajo angažiranost in zadovoljstvo z našim delovanjem in motivacijskimi stanji, negativna pa opustitev in frustracijo v zvezi z našim delovanjem in motivacijskimi stanji. Pozitivna čustva odsevajo našo uspešno prilagojenost danim okoliščinam, negativna pa kažejo, da se nanje nismo znali učinkovito prilagoditi. S te perspektive čustva nimajo enakega statusa v motivaciji kot potrebe in kognicije, ampak odločajo o tem, ali bo nek motiv sploh zadovoljen ali ne [8]. Pozitivna čustva torej spodbujajo zadovoljitev motiva, negativna pa ga preprečujejo.

2 KOGNITIVNE IN MOTIVACIJSKE RAZSEŽNOSTI ČUSTEV

Pri razlagi kognitivnih vidikov čustev nam je v pomoč ena od vodilnih kognitivnih teorij čustev ameriškega psihologa Richarda Lazarusa [9], ki predpostavlja dvoje:
a) čustva nastanejo kot posledica kognitivne ocene dražljaja oz. situacije
b) mediator med dražljajem in nastankom čustva je nezavedna avtomatična ocena

Lazarus [9] razlikuje med znanjem in oceno. Znanje naj bi bilo pogoj za oceno, saj ocena vedno vključuje subjektivno doživljanje in pomeni osebno mnenje, ki je osnovano na ustreznem znanju. Znanje je torej nujen, a ne zadosten pogoj za nastanek čustva. Ocena je lahko nezavedna ali zavestna, a svojo teorijo gradi iz pomena zavestne ocene. Ocena je torej kognicija, na osnovi katere nastanejo čustva. Vsaka taka ocena je subjektivna in hevristična. Brez kognicije ni čustva. Smith in Lazarus [10] prepoznavata dva tipa kognitivnih procesov, ki so povezani z nastajanjem čustev
a) procesi primarne ocene in
b) procesi sekundarne ocene

Procesi primarne ocene so tisti, s pomočjo katerih vrednotimo naravo situacije, v katero smo vključeni, pri čemer je ocena situacije vedno anticipirana v oceni cilja. Procesi primarne ocene so trije:
- motivacijski pomen cilja
- motivacijska skladnost s ciljem
- samovključenost ali motivacija za oceno

Motivacijski pomen in motivacijska skladnost sta po Lazarusu [9] primarni oceni, ki sta predstavljata temelj za razvoj visokega psihičnega blagostanja, ki se kaže v tretjem primarnem procesu ocene, to je v lastnem angažmaju za dosego cilja. Motivacijski pomen je stopnja pomembnosti situacije za posameznika glede na osebne cilje, motivacijska skladnost se nanaša na to, ali je situacija taka, da spodbuja ali zavira doseganje osebnih ciljev. Če je situacija konstruirana kot motivacijsko pomembna, bo ocena situacije kot motivacijsko skladne ali neskladne determinirala celotno valenco čustvene izkušnje [9].

Če je primarna ocena podlaga za nastanek valence čustva in torej odloča o tem, ali bosta za nas neka situacija in cilj prijetna ali ne, pa procesi sekundarne ocene sodelujejo pri specifični izraznosti čustva, se pravi, odločajo o tem, katero čustvo bomo doživeli in izrazili. Nanašajo se na procese kontrole nad situacijo in iskanje lastnih virov za spoprijemanje z nastalo situacijo, če jo ocenimo kot pomembno. Gre za štiri sekundarne ocene: samoodgovornost, osredotočenost na 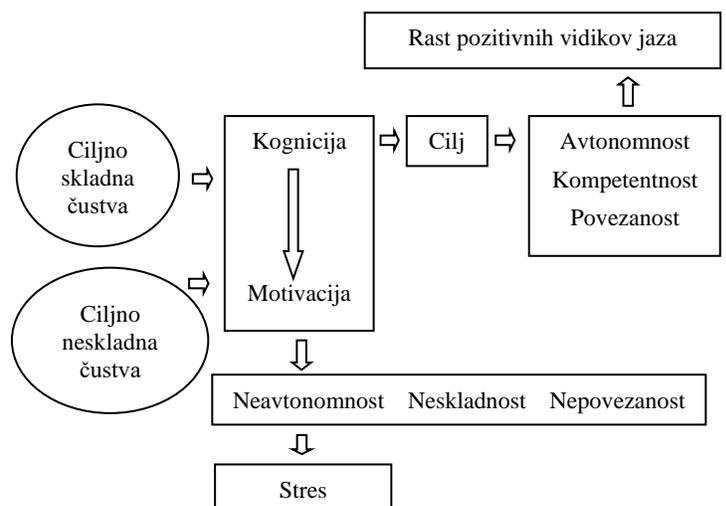problem, osredotočenost na čustva in pričakovanje. Pri samoodgovornosti ocenjujemo, koliko smo sami odgovorni za nastalo situacijo, pri osredotočenosti na problem ocenjujemo, koliko lahko dano situacijo izboljšamo, ko smo osredotočeni na čustva, ocenjujemo, koliko se lahko sami prilagodimo na nastalo situacijo, torej ali lahko spremenimo odnos do nastale situacije, pričakovanje pa zajema oceno, ali lahko v prihodnje sami prispevamo k spremembi situacije. Vsakemu čustvu odgovarja specifična sekundarna ocena, ki jo Lazarus [9] metateoretično imenuje ključne teme, povezane z dogodkom Gre za tipične vsakdanje situacije, ki jih ocenjujemo glede na tipične hevristične kognitivne sheme. Vsaka od teh situacij je podvržena najprej primarnim, nato pa še sekundarnim procesom ocene, kar posledično vodi do specifičnega tipičnega čustva. Tako naj bi neugodne situacije odgovarjale ocenam ciljne pomembnosti, a hkrati neskladnosti, ocene razpoložljivosti notranjih virov za spoprijemanje s situacijo pa naj bi bile nizke. In obratno, pozitivne situacije naj bi se skladale z ocenami, ki so ciljno pomembne in skladne, zajemale pa naj bi tudi visoko vrednotenje razpoložljivih notranjih virov oz. spoprijemalnih strategij [9].

Sledi še proces terciarne ocene, ki ga Lazarus [9] imenuje ponovna ocena. Z njo presojamo pomen sekundarne ocene, pri čemer se skušamo psihološko spoprijemati s psihičnim in fizičnim stanjem napetosti zaradi nastale situacije. V ponovni oceni angažiramo vse svoje notranje vire, ki nam pomagajo k blaženju nastale napetosti ali pa celo omogočiti občutek ugodja in pozitivnih čustev [9].

3 HIPOTETIČNI MODEL ČUSTVOVANJA V VSAKDANJEM ŽIVLJENJU

Na osnovi zapisanega postavljamo hipotetični model čustvovanja v vsakdanjem življenju, ki nam pomaga razumeti, katere psihične komponente in kako so vključene v naše vsakdanje funkcioniranje in vodijo do bolj ali manj optimalnega delovanja. Za preverbo tega modela postavljamo naslednjo hipotezo:

H1: Kognitivna skladnost med oceno cilja in oceno situacije ojača ciljno skladna čustva, izpolnjenost temeljnih potreb se zviša, posledica je rast pozitivih vidikov jaza, kognitivna neskladnost med omenjenima ciljema vodi stran od cilja, negativna čustva se ojačajo, izpolnjenost temeljnih potreb se zniža, posledica je stres, lahko pa tudi psihopatologija.

Slika 1: Kognitivno–motivacijski model čustvovanja v vsakdanjem življenju

Lazarus [9] razlikuje čustva glede na skladnost ali neskladnost s cilji: ciljno skladna čustva nas vodijo k cilju, ciljno neskladna pa nas od njega odvračajo, čeprav si ga želimo doseči. Avtorjeva [9] perspektiva se v tej točki močno sklada z različnimi teorijami motivacije, še posebej z motivacijsko teorijo postavljanja ciljev [11], ki opozarja na pomen ciljne motivacije pri našem mišljenju in vedenju. Robert Franken [12] v knjigi *Human motivation* poglobljeno razlaga hedonizem, srečo, upanje, optimizem pripadnost, navezanost in komunost, ki jih umešča med ciljno skladna čustva, ter strah, anksioznost, pesimizem, depresivnost, krivdo in sram, ki sodijo pod ciljno neskladna čustva. S cilji skladna čustva nam pomagajo, da želene cilje dosežemo, naš občutek splošne življenjske kompetentnosti se poveča. Če pa so čustva neskladna s cilji, teh ciljev kljub želji, da bi jih dosegli, ne dosežemo in naš občutek kompetentnosti se zniža.

V modelu predpostavljamo, da čustva omogočajo doseganje ali odvračanje od cilja, pri čemer je bistvena ocena cilja. Če ocenimo, da je cilj za nas pomemben, se bo ojačala motivacija za doseganje cilja. Pri tem se bodo pojavljala čustva, ki so skladna s tem ciljem, se pravi, ki nas vodijo k njegovemu doseganju. To so npr. veselje, ponos, optimizem ipd. Nastalo situacijo bomo doživljali kot prijetno. Naše temeljne potrebe, kot so: potreba po avtonomnosti, potreba po kompetentnosti in potreba po povezanosti [13, 14] bodo v tem primeru zadovoljene in posledično bomo občutili psihično zadovoljstvo in pozitivi vidika jaza se bodo krepili. Potreba po avtonomnosti se kaže v težnji po usmerjanju lastnega vedenja s strani lastnih želja, izbir, ciljev in odločitev. Če je potreba po avtonomnosti zadovoljena, doživljamo naše vedenje in posledice vedenja kot izbire, ki smo jih povzročili sami in nad katerimi drugi nimajo vpliva. Nasprotno pa se nezadovoljenost potrebe po avtonomnosti kaže v nesamostojnosti in odvisnosti pri odločanju ter doživljanju zunanje kontrole nad našim mišljenjem, čustvovanjem in vedenjem [13]. Potreba po kompetentnosti se izraža kot težnja po učinkovitem delovanju na najrazličnejših življenjskih področjih, ki ga realiziramo v skladu s svojimi zmožnostmi in sposobnostmi. Ta potreba je zadovoljena, kadar v svojem okolju uspemo poiskati ustrezne izzive, s pomočjo katerih realiziramo razvoj svojih sposobnosti in učinkovitega funkcioniranja. Če pa izzive ocenjujemo kot preveč enostavne ali preveč zahtevne, se na ravni kompetentnosti ta potreba izkazuje kot nizko zadovoljena ali pa celo nezadovoljena. Potreba po kompetentnosti se povezuje z občutkoma samoučinkovitosti in samozaupanja, kar posledično vodi do visokega samospoštovanja in psihičnega blagostanja [13, 14]. Potreba po povezanosti oz. pripadnosti pa se kaže kot težnja po izražanje naklonjenosti, sprejemanje, zaupanje v druge [13, 14].

V primeru, ko doživljamo s cilji neskladna čustva, ocenimo, da je zastavljeni cilj za nas pomemben, za njegovo dosego smo motivirani, a nam čustva, kot so npr. strah, tesnoba, žalost ipd. preprečujejo, da bi ga dosegli [12]. Tako se od cilja le še bolj oddaljujemo, nastalo situacijo doživljamo kot ogrožujočo, naša s ciljem neskladna čustva se poglabljajo, zadovoljenost temeljnih potreb se odmika in posledica je doživljanje stresa, ki lahko preraste v psihopatološke pojave.

Pri odnosu med ciljno skladnimi in ciljno neskladnimi čustvi se izkaže naslednje: univerzalna čustva so po definiciji tista, ki so nam kot človeški vrsti pomagala k preživetju, pa tudi na individualni ravni nam večkrat služijo temu istemu cilju, se pravi, preživetju, obenem pa z njihovim doživljanjem tvegamo, da cilja ne bomo dosegli [15]. Tako čustvo je npr. strah, ki ga Lazarus [9]umešča pod ciljno neskladna čustva, se pravi tista, ki nas vodijo stran od cilja, obenem pa vemo, da je prav strah tisto univerzalno čustvo, ki nam pomaga, da zbežimo oz. se odstranimo iz nevarne situacije in nam

tako zagotovi preživetje. Kaj pa druga čustva? Za veselje npr. ni nobenega dvoma: kot pozitivno in s ciljem skladno čustvo nas bo usmerjalo k cilju, zato se bomo doživljali kompetentnejše in učinkovitejše. Drugače pa je z jezo in gnusom. Jeza in njen vedenjski korelat agresivnost nista skladna s ciljem, saj nas tako doživljanje kot izražanje jeze vodita stran od želenega cilja [9, 12]. Z jezo in agresivnostjo, ki jo usmerjamo navzven (ali navznoter), tvegamo, da cilja ne bomo dosegli, posledično pa se bomo počutili nekompetentne in nesposobne spoprijemanja s težavami [9, 12]. Pri gnusu pa je bolj kompleksno. Gnus, ki ga doživljamo ob pogledu na npr. pokvarjeno hrano, nam pomaga, da se te hrane niti ne dotaknemo niti je ne pojemo, torej se od cilja odmaknemo, to pa nam omogoči preživetje, naš občutek kompetentnosti pa se poveča [16]. Če pa se nam npr. gnusi dotik osebe z nenalezljivo kožno boleznijo in se tako cilju (osebi) izognemo, tvegamo izgubo morebitnega kakovostnega medosebnega odnosa s to osebo, ki je zaradi kožne bolezni ne pripustimo k sebi, pa čeprav ni nalezljiva [16]. Posledično se naš občutek socialne kompetentnosti zniža, naše nezadovoljstvo s samim seboj pa zviša.

4 ZAKLJUČEK

Predlagani model čustvovanja, ki ga razlagamo z vidika kognitivno-motivacijskih razsežnosti, je hipotetični prikaz gradbenih prvin in njihovega delovanja. Namen modela ni v vključitvi vseh psiholoških razsežnosti, saj je to nemogoče, temveč predvsem tistih, ki prispevajo v smeri rasti pozitivih komponent jaza bodisi v smeri doživljanja stresa in pojavljanja morebitnih psihopatoloških pojavov. V nadaljevanju bo smiselno model tudi empirično preveriti, z namenom ugotoviti psihološke napovednike optimalnega delovanja v vsakdanjem življenju.

OPOMBA AVTORICE

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Motor learning and cortical plasticity: TMS motor mapping using the pseudorandom walk method

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ABSTRACT

Motor recovery after stroke relies on the ability of the primary motor cortex (M1) to functionally reorganize and adapt the existing muscle synergies. M1 reorganization can be measured by mapping the cortical muscle representations using transcranial magnetic stimulation (TMS). A recently developed mapping technique, the pseudorandom walk method, significantly reduces time needed to perform TMS mapping without sacrificing the reliability of the measurements. Due to this faster technique, it is now possible to map several muscles at once, which was not viable before with the traditional mapping method. Furthermore, motor mapping of the proximal Medial Deltoid (MD) and the distal Brachioradialis (BR) muscle using this technique has not yet been performed. Therefore, the aim of this study is to investigate the use of pseudorandom walk method to measure the training-induced plasticity of the M1 while taking these two muscles into account. First, we will perform the baseline TMS motor mapping. Second, the participants will go through a six-week training period in a complex motor learning task performed with their non-dominant hand. After this training period, we will determine the training-induced plasticity by comparing the baseline and the post-training measurements. A control group will be included to control for the reliability of the measurements. Further, we will determine the training-induced change in the muscle synergies by comparing the overlap in cortical muscle representations. Finally, we will explore the training effect on the non-trained dominant hemisphere. We hypothesize to observe a training-induced change in the motor maps and an increase in the overlap between the two muscle representations in the training group. Based on the intermanual transfer we expect to find a training-induced effect on the dominant hemisphere.

KEYWORDS

Motor learning, plasticity, transcranial magnetic stimulation, pseudorandom walk, primary motor cortex

1 INTRODUCTION

One of the most common impairments after stroke is hemiparesis - weakness of one entire side of the body [1]. Patients' recovery relies on the motor system's capacity for functional reorganization [2]. A better understanding of the primary motor cortical (M1) reorganization and its' influence on the coordinated multiple joint movements could help improve design of therapies.

M1 plays a key role in the control of movement. Movement research has recently shifted from the traditional view that M1 controls limb muscles individually, towards the postulate that M1 controls limbs as whole segments [3]. It is suggested that this control is done via specific predefined modules, termed muscle synergies, that the central nervous system utilizes to accomplish a motor task. By using muscle synergies, instead of controlling each muscle individually, the central nervous system alleviates the computational burden of the movement execution [4].

In the proximal-distal muscle synergy, activation of both shoulder and forearm muscles are involved in a common motor cortical circuit in an integrated manner [5]. Activity-dependent couplings of networks are observed after extensive training of coordinated movements with these muscles [6]. Such changes in muscle synergies, when neurons adapt to an unfamiliar task, might reflect similar changes that occur during recovery from moderate stroke [7]. One way to measure such change is by TMS.

TMS and the pseudorandom walk method

TMS is a valuable tool to study M1 plasticity. This can be done by comparing the location, size, and excitability of cortical muscle representations before and after intervention [8]. The TMS stimulation produces motor evoked potentials (MEPs) in the muscles that can be measured with electromyography (EMG) (Figure 1B). By observing their latency and amplitude it is possible to determine the cortical area that is connected with the muscle of interest (Figure 1C). Plasticity can be determined by an increase in the number of cortical sites where MEPs are induced [8]. An increase in the mean MEP amplitude measured at the most responsive cortical site, called the hotspot, can indicate an increase in cortical excitability [10].

Muscles can be mapped at rest [11] or during low-level activity [12]. Low-level contraction permits the observation of MEPs at a lower rate of stimulation [12], especially for proximal muscles that are difficult to map at rest [13]. Distal muscle representations tend to be larger than proximal ones, and larger on the dominant side, contrary to proximal muscles [9]. Motor learning of a complex upper limb task leads to a common control of the proximal and distal muscles [8]. This results in an expansion of the muscle representations, an increase in their muscle representation overlap, and an increase in MEP's size [8,9]. Similar changes can be observed not only in the trained but also in the contralateral hemisphere [14], although some studies did

not observe that [9]. This reorganization of the non-trained hemisphere can be extremely useful for patients with hemiparesis for whom it is difficult to train the impaired side. Therefore, further research is needed in order to better understand how intermanual transfer in complex motor learning occurs.

Changes occurring as a result of motor learning can be measured using various TMS methods to map muscles of interest. In the traditional mapping method, multiple TMS stimuli are used at predefined grid points on the scalp at M1 to measure MEP size. Such mapping can take between 15 up to 60 minutes for one muscle [15].

A new pseudorandom walk method was recently developed that takes less than 5 minutes without sacrificing reliability [15,16,17]. In this method, one does not need to repeatedly place the coil in a predefined position when delivering the stimuli (Figure 1A). The starting point for the delivery of the stimuli is at the hotspot, out of which consecutive stimuli are delivered in eight straight lines. The lines are then connected creating an ellipsoid. The rest of the stimuli are randomly applied within this ellipsoid [17].

Overall aim and key objectives

The aim of this project is to map the proximal MD muscle and the distal BR muscle using the pseudorandom walk method. These maps will be used to measure plasticity in M1, induced after extensive training of a complex motor task. The complex motor task will be a darts-throwing task, in which all joints in an upper limb are involved in a specific coordination pattern and timing of proximal and distal muscles [7,3]. Changes in white matter can be induced after a minimum of six-week repetitive training [4]. Accordingly, participants will train darts at home for a period of six weeks using their non-dominant hand. The non-dominant hand has a lower level of baseline performance that can improve significantly more than the dominant hand, suggesting that the plasticity might be greater [18]. We will compare cortical muscle representations and their overlap before and after training.

The key objective is to map the MD and the BR muscle representations using the pseudorandom walk method. Supporting objectives are to determine the training-induced plasticity of the M1, the training-induced changes in muscle synergies, and the training-induced effect in the dominant hemisphere. We hypothesize that there will be a significant increase in the experimental group in the motor map area, volume, a change in the centre of gravity of the muscle representations, and a change in the mean MEP amplitude after training. We further hypothesize to observe an adaptation of the existing muscle synergies in the experimental group as shown by the increase in the overlap between muscle representations. We expect to observe changes not only in the non-dominant hemisphere but also in the dominant hemisphere.

Because of a significant reduction in time needed to perform the measurements, motor mapping can now be used not only in research but also in clinical practices. Additionally, understanding how the M1 reorganization after training occurs could help design better treatments for stroke patients.
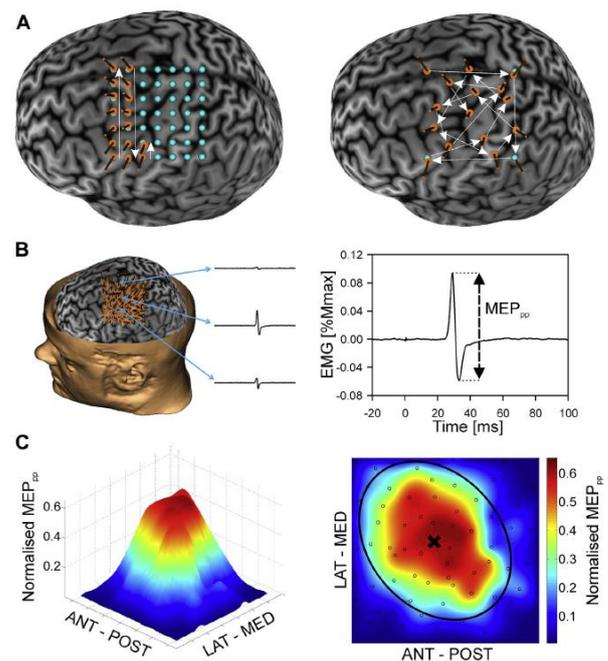

Figure 1: An illustration outlining the creation of a TMS map [15].

A: The traditional mapping method on the left and the pseudorandom walk method on the right. **B:** A square grid with each stimulation site is matched with the recorded EMG. MEP's peak-to-peak value is extracted. **C:** The surface is fitted through the 3D position data cloud to create a 2D plane. The 2D position data are matched with the MEP data to fit the surface map.

2 METHODS

Participants

We will measure two homogeneously matched groups of healthy participants based on their gender and age. We will include male and female participants aged between 18 and 45 years old. The sample size will be 30 participants per group (Cohen's d = 0.7419, power= 90%; α= 0.05, according to area sample size calculations [17]). All participants will be right-handed as measured by the Edinburgh inventory [20]. Participants will not be recruited if they report having any metal implants in the surrounding area of the head or any history of epilepsy.

Experimental protocol

Both groups will be measured twice with a six-week period in between. Control group will not perform any training in throwing darts. The measurements at each session will include TMS motor mapping and mean MEP acquisition of MD and BR on both hemispheres, as well as a measurement of darts performance (Table 1).

Table 1: A scheme of the experimental protocol

	Session 1	Training period	Session 2
Experimental group	TMS motor mapping MEP acquisition	Darts training (6 weeks, 15 – 20 mins, 60 – 80 throws)	TMS motor mapping MEP acquisition
Control group	Darts test	No training	Darts test

TMS measurements

The muscle motor maps will be determined by monophasic TMS pulses with a posterior-anterior current direction with the coil handle pointing 45° from the midsagittal line. The EMG electrodes will be placed on the MD and BR muscles in a belly-tendon montage. Participants will be seated with their hands relaxed on the table. First, the head of the participant will be co-registered to a stock MRI scan. Second, the hotspot, the location with the largest MEPs, will be estimated using the pseudorandom acquisition with 80 pulses and 2s interval [15]. The stimulation intensity will be set to 50% of the maximum stimulator output (MSO) and increased with 5% MSO if there will be no measurable MEPs after 15 pulses. Furthermore, the resting motor threshold (RMT), which is the lowest stimulator intensity with a 50% probability to produce the MEP at the hotspot, will be determined. EMG responses with a peak-to-peak amplitude 0.05mV, between 5 and 45ms after stimulation, will be considered MEPs. Finally, the motor maps will be acquired with a stimulation intensity of 110% RMT [17]. The pseudorandom walk method will be performed as described previously [17]. This measurement will be done on both hemispheres for both muscles in each session and will take approximately 30 minutes per hemisphere. Additionally, after motor mapping, 40 TMS pulses will be applied at the hotspot to obtain mean MEP amplitudes, which will take approximately 5 minutes per hemisphere [10].

We will first pilot the motor mapping of the MD and BR cortical representations under resting conditions before the experiment is carried out. We will switch to measurements performed under low-level active conditions if the motor mapping under resting conditions yields unreliable results [13].

Test and training protocol

The participants in both groups will do a test of dart-throwing skills at both sessions. The participants will stand with the left foot on a black line on the floor set at 2.4m from the dartboard. The center of the target will be 1.73m above the floor. They will be instructed to throw 15 darts and to aim for the center. The dartboard will have 10 concentric circles worth 10 points for the center and 1 point for the outer-most layer.

The participants in the experimental group will do training sessions at home. The place of the training was determined based on COVID-19 measures. This way the participants are not taking higher risks for infection by participating in this study (e.g. increased use of public transport). They will receive three darts, as well as several papers with the same dartboard design as used in the test. The holes in the papers will be considered as proof of training. Each training session will last 15 – 20 minutes and consist of 60 – 80 throws. They will be asked to perform the training consistently over the whole period and to keep a diary of their performance.

Outcome measures

For the key objective, four parameters from the TMS motor maps of each muscle will be calculated - the area, volume, and center of gravity (cog) in two dimensions. Additionally, the mean MEP amplitude at each muscle hotspot will be calculated.

The effects of the training-induced plasticity of M1 will be determined using the outcomes from the key objective. The repeated measures ANOVAs will be fitted to each variable separately to evaluate group (between factor: experimental vs control) and session (within factor: baseline and post-training). Additionally, a comparison of the baseline and post-training darts test scores will be done on both groups to determine the effect of training.

Training-induced change in muscle synergies will be measured by first superimposing the cortical motor maps of the two muscles and measuring their overlap. Then, the change in the overlap will be determined using the repeated measures ANOVA to investigate the interaction between groups (control, experimental) and sessions (baseline, post-training).

The contrast between the map areas of the dominant versus non-dominant hand will be compared between baseline and post-training using a paired t-test to determine if there is an overall effect on both hemispheres.

3 CONCLUSION

This research project exploits the novel TMS mapping procedure to further validate it on upper-limb muscles that haven't been mapped yet using the pseudorandom walk method. Furthermore, using this technique, the project also explores the effect of extensive motor learning on the M1 plasticity. The motor learning is approached holistically by analyzing motor maps, MEPs, motor performance, interhemispheric transfer, and the proximal-distal muscle synergy. The latter also adds to the developing paradigm of muscle synergies and explores ways in which the upper limb is controlled as a whole. Results from the project will contribute to our understanding of the proximal-distal synergy and its' involvement in reaching movements. Moreover, the results will contribute to a better design of rehabilitation therapy for patients with M1 impairment. Using the pseudorandom walk method, the therapy could become more efficient and quicker.

4 ACKNOWLEDGMENTS

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Chronotopic Maps in Temporal Processing and Perception

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ABSTRACT

Neurons maximally tuned to specific durations in the hundreds of milliseconds to seconds are widely observed in studies using monkeys. These tuned neurons are observed in areas that are previously known to be involved in timing research—pre-supplementary motor area and basal ganglia. However, the role duration tuned neurons, in these brain areas, play in temporal processing remains unclear. In this review, I present and discuss evidence from recent neuroimaging studies that show the presence of a topographical organisation of duration tuned neuronal populations in the human brain. The studies, using ultra-high field fMRI, have found that the duration tuned clusters at the voxel level in the occipital, parietal and frontal areas, including the supplementary motor area (SMA), are topographically organized as duration maps—chronomaps. Duration tuning and chronomaps could thus serve as a functional mechanism for the encoding and representation of abstract stimulus features such as time.
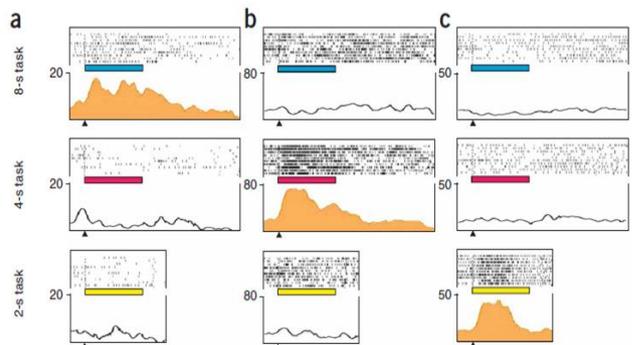
KEYWORDS

Time perception, temporal processing, duration tuning, fmri, chronomaps, supplementary motor area

1 DURATION TUNING

Interval timing refers to the behavior of perceiving, estimating, and representing durations in the hundreds of milliseconds to minutes range crucial for human behavior, in decision making, speech processing, motor activity and music perception [1]. Studies using functional magnetic resonance imaging (fMRI) have found brain activity in certain key brain regions to be correlated with interval timing behavior. These areas include supplementary motor area (SMA), intra parietal sulcus, basal ganglia, and cerebellum [1,2,4,5]. Electrophysiological studies on monkeys have found neurons from these timing brain areas to exhibit duration tuning [6,7]. When neurons are tuned, they preferentially fire for specific task durations. Mita *et al.* [6] found that neurons in the monkey pre-SMA (human SMA) fire

preferentially for task durations (Fig. 1). Two Japanese monkeys were trained to perform an interval-generation task that required them to determine a hold time of three different intervals of 2s, 4s and 8s, before initiating a key release movement LED lights indicated the specific waiting times before key release: yellow light indicated 2s; red light indicated 4s: and blue light indicated.

Adapted from Mita et *al.,*

Figure 1: Raster displays and spike-density functions illustrating selective neuronal activation during the 8-s task (a), 4-s task (b) and 2-s task (c). Mita et al. [6].

While duration tuning in timing brain areas associated with interval timing is well observed, the neuronal mechanisms linking the areas to the perception, estimation and representation of durations remain unknown [1,2,3]. One possible link between duration tuning to temporal processing could be that duration tuned neurons in the SMA, tuned to different durations, are topographically organised as functional maps. Such functional maps could then provide a mechanism for the perception, estimation, and representation of durations. Could such a topographic organisation of duration tuned neurons exist in the human brain? If so, could such a topographic organisation be studied non-invasively in humans?

2 REPRESENTATION OF ABSTRACT STIMULUS FEATURES THROUGH MAPS

Representation of stimulus features through topographically organised sensory maps is well known, such as, the tonotopic maps in the auditory cortex or the retinotopic maps of the occipital cortices. Could a similar topographical organisation of abstract stimulus features such as time and numerosity exist?

Further, could such a topographical organisation be studied non-invasively in humans?

Harvey *et al.* [10] using ultra high-field fMRI (at 7 Teslas) showed the existence of topographically organized numerosity maps in the human parietal cortex (Fig. 2). Numerosity refers to the size of a group of objects. Participants in the study were presented with visual stimuli of varying numerosity. The results showed that parts of the cortical surface corresponded to specific numerosity, in a topographical manner increasing from the medial to lateral ends. The results provided evidence that higher-order abstract features and their topographical organizational principles could be studied non-invasively in humans.
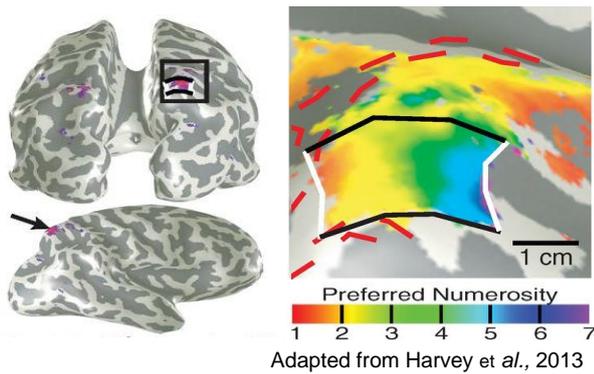

Adapted from Harvey et *al.,* 2013

Figure 2: High-field fMRI data was acquired while subjects were shown visual stimuli of varying numerosity. Numerosity maps showing preferred numerosity increasing from the medial to lateral ends (white lines) of the region of interest (ROI) (black and white lines). Harvey *et al.* [10].
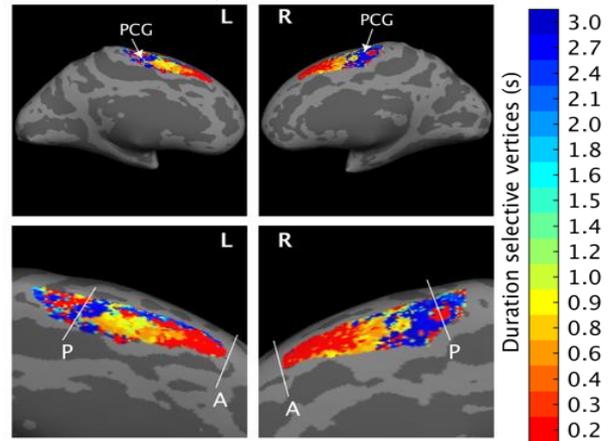
3 REPRESENTATION OF DURATIONS THROUGH CHRONOTOPIC MAPS

Like the topographical organization of numerosity, could task durations have a similar map-like organization? Protopapa et *al.* [8] provide the first evidence for a topographical representation of durations in the human supplementary area. Protopapa et *al.* [8] used data from ultra-high field fMRI (at 7 Teslas) and showed the results to be independent of task design and analysis approaches. In Experiment 1 of the study, volunteers participated in a visual, temporal discrimination task, where subjects had to compare and respond if the second stimulus lasted shorter or longer then the first. The resulting data were analyzed using a general liner model (GLM) approach. While in Experiment 2 of the study, participants performed a visual, temporal, and spatial discrimination tasks. In the temporal task, subjects had to compare and respond which of the two presented stimuli lasted longer. While in the spatial task, they judged which of the two stimuli underwent the largest change in orientation. The data were analyzed with neural population receptive field approach [9]. Chronotopic maps, topographic organization of durations in the range of 0.2 to 3s, was observed in the SMA both in the left and right hemispheres (Fig. 3). The progression of the maps was seen in a fixed, rostro–caudal direction, with vertices sensitive to the shorter duration located in the anterior and those sensitive to the longer duration in the posterior SMA. Chronomaps were also found in a task independent manner: topographic organization of durations

was observed even in a control condition when subjects were instructed to focus only on the spatial aspect of the stimuli and ignore their temporal properties.

Protopapa et *al.* [8] connected the previously reported neuronal duration tuning in monkeys' medial premotor cortex [6,7] to a representational format in humans. Although previous duration tuning seen in monkeys were exclusively associated with motor-timing behaviour, Protopapa et *al.* [8] showed the presence in human premotor cortex of a duration tuning mechanisms in a purely temporal perceptual task.

A recent study, Harvey et al. [11] has added to the evidence on chronomaps, and the topographic organization of stimulus frequency. In the study, high field fMRI (7 Teslas) data from volunteers were acquired while they were presented with a rapid succession of visual stimuli varying in duration, frequency, or both. The resulting data were analyzed using a population receptive field approach [9]. Topographic organization of voxels that were maximally responsive to stimulus duration and frequency was observed in ten different cortical regions, from occipital to parietal to frontal lobe. The duration and frequency maps were observed in both the hemispheres. Another intriguing finding of the study was that the orientation of the maps was found to be variable unlike, the fixed, anterior-posterior orientation from Protopapa et *al.* [8]. Thus, Harvey et al. [11] added to the evidence of existence of topographic maps linked to abstract stimulus features of numerosity, time and frequency.

Adapted from Protopapa et *al.,* 2019

Figure 3: Chronotopic maps showing the topographic organization of duration-sensitive vertices in bilateral SMA with the progression in the rostro–caudal direction, with vertices sensitive to the shorter duration (vertices in warmer colors) located in the anterior and those sensitive to the longer duration (vertices in colder colours) in the posterior SMA. A, anterior; L, left; P, posterior; PCG, precentral gyrus; R, right; SMA, Supplementary Motor Area. Protopapa et *al.* [8].

4 PROPERTIES OF CHRONOTOPIC MAPS

Protopapa et *al.* [8] and Harvey et al. [11] were successfully able to show the existence of chronotopic maps. The two studies helped characterise the interesting properties of chronomaps: chronomaps exist in both cerebral hemispheres; chronomaps

exhibited variable orientations in their topographical organisation; chronomaps exist in multiple brain areas; chronomaps organise in a task-independent manner; and finally, chronomaps are linked to temporal perception and performance.

The results from Protopapa et *al.* [8] and Harvey et al. [11] further raise some interesting questions on other characteristics of chronomaps. Are the chronotopic maps organized in an absolute or relative manner (Fig. 4)? If duration clusters from an existing chronomap changes its spatial position based on a new duration range, then the durations are encoded in a relative manner. Next, are chronomaps amodal? If the maps are amodal, then the maps in Fig.3 resulting from tasks in visual domain, would not change if the durations were presented in an auditory domain. Next, are chronomaps experience based or present from birth? Lastly, Harvey et *al.* [10] showed the topographic organization in multiple areas, how do these representations vary and contribute to the encoding and perception of durations?
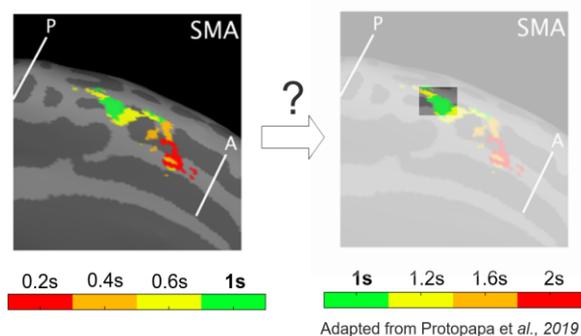

Figure 4: Are chronotopic maps encoding duration in an absolute or relative manner? The left panel shows the chrontopic map from Experiment 1 of Protopapa et *al.* [8]. How are the clusters encoded for 1s duration (in green)? If the range of durations that 1s is presented in changes (right panel), does the spatial position of the green clusters remain the same or change in the new chronotopic map? If the green clusters retain their spatial position, then the durations are organised in an absolute manner. If they change their spatial position based on the duration range the durations are encoded in a relative manner.

In summary, there is growing evidence that chronomaps could provide a possible mechanism for the encoding and representation of durations associated with temporal processing and perception. Despite the difficulty to link the voxel level chronomaps in humans to the duration tuned neurons in monkeys, these new findings are influencing and contributing to the field of temporal cognition.

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Being in Brackets: A First-Person Exploration of the Phenomenological Method of Epoché

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ABSTRACT

This article is an excerpt from the ongoing research exploring the experience of carrying out the phenomenological method of epoché from the first-person perspective. First, we outline the state of the field and then dive into the first-person exploration, describing the method used in gathering our experiential data. After that, we focus on presenting a data-derived first-person model that describes the experience of epoché as a diachronic process, comprised of five phases: 1) The pre-epoché phase and the experience of the natural attitude shifting; 2) Entering the experiential phase of the epoché; 3) The experiential phase of the epoché; 4) Exiting the experiential phase of the epoché; and 5) The post-epoché phase and how the natural attitude is experienced after the epoché.

KEYWORDS

Phenomenology, first-person research, epoché, natural attitude

1 INTRODUCTION

To better understand our enterprise, we must first familiarize ourselves with the concept of the "natural attitude". In *Ideas I*, Edmund Husserl [1] introduces the natural attitude as our everyday assumption that the world exists independently of our conscious awareness. In this attitude we take the world as always already present, prior to any reflection. Expanding on this conceptualization, in Eugen Fink's "Sixth Cartesian Meditation" [2, p. 166], Husserl goes on to say: "In the natural attitude, in which for ourselves and for others we are called and are humans, to everything worldly there belongs the being-acceptedness: existent in the world, in the world that is always existent beforehand as constant acceptedness of a basis. So, also man's being is being in the world that is existent beforehand. In phenomenology, this being-beforehand is itself a problem."

This everyday forgetfulness thus permeates our everyday life. We operate on the basis of natural naivety, assuming that reality exists 'out there' and is waiting to be discovered and explored. This reality is supposed to be independent of our experience and

exists as it is perceived even if there is no one to direct attention to it or perceive it [3].

The basic method of the phenomenological approach is to direct one's attention from what the experience is assumed to be about to the observation of the experience itself, as it is given in consciousness. In order to avoid succumbing to our everyday embeddedness in the natural attitude, we must bracket our presuppositions, values, judgments and opinions about the world. To do this, we employ a particular gesture of awareness – the epoché. Husserl [1] asserts that the epoché enables a return to "the things themselves", to the world as we directly experience it. In performing the epoché, we put in brackets, or "turn off" the whole world as we normally experience it. The task is to re-awaken us to recognize the meaning we bestow upon our experiences. As Maurice Merleau-Ponty [4, p. xv] puts it, performing the epoché does not mean to withdraw from the world or the phenomena, but to "slacken the intentional threads which attach us to the world and thus bring them to our notice".

1.1 State of the art in contemporary first-person research

The definition of the method of epoché as well as the question of its importance in phenomenology and the possibilities of implementation outside philosophical fields have been the source of many debates (e.g. [5,6]). Moreover, contemporary discussions [5,7] point to a lacking definition of the concept. In addition to problems of interpretation, there is also the question of how the realization of such a state takes place from the first-person perspective (i.e. what is it like for me, the experiencing subject, to perform the epoché). Similarities between the concept of the epoché and various Eastern practices have also been illuminated in recent decades, such as the yoga practice of prāṇāyāma (breath control) [8] and Samatha-Vipassanā meditation [9].

Due to the uncertainty that permeates the field and the various interpretations about what epoché is and how to carry it out, we have decided to investigate the experiential process from a first-person perspective in the hopes of providing more clarity and being able to better distinguish what it is we are talking about when we talk about the practice of epoché.

In this article we broadly focus on the following questions: what is it like to come into contact with the experience of epoché and what are the characteristics of carrying it out from a first-person perspective. We present the diachronic process involved in performing the method of epoché, focusing on a) how an

individual moves away from and back towards being immersed in the natural attitude; b) how an individual relates to her own experience and c) what changes in the process.

2 METHOD

The findings presented in this article are part of a broader study in which we are exploring epoché with the micro-phenomenological interview method [10]. The aim of the micro-phenomenological interview is to help co-researchers become aware of a past experience and access detailed descriptions of that same concrete experience, enabling the coming into contact with previously unattainable dimensions of lived experience and cultivate an individual's reflection and retrospective reporting of experiential data.

The co-researcher

Our co-researcher, a female aged twenty-seven, is trained in the micro-phenomenological method, has considerable phenomenological and first-person knowledge with more than 500 hours spent observing experience and participating in first-person and micro-phenomenological research (as interviewee and interviewer). She also has six years of meditative practice.

Selection of the explored experiences

What constituted the moment of epoché was partly decided prior to gathering the data, based on prior theoretical knowledge of the components of epoché provided by Depraz et al. [11]. This view was then modified during the study to incorporate the co-researcher's own individual perspective. The criterion for what constitutes the moment of epoché from the co-researcher's perspective was as follows: noticing a profound shift in the quality of one's experience of the world and relating towards the world, characterized by a lack of judgment directed towards the world.

Interviews and procedure

Altogether we have gathered nineteen journal entries describing experiences during meditative practice – either a Vipassanā meditation (with eyes closed), or a walking mindfulness meditation (with eyes open). After each meditation session, the concrete moment of what was experienced was written in the journal and later explored during the micro-phenomenological interviews in more detail. The interviews were carried out with investigators trained in the micro-phenomenological method. Eight interviews were conducted on eight selected journal entries, which were judged by the co-researcher to be the most vivid experiences of epoché. Two of the interviews were performed in Slovene, while the other six were conducted in English. The duration of the interviews ranged from 60 to 90 minutes. The interviews were audio recorded on a personal smart phone or a Zoom H4n audio recorder.

All of the investigated experienced have occurred within the past year. Five interviews were carried out within 24 hours of the experienced moment, two took place a few days after the experience and one experiential episode was investigated a few months after the experience took place.

The interviews were transcribed in full. Relevant parts of the interviews conducted in Slovene were translated into English for the purposes of this article.

3 RESULTS

The findings presented below are a tentative illustration of our research. Since the study is still ongoing, we have not yet carried out a systematic analysis of acquired descriptions and present here merely an excerpt of data collected so far.

Preliminary analysis of the transcribed texts focused on both synchronic and diachronic dimension of the experiential episodes and attempted to create an overview of which experiential moments were prevalent in all eight investigated journal entries and which were distinct. This has led us to propose the basic shape of a data derived first-person model, which frames epoché diachronically as a five-phase process.

Of particular note here is that these are preliminary findings meant to illustrate the experiential process of the co-researcher's individual experience and should be refined in future research with reports provided by other co-researchers to yield a more fruitful reflection of patterns and categories of carrying out epoché from a first-person perspective.

3.1 Pre-epoché phase and the experience of the natural attitude shifting

This phase is characterized by a gentle awareness of the co-researcher's surroundings (sensing them, but not engaging with them, letting them pass by). The experience of the natural attitude shifting was in all interviews accompanied by a relaxed and stable state of body and mind. In one particular interview it was described as follows:

> "And as I stand there, I also hear people, this soft shuffling of the people around me, silent, soft movements of feet shifting on the ground and shuffling on the ground. And there is this feeling in my body of stable ground. […] And I feel my body as a whole, just this being in the standing position. And a general calmness that comes with this feeling."

3.2 Entering the experiential phase of the epoché

The co-researcher has reported on experiencing an element of transition between the pre-epoché phase and the experiential phase of the epoché, which could be faster or slower. In the majority of the investigated experiences (6 out of 8), entering the epoché started by spontaneously "slipping into" the experience, whereby the experience of epoché seemed to arise by itself. Conversely, in the other two experiential episodes, there was a slow transition which took place either by remembering what it was like before and trying to follow that felt atmosphere, or by softly settling in the body (or a body part) and allowing the sensation to come, gently holding it in awareness. The co-researcher has reported on there being a feeling of tension in the body, which she was able to recognize and intentionally relax, for example:

> "I relax the shoulders, I let them [the arms] slump next to my body. Then there is this very soft, slow movement, with no pressure in it. As this relaxation of the upper part of the body and a move towards the

lower part takes place, I relax into this feeling. It is bodily, as I shift a bit with my shoulders, but also it is attentional – not focusing directly, just letting things go and flow down here [in the belly area]."

This settling into the (part of the) body was then followed by a feeling of space being more open, as though:

"My body can relax into this openness. Like, my body as a shape can flow into this [space], a boundary where my skin is can flow into this open, flowing, shimmering, static feeling [felt as the boundary, a space a few centimeters around her body and slowly entering the space further "away" from the body]. There is this feeling of being just open and relaxed, there is an openness at the sides."

The feeling described here as a shimmer, or a static-like feeling in quality, was in the majority of cases (5 out of 8) experienced as a sensation of spreading that lent itself towards lessening the sense of bodily boundaries.

3.3 The experiential phase of the epoché

We have found that the experiential phase of the epoché has a variety of dimensions often appearing together. Here we describe a few that have occurred throughout our investigation.

The phase of the epoché was in all investigated experiences characterized by a serenity and letting-be. The co-researcher was not actively searching for information or any type of stimulus in the world, rather the atmosphere was experienced as a calmness in being, an allowing of appearances. In six interviews a profound aspect of epoché was a felt sense of stability. It was described as a feeling of "sitting in myself" in the interview situations, yet it is important to note that this experience had very little to do with the experience of bodily sensations. Rather, it related more to the feeling of the body as a whole, to the gestalt of the body.

Another aspect that permeated all of the investigated experiences was no directedness of the co-researcher's attention towards the world or "towards the front of oneself". In an interview it was described as:

"Being directed towards the back and also being aware of the spinal cord, of the position of the spine."

The active engagement of the co-researcher was felt only in the act of sustaining awareness on the whole bodily gestalt. This act was in one of the interviews perceived as:

"It is effortless and feels like just being there with the awareness."

This type of awareness brought about a change in the co-researcher's visual field, if the eyes were open (this has occurred in 4 out of 8 investigated experiences). The world was perceived without its usual depth and was in the interview situation described as follows:

"I feel as if I am looking at a 'picture' in front of me, there is this lack of spatial depth in what I am seeing. And at the same time there is a feeling of seeing through this 'picture', this sensation. It feels as though my visual field is a veil and has its own dimension of depth and of spatiality being present in the natural, everyday world. But what I am sensing is that which is 'beyond it', 'through it' […] It is like another feeling of space around me that is at the same time dense, filled, thick, light, flowing, all-encompassing. I feel this spatiality as an atmosphere, it is primarily felt as air around me. And it goes on, it is felt as though the visual field [the veil] has a certain stopping point – it stops the perception on a certain point. But this denser spatiality is felt as limitless, it goes on, it feels as limitless potentiality all around me."

The phase of the epoché was in all instances also characterized by a feeling of a primordial space. This space was experienced as having the quality of density, thickness and sometimes warm air that is:

"Not visible, it is a felt air, felt as oneness around me [the felt location], to the sides, everywhere around me."

In three experiential episodes during meditation, in addition to what was described above, a feeling of space as a "background of holding" was identified. This background was felt by the co-researcher as being held by space, which had a profound quality of darkness and thickness.

The phase of epoché was in all investigated experiences also accompanied by the loosening of the sense of bodily boundaries and dissolving the separation between what is inner and what is outer, described in the interview situation as follows:

"There was no more separation, there was nothing out [there], there was just this blackness and this familiarity that was felt as and felt in this warm quality of blackness. And just the location that is this space where I feel my awareness to be and that is all."

3.4 Exiting the experiential phase of the epoché

Exiting the experience of epoché has occurred spontaneously and unintentionally in the majority of the investigated experiences (6 out of 8). The co-researcher has reported that the feeling of the world slowly began drifting back in as attention started to become more focused on the external world and she felt herself getting more directed towards it.

In a few examples (4 out of 8 investigated experiential episodes), there was a profound feeling of no separation between the co-researcher and the world during the experiential phase of the epoché, which was later contrasted by a feeling of separation on returning to a more "natural", habitual mode of being in the world. There were also a few (2 out of 8) instances of intentionally exiting, or rather of a feeling of "having to return", which was experienced as a desire, an anxiety or a nudge urging the co-researcher to return to the natural mode of being.

In all of the investigated experiences, a big part of exiting the epoché was for the co-researcher a felt sense of coming back to

her own body from the (above mentioned) primordial space. It was described as coming closer to a point where she feels herself to be situated in space and the space around that area becoming thicker and more condensed. This condensed and thicker feeling started in a part of the body (the area of the torso; 5 out of 8 explored experiential episodes) or was felt as the whole gestalt of the body becoming denser and heavier (3 out of 8 experiential episodes).

Heaviness and denseness also appeared to allow a sharper focus on the body in all of the investigated experiences of epoché, which began to separate the body of the co-researcher from the rest of the world. As she started to become more actively directed towards the world, stronger feelings of differentiation between form and background in the visual field become more noticeable to her. For example, she reported her environment began to hold more graspable and holdable possibilities, which came to the fore as the feeling of her body also shifted towards the background:

> "I am able to "pick out" a particular tree from a myriad of different trees, able to direct myself towards it and focus on it – making it stand out from the background as an entity."

3.5 Post-epoché phase and how the natural attitude is experienced after the epoché

Coming back from a profound phase of epoché has in all experiences left a mark on the co-researcher's way of interacting with the world and her way of being in the world. In all of the investigated experiences she reported on there being an immediate feeling of an increase in calmness, gentleness, contentment and a slowness of being after every experience of epoché. But also, a much more lingering feeling resounded through her being, namely the feelings of presence and the openness of space. She reported on experiencing a profound awareness of how her awareness shapes the surrounding world and how she is, in the end, inseparable from her surroundings.

4 CONCLUSION

In the article we have set out to enrich the traditional conceptualizations of epoché with in-depth descriptions of the first-person experiences of epoché elicited by micro-phenomenological interviews. In analyzing the experiential reports of performing epoché, we have made three notable observations. The first observation is a profound shift in the quality of experience, how one turns towards, notices and attunes herself to the world. The second and third observation are closely linked to the first one: the second one being a felt profound shift in how one experiences one's own existence, one's being in the world; and the third one being a profound shift in how the appearance of the world and its enclosedness appears to "the observer". Our preliminary analysis gave us a foundation for which experiential dimensions could be considered and additionally developed in future studies with more co-researchers. In addition, it would be fruitful to consider such endeavors more thoroughly in the frame of contemplative and

mystical traditions. It would also be interesting to design studies which bracket all such traditional presuppositions.

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A new study of expected human longevity

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ABSTRACT

In this paper we for the fifth consecutive year estimate the longevity of human civilization based on the absence of observable extraterrestrial civilizations. In addition to our previous studies, in this paper we add three more models and test all possible values of parameters and distributions. If there are not many advanced civilizations in our galaxy, as newest studies indicate, our longevity can again be estimated at up to 10 000 years. The consistency of studies may or even should shift focus of our civilization.

KEYWORDS

Human extinction, Drake equation, Civilization collapse, Rare Earth hypothesis

1 INTRODUCTION

After more than 50 years of searching for extraterrestrial civilizations there is only one thing we know for sure: we have not found any yet. After scanning more than 10 millions stars [14] we have not found any extraterrestrial life and that could indicate that the longevity of such civilizations might not be so long. While we know that we will die someday, we do not act like this. On the similar note we as civilization will also extinct someday in the future and that future might not be so far. Do we realise that we could be on the verge of the extinction? For that reasons the question about the longevity of human civilization is directly linked to the cognitive science.

In our previous papers [9, 17] we approached the question "Where is everyone?" and presented the Drake equation that could potentially solve the issue. In the first paper [9] we presented and analysed Sandberg [10] interpretation of the Drake equation [2]. In the last paper [17] we presented possible causes for human extinction and used the Drake equation to estimate longevity of human civilization. We concluded that our technical civilization will most likely survive just another 10 000 to 20 000 years.

In this paper we analyze three models. The second and the third model are based on Drake equation with some adjustments. The second model uses substantially less parameters and the

third model includes inhabiting neighbouring planets. The fourth model represents the "rare Earth" hypothesis [15]. For each model we represent all possible predictions from the pessimistic (there are no other civilizations besides us) ones to the optimistic (there are a few thousands civilizations) predictions with different probability distributions to more accurately estimate longevity of human civilization. In summary, we test 4 different models under all circumstances (parameters, distributions).

2 RELATED WORK

There are various estimations of possible number of civilizations; some propose between 600 and 40 000 technological civilizations in our galaxy [13]. The differences often stem from the number of Earth-like planets in the habitable zone around stars. One of the newest studies found that there should be around 36 civilizations in our galaxy if estimated time for a planet to form an intelligent life (life that could communicate with others in our own Galaxy) is between 4.5 to 5.5 billion years (like Earth), assuming that an average longevity of civilizations is 100 years [16]. Using three different principles, the paper by Engler and von Wehrden [3] represented that number of civilizations that have likely arisen in our galaxy to date is between 7 and 300. However, it is estimated that with our tehnology the likelihood of detecting intelligent life could be two orders of magnitude smaller in comparison to the detection of primitive life [8] (by primitive life are defined mostly microbes and multicellular life and intelligent life is technologically advanced intelligence - species that are capable of producing detectable signatures of their technology). Another issue is the detection of their radio signals [7]. In detail, if there are 5 civilizations, the chance of us detecting them is 0.012%, but if the number is 300, the probability is 95%. A great number of undetected civilizations in therefore unlikely. However, if longevity of civilizations is less than 100 000 years, the signals arriving at Earth may come from distant civilizations long extinct [5]. The extinction due to natural causes is less likely - one research shows that the yearly probability for that is most likely to be less than 1 in 87 000 using four different models [12].

As already mentioned, in our research we wanted to look the Drake equation from the other side. Using 4 different models of the Drake equation with modifications we ask about the longevity of human civilization instead of the number of other civilizations in our Galaxy. For that reason this research is unique and first in this topic.

Table 1: Probability densities for the parameters in equation (1).

Parameter	Distribution
R_*	log-uniform from 1 to 100
f_p	log-uniform from 0.1 to 1
n_e	log-uniform from 0.1 to 1
f_l	log-normal rate, described in paper [10]
f_i	log-uniform from 0.001 to 1
f_c	log-uniform from 0.01 to 1
N	point values: 1 to 10 000

3 ESTIMATING THE LONGEVITY OF HUMAN CIVILIZATION WITH FOUR BASIC MODELS

The Drake equation consists of several parameters:

$$N = R_* f_p n_e f_l f_i f_c L,$$

where R_* is the rate of star formation per year, f_p is the fraction of stars with planets, n_e is the number of Earth-like (or otherwise habitable) planets per star that has planets, f_l is the fraction of habitable planets with actual life, f_i is the fraction of life-bearing planets that develop intelligence (technologically advanced civilizations), f_c is the fraction of intelligent civilizations that are detectable and L is the average longevity of such civilizations. Finally, N is the number of detectable civilizations. We used the following equation for computing L

$$L = \frac{N}{R_* f_p n_e f_l f_i f_c} \quad (1)$$

with the probability densities and limits from Table 1. In Table 2, the third column "stabilization" denotes the point where probability density stops decreasing, meaning that the major probability was up to this point.

3.1 Model 1

The first model was already fully described in [17].

3.2 Model 2

The main part of this model was inspired by [4]. It represents a simplified version of the Drake equation - parameters are reduced in just two: an astro-physical (presents total number of habitable zone planets) and a bio-tehnical (represents probability that a given habitable zone planet has ever evolved a technological species). The motivation for the introduction of the model 2 was smaller number of variables to avoid numerical problems.

We combined some parameters from the Drake equation and got the following equation:

$$N = [R_* f_p n_e][f_l f_i f_c] L = f_a f_b L \quad (2)$$

- f_a is the astro-physical probability
- f_b is the bio-tehnical probability

The longevity is calculated as $L = \frac{N}{f_a f_b}$. Results can be seen in Table 2 and Figure 1.

3.3 Model 3

This model is based on [1]. The main upgrade from the original Drake's equation to this model is an added possibility to expand civilization to neighbouring planets. Each newly inhabited planet

is treated as another civilisation, therefore N corresponds to the number of inhabited planets. The obtained equation is

$$f * (L + EL^4) = N$$

where E represents the estimated numbers of planets like Earth and is calculated as $E = 5.1334 * 10^{10+f_p+f_c} S$ (S is the density of the stars and equals to $4.7233 * 10^{-42}$) and f is calculated as $f = R_* f_p f_e f_i f_c$.

Results can be seen in Table 2, Figure 2 and Figure 3.

3.4 Model 4

The fourth model is based on the "rare Earth" theory and assumes that - as name already suggests - Earth is a very unique and rare planet. We used the equation 3 and combined it with the Drake equation again using probability distributions.

$$N = N^* n_g f_p f_{pm} f_i f_c f_l f_m f_j f_{me} \quad (3)$$

The parameters added to the Drake equation are

- N^* is the number of stars in the Milky Way galaxy, between 250 and 500 billion,
- f_{pm} is the fraction of planets that are metal-rich, between 1 and 10 percent,
- f_m is the fraction of planets with a large moon, between 0.3 and 3 percent,
- f_j is the fraction of solar systems with Jupiter-size planets, between 5 and 10 percent,
- f_{me} is the fraction of planets with a critically low number of extinction events, between 1 and 10 percent.

L is then calculated as $L = \frac{N^* f_{pm} n_g f_m f_j f_{me}}{N}$.
Results can be seen in Table 2 and Figure 1.

4 EXPERIMENTS

4.1 Single Models

To simulate longevity estimates L, we randomly generated values of each parameter for a chosen number N of advanced civilizations in our galaxy (civilizations that transmit electromagnetic signals to space) using the predefined probability density. Then, several derived graphs are generated, e.g. the one in Figure 1 (presented for models 1, 2 and 4, while model 3 is similar to 1).
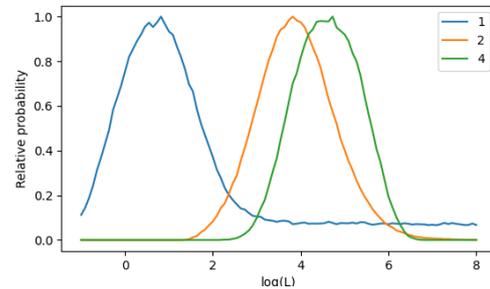

Figure 1: Probability density function of log(L), i.e. expected human longevity based on relative probability with N = 10 for models 1, 2 and 4.

Figure 2 and Figure 3 present the same relations as in Figure 1, but for model 3 and in different ways: Figure 2 presents a 3D view in the logarithmic scale, Figure 3 presents linear view on the same relation.

Table 2: Median and stabilization for different N for all 4 models.

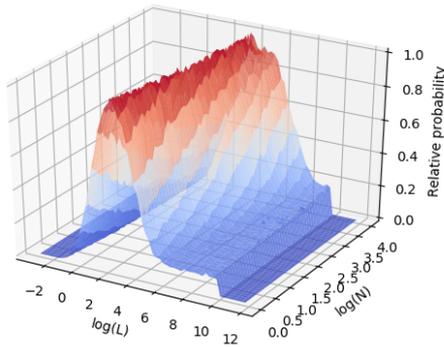| N \ model	median				stabilization			
	1	2	3	4	1	2	3	4
1	2 200	200	720	1 070	13 600	9 200	61 400	9 200
10	22 000	900	2 060	8 320	11 100	1 500	20 100	1 500
100	220 000	7 000	5 930	77 640	9 300	100	2 800	100
1000	2 200 000	70 000	19 570	763 190	5 800	20	300	20
10 000	22 000 000	700 000	65 000	7 588 330	/	/	40	/

Figure 2: Longevity based on N, side view for model 3.
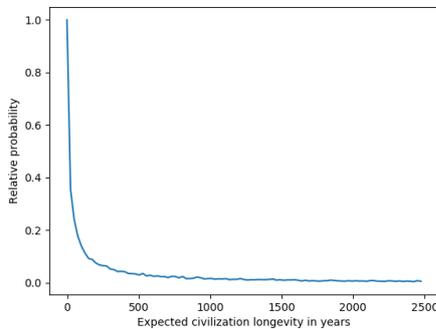

Figure 3: Longevity based on N for model 3, N = 1, median = 720, stabilization = 61400.

If we present the graph of probability densities in a linear (as in Figure 3) instead of logarithmic scale, we get quite different impressions: the majority of possibilities for greater N are at the left of the graph resulting in a faster decline and faster stabilization point. This relation is observable in Table 2 in the third, "stabilization" column, which denotes when a decline is less than 1 percent in a corresponding 100 years. It is important to distinguish between stabilization and median: the median presents a point dividing all simulations into two intervals that are equally frequent, and stabilization indicates the end of a steep dive. While the median is mainly linearly growing with the number of civilizations, the stabilization decline presents the point where probability "tail" smaller than 1 percent. At $N = 1$, the median is smaller than the stabilization, and at $N = 100$, the median is bigger for all models.

4.2 All Models Merged

In this section we combine results of all 4 models simultaneously and each parameter under 5 different distributions (log-uniform, uniform, half-normal, log-normal distribution and distribution with the most of the probability close to the upper bound). The results are presented in the form of histograms. We compute new linearly independent space pretending that a histogram is a vector using PCA - Principal component analysis. It turns out that the three dimensions with the biggest eigenvalue are informative enough, therefore we can draw 3D figures.

We compute some clusters using k-means algorithm and mean histogram for each cluster. Each cluster is approximated as a surface.
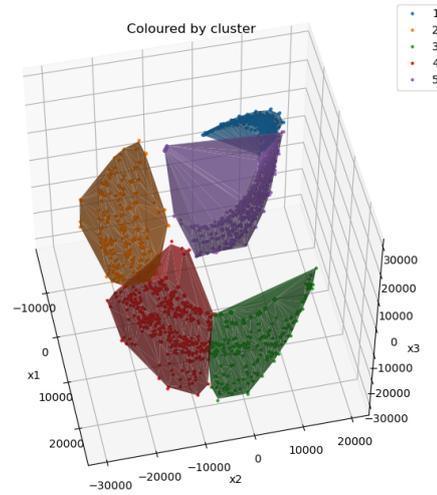
4.3 Results

Figure 4: Transformed space clustered into 5 clusters. Each dot is a histogram transformed to a new space using PCA. We can see the first three dimensions of this space.

One point in Figure 4 corresponds to one histogram, and histogram are clusters into splines of five different colors. The first and the fifth cluster contain mostly histograms for the first and the third model. All the other clusters consist of the second and the fourth model. The expected human longevity will be higher for these thee clusters.

In Figure 5 we present properties of the clusters by their means. As expected the first and the fifth cluster have peak before the others but later they are still higher because of a theoretical step that gives some probability even to practically unimaginable values (numbers high as 10^8 years which is 20 times more than the occurrence of Australopithecus [6]).
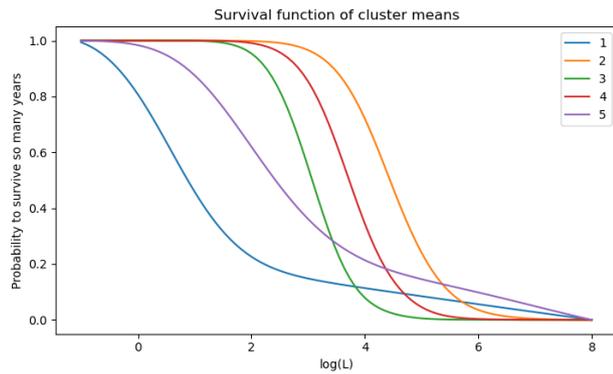
Figure 5: Mean survival function for each cluster.

Now we can compare a few distributions that are still different enough based on their peak density from lower to upper bound.

5 CONCLUSION AND DISCUSSION

Based on the research where several participants (general UK public, general US public, Oxford students) were asked about their view on the possibility of the human extinction, results show that they think it needs to be prevented [11].

This research designed models of probability densities of the longevity of human civilization in significantly more advanced ways compared to our previous studies. We generated all four models such that we distribute each parameter by all five selected distributions. To determine the realistic probability of longevity, Figure 3 is most relevant: after probability drops to low values and remains so for a long period of time. If integrated over a long period of time, it can result in big values as "mean" shows in Table 2. But in reality, the long close-to-zero tail seems more of a numerical curiosity. "Stabilization" is therefore the relevant indicator of civilization longevity.

The models analyzed here all show that if there are more civilizations, we have lower probability of living longer (column stabilization). Regardless of N and after initial fluctuations at the beginning, the curve of the longevity becomes static, monotonic, very slightly decreasing. From Figure 5 we can interpret that even the most optimistic cluster (cluster 2) gives us result that we will survive more 100 000 years with half probability and more than million years with 5% chances. Based on all of the clusters we can conclude that the highest probability is that we will survive at most 10 000 years.

In summary, this paper is relevant because it shows that we might not have a lot of time left, at least in terms of cosmic timing. Maybe we can buy us some time by taking better care of the Earth or by starting to colonizing other planets, but the most important thing is to start making more researches that could possibly help to prevent the extinction of human civilization or at least reschedule it later in the future.

ACKNOWLEDGMENTS

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Does sight provide insight into Alzheimer's dementia?

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ABSTRACT

Alzheimer's dementia (AD) is the most common neurodegenerative dementia. Its timely and early diagnosis is of great importance, as it allows patients to plan ahead and improve life quality with different non-pharmacological approaches. Several biomarkers, which allow for such a diagnosis, are already part of everyday clinical routine. While their role in the patient's assessment is undoubtedly valuable, they bear certain limitations, such as invasiveness and price. A search for a novel, non-invasive and inexpensive biomarker is underway. Eye movements have recently been proposed as a promising candidate for such a biomarker. Here, we offer a brief overview of both: the biomarkers most typically used in the clinical setting, and the eye movements, as tracked via eye tracker—a method, which already has a long tradition in the field of cognitive science.

KEYWORDS

Alzheimer's dementia, early diagnosis, biomarkers, eye movements, eye tracking, structural MRI, lumbar puncture, FDG PET

1 INTRODUCTION

Dementia is a clinical syndrome that involves impairment in at least two cognitive domains (i.e. memory, attention, executive functions, visuospatial abilities or language) and interferes with individual's ability to function in their daily activities [1]. It can arise as a consequence of various pathophysiological processes in the brain that start decades before the appearance of the first cognitive symptoms. The most common cause of dementia is Alzheimer's disease that causes 60 to 80% of all dementias [2]. Alzheimer's dementia (AD) is a final stage of Alzheimer's disease whose pathological hallmark is accumulation of misfolded proteins: amyloid β (Aβ) and Tau protein in the brain, which in turn cause synaptic dysfunction and neurodegeneration [3]. AD is usually preceded by symptomatic pre-dementia stage termed mild cognitive impairment (MCI), in which the physician can observe cognitive impairment that does not interfere with individuals' functional abilities [4].

There is a common public misconception that early diagnosis of AD is not essential due to the current lack of a disease-modifying drug. But such diagnosis is of paramount importance. Firstly, it allows people with dementia and their caregivers to

plan ahead and thus ameliorate caregiver burden. Furthermore, certain non-pharmacological interventions are more effective in the earliest stages of AD and early diagnosis can lead to early involvement into drug trials [5]. Additionally, bearing in mind that about 5–10% of patients with MCI progresses to dementia per year [6], we can also highlight the importance of accurate diagnosis of Alzheimer's disease and accurate identification of MCI patients who will progress to AD.

2 DIAGNOSIS OF DEMENTIA

Diagnosis of dementia is inherently linked to firstly, ruling out potentially treatable causes and secondly, diagnosing the underlying neurodegenerative process. In this section, we will first briefly address other, potentially treatable causes of cognitive impairment and then present the biomarkers of the most common neurodegenerative cause of dementia—Alzheimer's disease.

Individuals with cognitive impairment firstly undergo blood screening for systemic abnormalities (vitamin B_{12}, folate, thyroid-stimulating hormone, calcium, glucose, complete blood cell count, renal and liver function) and structural imaging with magnetic resonance imaging (MRI) or at least computer tomography (CT) to exclude other causes of dementia (i.e., tumor, abscess, stroke or normal pressure hydrocephalus) [7]. Core diagnostic criteria for AD are still rooted in clinical presentation, meaning that the physician can make an AD diagnosis even without the use of biomarker information [1]. Because clinical diagnosis of AD is not in concordance with pathological diagnosis in around 30% of cases [8], there has been a shift towards promotion of biomarker-supported diagnosis in recent years [9]. Biomarker is a characteristic that can be measured objectively and reflects a certain biological or pathological process [10]. Various biomarkers are already a part of everyday clinical routine.

Structural MRI is a recommended and widely used imaging method that can be used to assess atrophy in medial and lateral temporal lobe, medial parietal cortices and hippocampi—structures that are affected early and disproportionally in AD. Atrophy reflects the loss of neurons and can be seen clearly as disease progresses, but patterns of atrophy often overlap between different dementia syndromes and changes can be very subtle in early stages. Furthermore, structural MRI is useful for the assessment of the vascular burden—an important co-morbidity in AD [11]. Two other commonly used biomarkers of AD are analysis of cerebrospinal fluid (CSF) and functional brain imaging with 2-[^{18}F]Fluoro-2-deoxy-D-glucose and positron emission tomography (FDG PET). Lumbar puncture is performed to obtain CSF from which concentrations of Aβ_{42}, phosphorylated Tau and total Tau proteins can be measured. Reduction in concentration of Aβ_{42} protein (due to increase in extracellular binding in the brain)

in CSF can be observed decades before appearance of first cognitive symptoms, but $A\beta_{42}$ concentration reaches plateau already in the pre-symptomatic disease stage [12] and is thus not a suitable biomarker of disease progression. Furthermore, lumbar puncture is an invasive procedure with a non-negligible percentage of mild complications such as back pain or headache, however the percentage of serious complications is very low (< 1%) in specialized institutions [13]. FDG PET is a non-invasive brain imaging modality that provides information about synaptic dysfunction, which precedes atrophy, and is commonly used in early detection and differential diagnosis of dementia. Furthermore, it also provides an important insight into disease progression [14]. Because FDG PET imaging involves radiation exposure, it is not recommended to be performed more than once per year. Additionally, FDG PET is a relatively expensive procedure [11].

In summary, while the current biomarkers are able to detect AD in the earliest stages, they are either invasive (e.g., lumbar puncture) or relatively expensive (e.g., MRI, FDG PET). A discovery of a reliable, noninvasive and inexpensive biomarker would thus greatly advance the availability of early diagnosis of AD [15]. The search for such an alternative biomarker has already begun, and the research of the past two decades has yielded important advancements. In the next paragraphs we offer a short overview of one such potential biomarker—eye movements, as tracked via eye tracker. In order to do so, we first need to shift our focus away from the most commonly defined features of AD.

3　VISON IMPAIRMENTS IN ALZHEIMER'S DEMENTIA

As reflected in the clinical diagnostic criteria for AD, described above, the primarily addressed disorders of AD are the disorders of cognitive functioning [1]. However, a common, yet largely ignored feature of AD are also alterations in sensory capacity, particularly in visual processing [16, 17]. These are of extreme importance especially when talking about timely diagnosis of the AD, since they are present already in the early stages of the symptomatic disease [16, 17]. Possibly, these changes are often overlooked due to the fact that they are not present in all types of visual processing. For example, visual acuity, which is most commonly tested when an individual initially complains that their vision is not quite right, is typically no more impaired than in healthy elderly individuals [16]. But additional deficits can be observed in other, more subtle types of visual processing, such as contrast sensitivity (i.e., the ability to distinguish gratings of varying spatial frequencies at different contrast levels) [16], color discrimination (i.e., ability to distinguish different shades of colors) [18, 19], and eye movements [19, 20].

Despite the fact that these deficits are traditionally still not dealt with in clinical environment [21], the last two decades of interdisciplinary research have brought to light numerous new findings, particularly about the eye movement alterations in AD. This field of studies has recently been gaining more and more attention, and has since largely progressed along two lines of research: while the first one deals with correlation of the eye movement alterations and the disease severity, the second one focuses on the applicability of the eye movement alterations for early detection of cognitive decline [e.g., 19, 20]. In the remainder of this abstract, we will address the latter in more detail, and explore the potential of the eye movements as possible biomarker for diagnosis of AD.

3.1　Eye movements and their alterations in AD

Unlike the other methods, described above, eye movements, as tracked and recorded via eye tracker, present a sensitive, non-invasive, and inexpensive method [22, 23, 15], which allows for testing in a simple and everyday-like setup. As such, eye tracking presents an ideal method for testing patients with cognitive decline, since the tasks they perform during testing are relatively natural and thus easily comprehensible, without complicated instructions. Additionally, the method is appealing to the patients also due to the fact that they are simply sitting comfortably in front of a computer screen, while their head is typically stabilized through a chin rest, allowing them to relax their posture without compromising the accuracy of the recording.

In healthy individuals, who are not experiencing any kind of processing difficulties, the typical oculomotor behavior can be described with a series of eye movement measures. Here, we offer a description of two of them as an example. When we, for example, look at a presented picture, search for an object or read a text in font of us, we continuously make rapid linear eye movements—so called saccades, which can reach velocities as high as 500° per second [24]. During a saccade, the sensitivity to visual input is reduced, thus we essentially do not obtain new information from our environment while our eyes are moving [25]. In order to obtain this information, we make a series of stops in between the saccades—so called fixations, which typically last about 250ms [25, 20]. During this time our eyes remain relatively still, focusing on the information that is available in the momentary foveal vision (i.e., the center of the visual field, with the highest visual acuity) [26]. The role of the saccades is thus to move our eyes onto a new region of the processed stimuli, where we make a fixation to bring new informaton into our foveal vision, and consequently into our attention.

The main reason why eye tracking can so readily be used for an early detection of the neurodegenerative alterations is that it allows for a simple investigation of complex viewing behavior that humans automatically engage in when they are driven by top-down, goal-directed processes. Given the intimate link between the eye movements and cognition, any alterations in the typical oculomotor behavior can thus be used to infer AD-related changes in cognitive processing [27]. Carefully selected tasks that trigger complex viewing behavior, in which attention and its allocation, inhibitory control, working memory, or decision-making are required to successfully accomplish a goal, thus present an ideal testbed for early detection of the AD, since all these processes are altered already in the early stages of AD [20]. Importantly, such tasks are already well-defined and well-explored in the frame of studies with healthy participants in the filed of cognitive science. Here, we offer a short overview of the patient's performance in three such tasks: visual search, natural reading and antisaccade task.

3.1.1　Visual search task. In essence, visual search task is goal-directed search for a target (e.g., a specific object) among a number of distractors in an environment [27]. Compared to healthy control participants, patients with AD exhibit delayed target detection [27, 20], longer fixation durations [20, 28] and longer and less systematic exploration [29, 30, 28], which is often described as stochastic [29].

3.1.2　Natural reading task. Despite the fact that reading is an activity in which (literate) humans engage in on an everyday

basis and without much effort, this is a very demanding cognitive task [31, 32, 33, 34]. Successful reading process demands not only simultaneous processing of different linguistic information (e.g., letter identification, morphologic and semantic processing), but also precise coordination, attention allocation and planning (e.g., where and when will the eyes move in the text) [33]. Compared to healthy control participants, patients with AD exhibit a reading pattern that noticeably differs from a typical one, and is similar to alterations described in visual search task: longer fixation durations, increased occurrence of several fixations on the same word (so called refixations), increased number of saccades, which are shorter than the typical span of 8-9 characters [30, 20]. Additionally, there is also an increase of word skips (i.e., number of times a word is not directly fixated) during the first reading, which is accompanied with a larger number of regressions back to the already read parts of the text [26, 20, 30].

3.1.3 Antisaccade task. In a typical anti-saccade task the participants are required to inhibit a reflexive saccadic eye movement towards a presented target. Usually, their eyes are fixated on the central point on the screen until the so called distractor target appears in the peripheral visual field, either left or right of the fixation point. At this timepoint, participants are required to make a saccade to the opposite direction of the screen. Failure to do so results in so called anticcade error. Compared to healthy control participants, patients with AD exhibit an increase in the antisaccade errors [35, 36], as well as also a decrease in the number of corrected errors [36]. A very recent study reveals that such eye movement alterations are already present in patients with MCI. Importantly, these alterations reliably differ between the patients with amnestic and non-amnestic MCI, where the former are at a much greater risk of progressing to AD [15].

4 CONCLUSION

In the recent years, AD research and clinical work is experiencing a shift towards early and biomarker-oriented diagnosis. We are now increasingly more aware of the importance of early detection of the disease, which would significantly contribute to ameliorating the disease burden, while timely and accurate diagnosis could also accelerate the research of disease-modifying drugs. As addressed in this review, several biomarkers which allow for such a timely diagnosis are already available and are an important part of clinical diagnostic. Recently however, a need for a non-invasive and inexpensive biomarker has been emphasized. Eye movements, as tracked via eye tracker, have been proposed as a promising candidate for such a biomarker, since a rapidly growing number of studies in the recent years have demonstrated that they offer a highly reliable and sensitive method for detection of impairment of cognitive control in AD. Importantly, studies demonstrate that the eye movement alterations can, at least in certain tasks, already be observed at the early stages of the AD and even in patients with MCI. Even more importantly, the recent findings indicate that they can also reliably distinguish between the patients with MCI who are at risk of progressing to AD, and those who are more likely to progress to other disorders.

But the gap between the interdisciplinary research and the application of this method to everyday clinical practice still looms large. In the future work, the eye movements should be studied in more detail in a variety of tasks and in patients in different disease stages. Furthermore, prospective longitudinal eye movement studies could offer us an insight into disease progression. This could lead to a development of a sensitive battery of simple tasks, tailored to detecting and monitoring the disease at its specific stages, and to the specific needs of the patients with dementia, who require natural and simple tasks, which do no trigger any discomfort or risk of misunderstanding the task instructions.

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Patterns of Mental Behavior During Psychological Task Performance

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ABSTRACT

Psychological tasks are one of the main instruments used in experimental sciences of the mind. Recent meta-psychological discussions have shed light on the phenomenology, research design structure, and generalizability of psychological tasks. However, it remains unclear how psychological task performance modifies consciousness. Subjective reports on the experience of psychological task performance were gathered. A constructivist grounded theory approach was employed for analysis. A number of patterns of mental behavior and experiential states associated with psychological task performance are discussed.

KEYWORDS

Psychological task, constructivist grounded theory, mental behavior

1 INTRODUCTION

Psychological tasks are one of the main instruments used in experimental cognitive science. They are typically relatively simple, computerized activities, whereby mental phenomena are isolated and made measurable [1]. It has long been understood that psychological tasks constitute a culturally specific and artificially constrained context of inquiry [2, 3]. Recent discussions have attempted to add to the meta-psychological and anthropological understanding of psychological tasks by explicating the general phenomenology associated with the performance of psychological tasks [1], their formal structure as it pertains to their research designs [4], their generalizability [5] and in what manner participants respond to them [6].

It has been noted by Froese and colleagues that specific types of complex systems are characterized by the *theory-experience gap;* i.e., we cannot claim *a priori* as to how the complex system will modify the structure of consciousness of the individual interacting with it [7]. In its original formulation, the theory-experience gap refers to novel systems, such as virtual reality. However, it has recently been shown that psychological task performance is associated with a relatively large array of unexpected experiential states as well [8].

The goal of this study is to contribute towards the general meta-psychological understanding of interacting with a psychological task in a research setup; i.e., what is the experience of performing a psychological task *as such,* rather than a *specific* psychological task. As the purpose of the psychological task is to elicit a specific cognitive function, this study is interested in the patterns of mental behavior when participants are exposed to any experimental setup.

2 METHOD

18 participants (10 females) gave their oral consent to participate in the study. The average age of participants was 27.2 (SD = 2.9). All the participants were right-handed. Except for one, all the participants were current or former students of cognitive science. The average total number of years of education for participants was 15.8 (SD = 1.15). The participants were informed ahead of time that they will be participating in a psychological study.

The participants sat in front of a laptop, displaying a blank screen. Throughout the study, the researcher sat behind them. They received the following set of instructions: *There will be an image displayed on the computer screen for 10 seconds. I would like you to observe the image without doing anything with it or performing any mental gestures upon it. All you have to do is to focus on it.*

A randomly selected stimulus appeared on screen. There were four possible stimuli. They were all composed of a grid with some boxes filled in black, and other boxes left empty (i.e., white). After 10 seconds elapsed, the participants were prompted to report on their experience of observing the stimulus.

The researcher guided the participant through the subjective report. Initially, the participant was asked to provide a rough overview of their experience of the observation of the stimulus. Afterwards, the researcher guided the participants through each salient event that was mentioned in the initial overview. The participant was asked open-ended follow-up questions regarding each event until a precise description of how it had been experienced was achieved. To promote a detailed account, the researcher consistently recapitulated parts of the subjective report under discussion. The descriptions were considered valid, if they were grounded in a) bodily feelings; b) sensory modalities; c) mental gestures; and d) attitudes. Descriptions of theoretical concepts, folk psychological assumptions, or metaphorical ideas were considered invalid.

After each mental event was grounded in a concrete description of experience, a debriefing interview about the interview itself was conducted. The participants were asked about how they experienced the interview and the research setting. If the participants reported an awareness of confabulating a specific aspect of the report or a social distance from the researcher, the sample was discarded. Three samples were removed. The entire interview was recorded on an audio recording device.

3 ANALYSIS

In total, 15 admissible samples were gathered. The samples were analyzed according to the principles of constructivist grounded

theory [9]. The audio recordings were transcribed verbatim. Descriptions of theoretical concepts, folk psychological assumptions, and metaphorical ideas were removed. The data were analyzed via coding: general descriptive tags were assigned to the concrete subjective reports. In order to minimize bias, a meaningful code was assigned to each line of the interview. The data were coded inductively: the codes emerged from the text rather than from the scientific literature. Each category was given a name and specified according to a) its salient phenomenological properties; b) relationships to other categories; and c) meaningful quotes from the transcripts.

The data were coded on two levels: a) relational and b) experiential. The former refers to the abstract relationships between types of mental behaviors relative to how the participants performed the task. The latter refers to the categories constructed on the basis of subjective reports relative to participants' bodily feelings; sensory modalities; mental gestures, and attitudes as they pertain to individual mental behaviors.

As individual samples displayed a high degree of variability (i.e., experience rapidly changed from moment to moment), each sample was assigned a number of both relational and experiential categories. Thus, a given category may have appeared more than once within a single sample. The number of categories assigned to each sample depended on the variability of experience and thus varied from sample to sample. For the sake of parsimony, relational categories - where variability was the highest - were grouped together into typical *patterns of mental behavior.* These patterns are presented in Section 5 in the form of grounded theory.

4   RESULTS

4.1 Relational categories

Four categories of mental behavior were induced from the data:
a) *nominal task performance*;
b) *constructed task performance*;
c) *mind-wandering*;
and d) *ambiguity*.

Nominal task performance (NT) refers to situations in which participants' phenomenology is congruent with the phenomenology expected by the design of the task. In the case of the simple observation task used in this study, *nominal task performance* refers to experiential states that amount to a disengaged, receptive observation of the stimulus. NT was observed 13 times (on average 0.86 times per participant).

Constructed task performance (CT) refers to situations in which participants deviate from the task that was created by the researchers. Phenomenologically-speaking, *constructed task performance* is characterized by goal-oriented mental behavior, however, the goal itself is something that the participants constructed anew. As participants had a background in cognitive science, they constructed a novel task because they were distrustful of the researcher's instructions. Thus, the tasks that were typically constructed were associated with well-known cognitive functions (e.g., pattern recognition, geometric analysis of stimuli, working memory). CT was observed 12 times (on average 0.8 times per participant).

Mind-wandering (MW) refers to situations in which participants engage in mental behavior that is unrelated to the *nominal task performance* but is itself not oriented towards a task. Participants engage in remembrance (i.e., contemplating various memories from their own life), reverie (i.e., engaging in fantastical stories about their own life), planning (i.e., thinking about the future), and, interestingly, theorizing about the nature and purpose of the psychological research design and/or the algorithmic structure of the code running the task itself. MW was observed 6 times (on average 0.4 times per participant).

Finally, *ambiguity* (AM) refers to moments of disengagement from any explicit mental behavior. Participants find themselves unsure as to what they are supposed to do. AM therefore amounts to an attitude of searching for the appropriate mental behavior. AM was detected 14 times (on average 0.93 times per participant).

4.2 Experiential categories

Qualitatively, the most salient aspects of experience in relation to mental behavior were the *sense of agency* and *attentional dispositions.* Three experiential categories of *sense of agency* were induced from the raw data:
a) *willful;*
b) *automatic;*
and c) *vetoable.*

Willful sense of agency refers to the experience where participants felt that a particular event that occurred in their awareness was the result of their action. In total, *willful sense of agency* was observed 15 times (on average 1.0 times per participant). *Automatic sense of agency* refers to the experience where participants felt that a particular event that occurred in their awareness was something that happened to them. In total, *automatic sense of agency* was observed 19 times (on average, 1.27 times per participant). Finally, *vetoable sense of agency* refers to situations where participants felt that a particular event that occurred in their awareness was something that was happening to them; however, they had the capacity to continue to enact this event or terminate it. *Vetoable sense of agency* was observed 15 times (on average 0.4 times per participant).

Attentional disposition is an aspect of experience that refers to an attitude taken in attention to a particular object of one's perception. Based on this attitude, the object itself may be experienced differently. Three experiential categories of *attentional dispositions* were induced from the raw data:
a) *progressive;*
b) *receptive;*
and c) *distant.*

Progressive attentional disposition is an aspect of experience wherein participants experience themselves going towards the psychological task. While mostly attentional, this experience can be so salient that it is experienced as a force, located beyond one's body, going forward or bodily sense of leaning forward. *Progressive attentional disposition* was observed 24 times (on average, 1.6 times per participant). *Receptive attentional disposition* is an aspect of experience wherein participants experience the psychological task coming towards them. While mostly attentional, this experience can be so salient that it is experienced as a force, located beyond one's body, pulling them

away from the task, or a bodily sense of leaning backwards. *Receptive attentional disposition* was observed 10 times (on average 0.67 times per participant). *Distant attentional disposition* is an aspect of experience wherein participants experience an attentional disconnect from the task. Commonly described as "looking but not seeing," this experience may be so salient that the psychological task fades from participants' awareness. *Distant attentional disposition* was observed six times (on average, 0.4 times per participant).

5 GROUNDED THEORY

Individual states relative to the performance of the psychological task did not appear in isolation. Rather, within a single performance, participants underwent a number of states of mental behavior. The manner in which states followed each other formed a number of patterns. These patterns are outlined in this section. Six patterns of mental behavior relative to the performance of the psychological task were detected:

a) *simple coalescence*;
b) *complex coalescence*;
c) *simple tangentiality;*
d) *complex tangentiality*;
e) *digression*; and
f) *separation*. On the basis of reports from the literature, another pattern of mental behavior is conjectured:
g) *breakdown*.

Coalescence is a descriptive tag for a pattern of mental behavior that tends towards NT. *Simple coalescence* refers to situations in which participants transition directly from AM towards NT. *Complex coalescence* refers to situations in which participants begin with AM, transition towards a number of states unrelated to NT, but ultimately tends towards NT.

Tangentiality is a descriptive tag for a pattern of mental behavior that tends towards CT. *Simple tangentiality* refers to situations in which participants transition directly from AM towards CT. *Complex tangentiality* refers to situations in which participants begin with AM, transition towards a number of states unrelated to CT, but ultimately tend towards CT.

Digression is a descriptive tag for a pattern of mental behavior that initially tends towards NT, digresses into mental behaviors unrelated to NT, and ultimately returns to NT.

Separation is a descriptive tag for a pattern of mental behavior that tends towards MW.

Finally, a hypothetical pattern of mental behavior needs to be addressed. While not observed in this study, empirical phenomenological studies report on the category of *informational chaos* [8, 10]. It refers to experiences of extreme

AM. The participants feel that the psychological task is too complex to be solvable. This feeling may be associated with negative emotional valence. Based on these reports, another pattern of mental behavior is conjectured: *breakdown. Ex hypothesi*, *breakdown* refers to the pattern of mental activity that begins with AM and tends towards the experience of *informational chaos*. In these cases, individuals cannot tie the psychological experience to a mental strategy known to them from everyday life [1]. Depending on the task design, this outcome may be undesirable.

6 CONCLUSION

The study represents a continuation of qualitative inquiries into the meta-psychology of psychological task performance (e.g., Morrison et al., 2019). A grounded theory is proposed that may assist in future understanding of psychological tasks, in particular, what is the dynamics whereby they isolate the intended cognitive functions or an unrelated self-imposed task.

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Vpliv posturalnih perturbacij na stresni odziv pri človeku

Effects of Postural Perturbations on Human Stress Response

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POVZETEK

Namen tega dela je bil opazovati stresni odziv, ki se pojavi takoj po motnji stabilnosti. Zanimalo nas je i) kako se stresni odziv spreminja s spremembo smeri posturalne motnje in ii) če pride do prilagoditve po več (devetih) zaporednih posturalnih motnjah. Za oceno stresnega odziva smo uporabili meritev elektrodermalne aktivnosti. Analiza je pokazala, da se splošno vzburjenje ni spremenilo s spremembo začetne smeri motenj. Ko pa se je smer posturalne motnje spremenila iz naprej v nazaj, so se udeleženci odzvali hitreje in močneje. Pri ponavljajočih se posturalnih motnjah se je splošno vzburjenje zmanjšalo, udeleženci pa so se po deveti zaporedni motnji odzvali hitreje in močneje. Nobena sprememba v tej pilotni študiji ni bila statistično pomembna. Znanje, pridobljeno s tem delom, prispeva k boljšemu razumevanju stresnega odziva človeka na posturalne motnje.

KLJUČNE BESEDE

Elektrodermalna aktivnost (EDA), posturalne perturbacije, posturalne motnje, stresni odziv, motnje stabilnosti

ABSTRACT

The purpose of this work was to observe the human psychophysiological stress response, which occurs right after a stability disturbance. We were interested in i) how the stress response changes with the change in direction of a postural perturbation and ii) if there is any adaptation after several (nine) consecutive postural perturbations. Electrodermal activity was used to assess the stress response. The analysis showed that the general arousal did not differ with the change in the initial direction of perturbation. However, when the direction of postural perturbation was changed from forward to backward, subjects reacted faster and more strongly. In recurrent postural perturbations, general arousal decreases, and subjects respond faster and stronger after the ninth consecutive perturbation. Since this was a pilot study and only four healthy volunteers participated, none of these results were statistically significant. The knowledge gained from this work contributes to a better understanding of human stress response to postural perturbations.

KEYWORDS

Electrodermal activity (EDA), postural perturbations, stress response

1 UVOD

Zmožnost ohranjanja stabilne, pokončne drže med soočanjem z motnjami ravnotežja je kritična komponenta vsakdanjega življenja. Motnje ravnotežja so lahko zunanje (npr. neravna podlaga, slaba osvetljenost okolice, obutev) ali notranje (npr. stanje ravnotežnega organa, posledice starostnih degenerativnih bolezni, utrujenost, posledice zdravil). Padci in poškodbe, povezane s padci, predstavljajo globalno skrb za javno zdravje naših starajočih se družb [1].

Za nadzorovanje stabilnosti in orientacije človeškega telesa skrbi posturalni nadzorni sistem. Posturalna orientacija je definirana kot sposobnost vzdrževanja primerne poravnave med deli telesa in poravnave telesa glede na okolje [2]. Posturalna stabilnost ali ravnotežje telesa je sposobnost nadzorovanja središča mase (ang. Centre of Mass – CoM) oz. projekcije CoM glede na podporno ploskev (ang. Base of Support – BoS) [2]. Podporna ploskev zajema območje pod predmetom ali osebo, ki vključuje vsako točko stika, ki jo predmet ali oseba naredi s podporno površino in vso površino vmes. Te točke stika so lahko deli telesa (npr. stopala ali roke) ali predmeti (npr. stol, na katerem oseba sedi) [3].

Center mase - CoM je definiran kot točka v središču celotne mase telesa [4]. Določimo ga kot uteženo povprečje centrov mas vseh segmentov telesa. CoM ni fizična spremenljivka, ampak virtualna točka v prostoru, ki je odvisna od položaja vseh delov telesa. CoM je ključna spremenljivka, ki jo nadzira posturalni nadzorni sistem [4].

Središče pritiska (ang. Centre of Pressure – CoP) je vsota vseh sil in navorov, ki jih povzroča telo na podporno površino [2]. Pri izgubi nadzora položaja telesa se projekcija CoM premakne iz mej podporne ploskve. Meje stabilnosti predstavljajo območje, znotraj katerega lahko telo ohrani stabilno lego brez dodatne spremembe BoS.

Predhodni dokazi kažejo, da se lahko po nestabilnosti pojavi simpatična modulacija, ki podpira hipotetično vključenost avtonomnega živčnega sistema (AŽS) v posturalno kontrolo [5, 6]. Simpatična modulacija oz. kompenzacijski posturalni odziv

je po motnji stabilnosti pomemben za ohranjanje ravnotežja in preprečevanje padca.

Avtonomni živčni sistem se deli na parasimpatično in simpatično živčevje. Fiziološke posledice aktivacije simpatičnega živčnega sistema so npr. pospešeno bitje srca, pospešeno in bolj globoko dihanje, razširjene zenice, povečan krvni tlak, upočasnjena presnova hrane, zakrčenost mišic ter povečana prevodnost kože [7]. Našteti pojavi so del stresnega odziva. Nacionalni institut za javno zdravje je stres definiral kot:

»… normalen odziv posameznika, kadar je začasno porušeno njegovo ravnovesje (telesno ali duševno) zaradi notranjih ali zunanjih vplivov (stresorjev). Stresorji so lahko pojavljajo v različnih oblikah. Lahko so manjši (npr. gneča na cesti) ali večji (npr. smrt v družini), zunanji (npr. kratek časovni rok za določeno delovno nalogo) ali notranji (npr. skrbi, črne misli), negativni (npr. prometna nesreča) ali pa celo pozitivni (npr. rojstvo otroka). Enak dogodek bo nekomu predstavljal stresor, drugemu pa spodbudo, odvisno od posameznikove osebnosti, izkušenj.« [8]

Kot stimulus, ki sproži stresni odziv opazovane osebe, lahko obravnavamo tudi posturalno motnjo, ki vpliva na premik osebe iz ravnotežja. V tej študiji nas je zanimalo, kakšni so psihofiziološki odzivi človeka ob nepričakovanih motnjah stabilnosti, da bi potrdili domnevno vključenost AŽS pri posturalnem nadzoru.

Oblikovali smo naslednji hipotezi: i) stresni odzivi se razlikujejo glede na začetno smer posturalne motnje (H1) in ii) stresni odziv se spremeni po več (devet) zaporednih motnjah enake amplitude in smeri (H2). Če bi hipotezi potrdili, bi pridobili še dodatne informacije o opazovani povezavi med stresom in posturalnim nadzorom. Ugotovili bi, kako sprememba smeri posturalne motnje in kako ponavljajoče posturalne motnje vplivajo na stresni odziv.

2 METODE

2.1 EKSPERIMENTALNI PROTOKOL

Štirje mladi odrasli (povprečna starost; standardni odklon (SD): 22,3 leta, SD = 2,4 leta), dva moška in dve ženski, so prostovoljno sodelovali pri eksperimentu. Vsi so bili zdravi, brez nevroloških in mišičnih posebnosti. Kandidati so bili seznanjeni s potekom meritev in podpisali so izjavo o prostovoljni in zavestni privolitvi po poučitvi.

Pred prihodom udeleženca sta bili izmerjeni temperatura in vlaga v prostoru (povprečna temperatura = 24,3 °C; STD: 0,5 °C, povprečna vlaga 42,2 %; SD = 1,9 %). Udeležence smo stehtali (povprečna teža = 65,6 kg; SD = 14,3 kg) in nanje namestili merilno napravo za merjenje elektrodermalne aktivnosti (EDA) Shimmer GSR Plus (Shimmer Sensing, Dublin, Ireland. Frekvenca vzorčenja: 504,3 Hz). Elektrodi za merjenje EDA sta bili nameščeni na proksimalni prstnici kazalca in sredinca njihove nedominantne roke. Za preprečevanje motenj v signalu elektrodermalne aktivnosti zaradi drgnjenja prstov smo jim uporabljena prsta (sredinec in kazalec) stabilizirali z lepilnim trakom. Med nameščanjem merilnih naprav so udeleženci odgovorili na nekaj vprašanj o svojem splošnem počutju, kar jim je omogočilo, da so se lahko privadili na laboratorijsko okolje in prisotnost vseh naprav. Udeležencem smo namestili še prilagojen
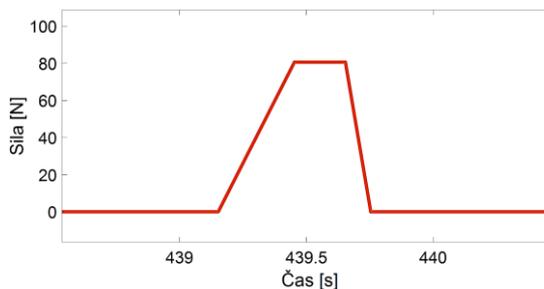
pas, ki omogoča priklop jeklenice. Jeklenica je bila del sistema za izvedbo posturalnih motenj z določeno silo, ki jo generirata dva električna servomotorja (Festo model EMMS-AS-100 z nazivnim navorom 5,69 Nm). V pasu je bil nameščen tudi aktivni optični marker, ki je bil del optičnega sistema Optotrak 3D Investigator (Northern Digital Incorporated, Kanada. Frekvenca vzorčenja: 1000 Hz), s katerim ocenjujemo položaj približka centra mase udeleženca.

Pred začetkom eksperimenta smo vsem udeležencem podali enotna navodila o njihovi nalogi, ki je bila, da v primeru posturalne motnje poizkusijo ohraniti svoj položaj na mestu, kjer stojijo. Merjenje se je začelo z dvominutno stojo na dveh pritiskovnih ploščah (Kistler Instrumente AG, Winterthur, Switzerland. Frekvenca vzorčenja: 1000 Hz) za zajem začetnega stanja. Prva motnja (prvi poteg jeklenice) je bila prožena ročno, ko smo sami ocenili, da je vrednost signala EDA, izrisana v realnem času, razmeroma konstantna (ni več sunkovito naraščala ali padala). Vsaka naslednja motnja je bila ročno prožena, ko se je udeleženec umiril (relativno gledano glede na začetno stanje vrednosti EDA). Motnje so bile izvedene v smeri naprej – nazaj. Vsi udeleženci so skupno prejeli deset motenj. Smer začetne sile je bila naključna, dva udeleženca sta začela z motnjami naprej in dva nazaj. Preostalih devet motenj je bilo izvedenih v nasprotno smer od tiste, s katero so udeleženci začeli.

Profil generirane sile električnih servomotorjev, prikazan na sliki Slika 1, smo časovno razdelili na tri dele v razmerju 3:2:1, kjer v prvem delu sila narašča, v drugem delu je konstantna in v tretjem pojema. Amplituda sile je določena z enačbo:
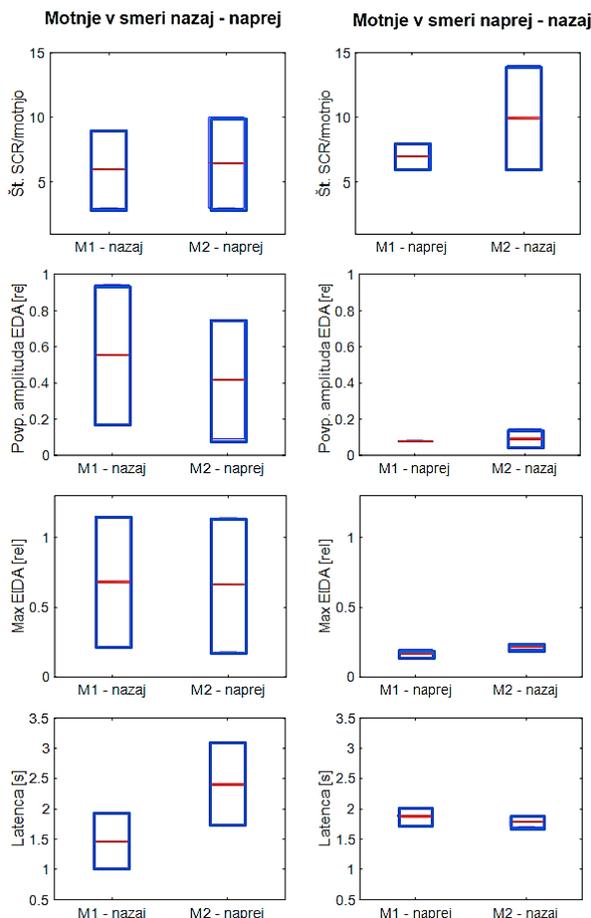
$$F = m * g * k = m * 9,81 \frac{m}{s^2} * 0,11, \quad (1)$$

kjer F predstavlja amplitudo sile v N, m je masa v kg, g je gravitacijski pospešek v m/s^2, k pa koeficient, ki predstavlja delež telesne mase preiskovanega udeleženca in je brez enote.

Slika 1: Profil uporabljene sile generirane na električnih servomotorjih.

Konstanta 0,11 izhaja iz ugotovitev študije [9], kjer so izvajali podobne posturalne motnje in uporabili koeficiente od 2,75 % do 22 % telesne mase. V rezultatih so predstavili, pri katerem koeficientu mora po povzročeni sili oseba narediti korak, da ohrani ravnotežje. Mejna vrednost, ko osebi še ni potrebno narediti koraka, je glede na njihove ugotovitve znašala 0,11 za motnje v smeri naprej. Za motnje v smeri nazaj smo sami preverili mejno vrednost po principu preizkušanja, ki pa se je izkazala za identično smeri naprej. Izbrani vrednosti koeficientov za smeri naprej in nazaj k(naprej) = 0,11, k(nazaj) = –0,11.

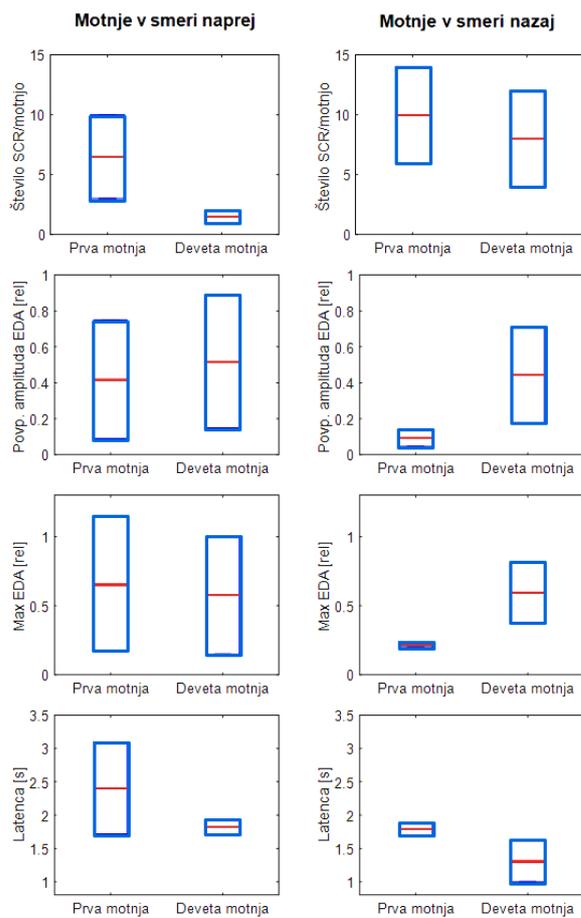**Slika 2: Rezultati analize EDA pri protokolu menjava smeri motnje.**

Slika 3: Rezultati analize EDA pri protokolu ponavljajoče motnje.

2.2 OBDELAVA PODATKOV IN ANALIZA

Merilnik Shimmer GSR+ za merjenje EDA zajema upornost kože v kΩ, zato smo najprej naredili pretvorbo upornosti v prevodnost (v µS). To smo naredili zato, ker je prevodnost v µS standardna veličina za opazovanje stresnega odziva. Zaradi razlik v tonični komponenti, ki so posledica različnih medosebnih lastnosti, smo celoten signal EDA normirali na začetno vrednost. Vzorčna frekvenca, ki smo jo uporabili za zajem tega signala, je bila 1000 Hz, nato smo jo pred začetkom analize zmanjšali na 100 Hz. Sledi segmentacija glede na dovedene posturalne motnje. Segment je bil definiran kot območje od začetka motnje do začetka naslednje motnje.

Za nadaljnjo analizo smo uporabili program Acqknowledge 4.1 (Biopac Systems Inc., USA), ki nam omogoča takojšnji izris, raznovrstne transformacije in specifične analize različnih bioloških signalov. Najprej smo ločili signal na fazično in tonično komponento s funkcijo »Derive Phasic EDA from Tonic«, ki uporabi visokoprepustni filter z mejno frekvenco 0,05 Hz, da pridobi novo fazično komponento iz podanega začetnega toničnega signala [10]. Uporabili smo algoritem »Locate SCRs«, ki na podlagi pragovne vrednosti signala (v našem primeru 0,02 µS) v fazični komponenti poišče odzive prevodnosti kože (SCR), ki so definirani od trenutka, ko pulz EDA prekorači to pragovno vrednost v omejenem časovnem intervalu (npr. pulzi, ki se

pojavijo v manj kot 9 s od začetka naraščanja) pa do padca na vrednost nič. Nastavili smo tudi zavračanje vrhov, ki so manjši od 10 % največjega vrha. Parametri, ki smo jih pridobili za posamezno opazovano motnjo:

- Število SCR-jev na motnjo je mera trenutnega vzburjenja udeleženca in je število vrhov signala prevodnosti kože. Vrednost nekaj SCR/min nakazuje, da je udeleženec miren, vrednost nad približno 20 SCR/min pa nakazuje na stanje vzburjenosti [11].
- Latenca je časovno trajanje med začetkom dražljaja in začetkom prvega odziva SCR (v sekundah).
- Amplituda SCR je razlika med največjo vrednostjo, ki jo doseže posamezen vrh, in vrednostjo pred začetkom odziva oz. naraščanja signala EDA. Iščemo povprečno in največjo amplitudo.

3 REZULTATI

3.1 Vpliv spremembe smeri posturalne motnje na stresni odziv

Za preverjanje H1 smo prvo in drugo motnjo izvedli v različnih, nasprotujočih si smereh. Dva udeleženca sta začela z motnjo v smeri naprej, nato pa sta prejela vse preostale motnje v smeri nazaj. Preostala dva udeleženca sta naredila ravno obratno. Na

sliki Slika 2 so prikazani rezultati analize EDA pri protokolu menjava smeri motnje. Prva vrsta prikazuje število odzivov prevodnosti kože (SCR) [št. SCR/motnjo], druga vrsta prikazuje povprečno amplitudo odzivov prevodnosti kože (SCR) [μS], tretja vrsta prikazuje največjo amplitudo odzivov prevodnosti kože (SCR [μS]), četrta pa latenco [s] prvega odziva SCR. Vsi grafi prikazujejo vrednosti, ločene za prvo in drugo dovedeno motnjo. Parametri v prvem stolpcu so rezultati udeležencev, ki so prejeli prvo motnjo v smeri nazaj. Drugi stolpec vsebuje rezultate udeležencev, ki so prejeli prvo motnjo v smeri naprej.

Stopnja splošne psihofiziološke vzburjenosti se s spremembo smeri začetne motnje ni razlikovala. Kljub temu pa vidimo, da so se udeleženci ob spremembi naprej – nazaj pri drugi motnji hitreje in močneje odzvali, na kar nakazujeta zmanjšana latenca in večja vrednost stresnega odziva.

3.2 Vpliv ponavljajočih posturalnih motenj na stresni odziv

Na vsakega udeleženca je bilo v eni smeri (naprej ali nazaj) izvedenih devet zaporednih posturalnih motenj iste amplitude, za preverjanje H2. Ker je bila med prvo in drugo motnjo prisotna sprememba smeri, smo za analizo ponavljajočih se motenj iste smeri vzeli drugo in deseto izmed vseh motenj, ki predstavljata prvo in deveto motnjo v isto smer (naprej ali nazaj). Na sliki **Error! Reference source not found.** so prikazani rezultati analize EDA pri protokolu ponavljajoče motnje. Prva vrsta prikazuje število odzivov prevodnosti kože (SCR) [št. SCR/motnjo]. Druga vrsta prikazuje povprečno amplitudo odzivov prevodnosti kože (SCR) [μS]. Tretja vrsta prikazuje največjo amplitudo odzivov prevodnosti kože (SCR [μS]). Četrta vrsta prikazuje latenco [s] prvega odziva SCR. Vsi grafi prikazujejo vrednosti ločeno za prvo in drugo dovedeno motnjo. Parametri v prvem stolpcu so rezultati udeležencev, ki so prejeli ponavljajoče motnje v smeri naprej. Drugi stolpec vsebuje rezultate udeležencev, ki so prejeli ponavljajoče motnje v smeri nazaj.

Splošna vzburjenost se je po devetih zaporednih motnjah zmanjšala ne glede na smer perturbacije. Zmanjšanje splošne vzburjenosti je bilo manjše ob perturbacijah v smeri nazaj. Udeleženci so se hitreje in močneje odzvali na stimulus po deveti zaporedni motnji, na kar nakazujejo povišana povprečna in največja amplituda ter zmanjšana latenca.

4 RAZPRAVA

Rezultati prvega dela nakazujejo, da so bili udeleženci po drugi motnji bolj vzburjeni, če so najprej izkusili posturalno motnjo v smeri naprej in nato še v smeri nazaj. Sklepamo, da je vzburjenost narasla po motnji v smeri nazaj, zato ker udeleženci niso imeli vizualnega nadzora nad okolico v smeri premika. Vizualni nadzor (vid) zagotavlja dodatne informacije o dogajanju v okolici. Iz rezultatov drugega dela sklepamo, da se po deveti zaporedni posturalni motnji vidi adaptacijo udeležencev na to posturalno motnjo. Zaradi majhnega števila udeležencev v tem pilotskem eksperimentu so naši rezultati omejeni in niso bili statistično značilni. Nekateri parametri sicer nakazujejo razlike med spremembo smeri posturalne motnje in izvajanjem več zaporednih posturalnih motenj, vendar ne moremo nobene hipoteze potrditi ali ovreči. Z eksperimentom

smo nakazali smernice za nadaljnje raziskave. Za zanesljivejšo in bolj statistično značilno študijo bomo testirali več oseb. Eksperiment bi v prihodnje lahko razširili še z motnjami v smeri levo-desno in tako upoštevali, da se oseba v realnem okolju giblje v vseh smereh. Znanje o spremembah stresnega odziva med soočanjem s posturalnimi motnjami lahko prispeva k izboljšavi aplikacij meritev stresa v realnem okolju in odpira nove možnosti uporabe ter razumevanja človeškega telesa.

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Facial skin temperature during deception

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ABSTRACT

Measuring peripheral tissue temperature is a well-known methodology to assess different physiological states of a body. It is also widely used in a clinical environment. On the other hand, measuring facial skin temperature for the identification of the psychological state of a person is not so common. This article will provide information on non-contact measurements of facial temperature in comparison with established psychophysiological measuring systems (electro-dermal activity and heart rate) for 24 participants. The experiment consisted of two different states of cognitive loads which were expressed through the narration of a true and untrue story. During a narration, on selected regions of interest (ROI), subjects were monitored using a thermographic camera. Although the results did not show statistically significant differences between the true and untrue story for facial thermal measurement (in inter-person and intra-person comparison), some differences did appear. Results of this study showed, a critical approach using information on a camera's accuracy, human skin properties, and other technical concerns) is needed when using facial temperature measurements with a thermographic camera for a reliable evaluation of different psychological states or loads.

KEYWORDS

Psychophysiology, thermal imaging, facial temperature, deception

1 INTRODUCTION TO THERMAL IMAGING

Historically, body temperature measurement for monitoring illness was very important. In early examinations, physicians observed mud when applied to the skin, on areas over the tumor mud was drying faster. First clinical thermometer was developed by Carl Wunderlich in 1868 and its principle is still in use [1]. Thermal imaging camera was invented by Hungarian physicist Kalman Tihanyi in 1929 for anti-aircraft defense in Britain [2]. Firstly thermal imaging cameras were long been in use for specialized law enforcement and military applications and soon later by the fire services [3]. A major development of electronic sensors for infrared radiation was in the early 1940s with indium antimonide, and the first medical images were made in London in 1959 – 1961 by a technique called thermogram [1]. Articles with thermal imaging correlating of psychophysiology are not so common but some studies have proven that with thermal imaging one can detect deception or lie with great accuracy [4–8].

2 METHOD

Research is based on an experiment with various measurements of physiological parameters. As a baseline method for psychophysiological measurements, electrodermal activity measurements were used [9–12]. In the experiment volunteered 24 healthy participants, of those 15 men and 9 women aged from 20 to 45 years old $23,9 \pm 5,0$. After reviewing the measured parameters, we included data from 9 persons in further analyzes, because, due to incomplete data or inadequately measured parameters. Monitoring parameters were: electrodermal activity, skin temperature, and heart rate. Psychological evaluations were done through interviews and standardized STAI-X1 agitation questionnaires.

2.1 ELECTRODERMAL ACTIVITY

Electrodermal activity (EDA) is a dermal property that is caused by different responses in electrical characteristics of the skin [13]. EDA has two components, the skin conductance level (SCL) and skin conductance response (SCR). SCL value describes the level of person psychological excitement, and SCR is the number of responses to the stimulus. The peak amplitude is typically reached within 1 to 3 s after the onset of the response [14]. EDA was measured with Biopac MP150 system (BIOPAC Systems, Inc., USA) and unit Biopac GSR 100C connected to silver electrodes on index and ring finger pads of nondominant hand as shown in figure 1. EDA data was processed by BIOPAC AcqKnowledge 5.0 software.

Figure 1: Illustrated human hand with corresponding signals measured on finger pads. Electrodermal activity on the index and ring finger, heart rate on the middle finger, and skin temperature on the little finger

2.2 SKIN TEMPERATURE

Skin temperature depends on the blood flow to the subcutaneous tissue. It may also depend on external factors such as exercise, ambient temperature, or medical condition. The temperature was measured on a little finger pad of the non-dominant hand (Figure 1). Contact temperature measurements were done with Biopac SKT 100C connected to the thermocouple. Contactless skin temperature measurements were done with a black-body calibrated Flir 650sc camera (FLIR Systems, USA). Camera uses a microbolometer type of detector with a resolution of 640 x 480 pixels. The camera was positioned 1 meter in front of the participant. Emissivity was set to 0.98 [15]. We have analyzed three main regions on the face. Size of regions of interest (ROI) were 2512 pixels for the forehead, 445 pixels for the nose, and 710 pixels for cheeks as seen in figure 2. Sampling frequency was set to 15 frames per second. Temperature was recorded as mean value with standard deviation for each ROI last 100 frames of each story and analyzed with FLIR ResearchIR Max software.
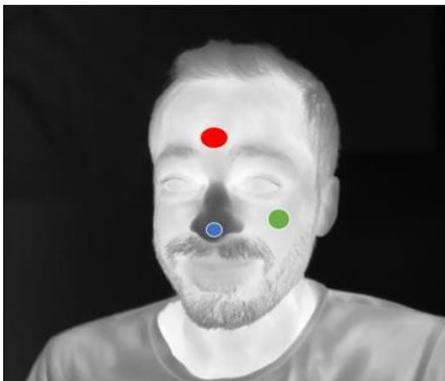

Figure 2: Capture from video taken with Flir 650sc, marked with positions of ROIs (red - forehead, blue - nose, green – cheeks)

2.3 HEART RATE

The heart cycle is the action of the human heart from one heartbeat to another. The cardiac cycle consists of two periods of time when the heart muscle relaxes and fills with blood (diastole) and the time of intense contraction and pumping of blood (systole). Heart rate is stable in a healthy adult at a rate of between 60 and 100 beats per minute. Heart rate was measured with Biopac module PPG 100C and an optical sensor placed on the middle finger pad of the nondominant hand (Figure 1). Heart rate and heart rate variability were processed with BIOPAC AcqKnowledge 5.0 software.

2.4 EXPERIMENTAL SETUP

Prior measurements, the experimenter records the temperature of the room, prepares a statement, psychological questionnaires, and calibrates the electrodes to measure the electrodermal activity of the skin. Participant is invited to the room and is asked to turn off cellphone and any other potentially disturbing factors. Experiment begins with an introduction interview, sensors placement on the participants hand (Figure 1), and STAI-X1 agitation questionnaire followed by the experimenter's general

neutral questions designed to relax participant. During this period participant also acclimatizes to room temperature. Participant is asked to tell two stories, one true and the other untrue. The stories should last for a maximum of 2 minutes each and should relate to the events of participants previous day. The participants choose the order of true and untrue stories by themselves. Before storytelling, a thermographic camera is set to recording. The recording was started remotely via a computer, eliminating the disturbance of the experimenter. After storytelling was completed, participants revealed which story was true and which not, at the same time, experimenter stopped all measurements. At the end of the experiment, participants resolved the STAI-X1 agitation questionnaire.
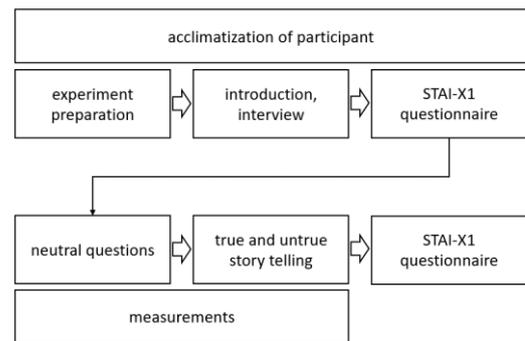

Figure 3: Block diagram of experiment flow

3 RESULTS

Measurements for forehead and nose were calculated with statistical Wilcoxon signed-rank test. Results showed that forehead temperature between untrue story (Mdn = 35.13) and true story (Mdn = 35.17) does not show statistically significant differences, $Z = –0.451$; $p < 0.652$; $r = 0.101$. Also, temperature of a nose between untrue (Mdn = 28.54) and true (Mdn =28.53) did not show statistically significant differences $Z = –0.568$; $p < 0.570$, $r = 0.127$. For temperature of the cheeks we used two-tailed test for the dependent samples which showed us there is no statistical difference between the untrue story M = 34.04; SD = 1.77) and true story (M = 34.07; SD = 1.60) $t(8) = –0.214$; $p = 0.836$.

For the EDA, two-tailed paired t-test did not show statistical difference between untrue story (M = 6.22; SD = 3.03) and true story (M = 5.78; SD = 2.59) $t(8) = 0.627$; $p < 0.548$.

For the finger temperature calculated with statistical Wilcoxon signed-rank test we did not find statistical difference between untrue story (Mdn = 24.49) and true (Mdn = 24.88) story, $Z = –1.035$, $p < 0.301$, $r = 0.231$. Also, we did not find statistical difference for heart rate between untrue story (Mdn = 95.66) and true (Mdn = 93.12) story, $Z= –0.339$; $p < 0.734$; $r = 0.0759$.

4 DISCUSSION

The major limitations of this study are: i) complexity of the psychological phenomena under observation (lying is difficult to induce), ii) moving artefacts due to the physical movement of the

face, iii) small number of participants, errors in measurements (EDA electrodes, calibration interval of IR camera).

Measurements were performed with different techniques to prove different psycho-physiological responses between true and untrue storytelling. The sample of 24 participants decreased to a total of 9 participants due to incomplete data or inadequately measured parameters. For thermal camera measurements, we excluded data of persons wearing glasses. Glass is not transparent for IR waves, and the method for measuring minimum temperature of a nose compromised the measurements. Also, there was a lot of face movement present in IR video and this made it difficult to determine temperature of an ROI. In some cases, camera performed calibration and focus corrections when recording in this case we excluded measurements for those participants. For EDA measurements we excluded participants with poor contact with silver electrodes. Although none of the tested parameters showed significant statistical differences, there are some differences between untrue and true storytelling. The temperature of the forehead ROI was 2,0 % lower, temperature of a cheek 0,1 % lower, and a nose 1,7 % higher, respectively there are more SCRs in EDA data and the finger temperature is lower when telling an untrue story.

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Cognitive, Psychological and Social Influence on Spread of COVID-19

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ABSTRACT

We investigated and confirmed the hypothesis that cognitive, psychological and social features of citizens in each country influence the spread of COVID-19 more than any other semantic feature group. Additionally, we investigated five sub-hypotheses in regards to socio-psychological traits of people and the spread of COVID-19, confirming two and rejecting three. Finally, we attempted to obtain deeper understanding of our results by finding which individual features within the social psychology group are most important.

KEYWORDS

psychology, sociology, covid-19, machine learning, feature analysis

1 INTRODUCTION

Since the spring of 2020, Coronavirus disease 2019 (COVID-19) has increasingly influenced our daily lives. The first wave of infections started to manifest globally around March, and different countries reacted differently and with different amounts of success in order to stop the early exponential growth. Countries differ from one another in many aspects, such as weather, demographics, development, economic strength, etc. Another important but often overlooked difference between countries is in the cognitive, psychological and social features of their citizens. We argue that these are some of the most important factors that might influence the spread of COVID-19, as they in turn influence how much people spend time with each other, how often they attend social and cultural events, etc. Thus, we focused on analysing these features in terms of their influence on spread of COVID-19 and their importance compared to other groups of features. Additionally, we investigated the importance of individual features that comprise the category of cultural features in an attempt to investigate if there is a single defining trait that dominates others.

The rest of this paper is structured as follows: we first investigate the related work in Section 2, then we list hypotheses in section 3 and describe the data in Section 4. We continue with the methodology and experimental setup in Section 5, and conclude with results and discussion in Section 6.

2 RELATED WORK

We focused on COVID-19 related work that deals with some properties of different world regions (typically countries) and compares them to a target variable related to the spread of COVID-19 in that region – with the goal of establishing the relationship between the two.

Many authors defined the spread of the disease in different ways. Most commonly researchers simply used the number of daily infections as the metric, which has the weakness of being biased towards countries with higher population, but can be normalized per capita [1]. Some other options are also possible, such as computing the reproductive rate of the virus, as proposed by Gupta et al. [6].

The country properties used to investigate the influence on virus spread were also varied. Most commonly, weather attributes were investigated [6], as well as indicators of development [1] and demographics [8].

In terms of machine learning (ML) methods, classical regression (e.g., linear regression) was used predominantly [6], while others used traditional statistical approaches [8], testing for statistically significant correlation between features and target variables.

Despite the large amount of research conducted in regards to COVID-19, the aspect of cognitive, psychological and social influence on the potential spread of COVID-19 has been poorly researched thus far, to the best of our knowledge. We aim to investigate and highlight the importance of the aforementioned influences and hopefully motivate more researchers to consider this important area.

3 RESEARCH HYPOTHESES

Unlike the various different influences on COVID-19 spread that related works focused on, the aim of this study was to concentrate on human behavior in terms of their social psychology, or interaction between their cognitive and psychological features and their social behavior. Generally, we believe that these significantly affect COVID-19 spread and should therefore be investigated to further understand not only this particular pandemic, but the influence of human behavior on pandemic in general.

Our primary research hypothesis is that human behavior statistically significantly affects COVID-19 spread. Furthermore, we have five secondary hypotheses:

(1) People with higher tendencies for social activities (higher extraversion) correlate with higher COVID-19 spread.
(2) People with higher tendencies for social compliance (higher agreeableness) correlate with lower COVID-19 spread.
(3) People with higher tendencies for being careful (higher conscientiousness) correlate with lower COVID-19 spread.
(4) People with higher tendencies for group consideration (lower individualism) correlate with lower COVID-19 spread.
(5) People with higher tendencies for desire gratification (higher indulgence) correlate with higher COVID-19 spread.

To investigate our research hypotheses, we turned to data repositories with psychological, cognitive and social features across countries. Since our final dataset will contain other features as well, those will be also investigated. The next section describes this data.

4 DATA

As our aim was to use ML algorithms to investigate the potential relationship between cognitive, psychological and social features of citizens and the spread of COVID-19 on per-country basis, we had to obtain and structure suitable data. The cognitive, psychological and social features were used as input features and were obtained for as many countries as possible. The spread of the virus itself was modelled using several binary classes, which were the targets of our classification.

4.1 Features on social psychology

To research our hypotheses, we did a limited literature review to find data spread between features that describe individual behavior and features that describes group behavior of societies as a whole. We selected three frameworks with which to work in this research. To account for individual behavior, the Big Five personality traits model [5] was selected, along with a feature on preferred interpersonal distances [11]. To account for group behavior, Hofstede's cultural dimensions theory [7] was selected.

The Big five personality traits model (B5) identifies five orthogonal dimensions which supposedly reflect an individual's personality and psyche. B5 is measured with a questionnaire. Extensive research has found significant statistical connections with a number of human behaviors (decision-making, crime, voting, health behavior, educational outcomes, etc.) [2]. B5 includes the following dimensions:

(1) Openness: describes how inventive or curious someone is.
(2) Conscientiousness: describes how careful, efficient or organized someone is.
(3) Extraversion: describes how outgoing or energetic someone is.
(4) Agreeableness: describes how friendly or compassionate someone is.
(5) Neuroticism: describes how sensitive or nervous someone is.

Data on preferred interpersonal distances comes from human spatial behavior research [11] and describes how comfortable people are in regards to different distance boundaries when in contact with other people.

Hofstede's cultural dimensions theory (HCDT) identifies six orthogonal dimensions that describe a country's values that drive

their group behavior. They have been found to correlate with a number of social phenomena (security, progress, environmental outcomes, etc.) [7]. HCDT includes the following dimensions (we did not include *Power distance* as it did not relate to our goal of finding data that describes phenomena that lie between individual and group behavior):

(1) Individualism-collectivism: describes how citizens of a country prefer and care for their in-group.
(2) Uncertainty avoidance: describes how averse citizens of a country are to uncertainty.
(3) Long-term orientation: describes how traditional citizens of a country are in terms of solving society's questions and their proclivity for change and adaptation (higher score means more long-term thinking, more adaptation and change).
(4) Indulgence: describes the degree to which citizens of a country seek desire fulfilling behavior.
(5) Task- vs. person-orientation: describes preference of citizens of a country towards tasks versus towards people.

Data on B5 questionnaire answers, which was collected from Open-Source Psychometrics Project's public database [9] (under "Answers to the IPIP Big Five Factor Markers"), had to be additionally pre-processed for this research. We processed the answers to the questionnaire to get individual personality profiles with the five dimensions for every person. Then we filtered the data by only keeping the countries where we had 100 individuals answering the questionnaire. Afterwards, we averaged the scores by countries to get group personality profile, each country having five dimensions.

Finally, we also considered data on levels of a nations' strength of social norms – referred to as (cultural) tightness-looseness. We used the tightness measure from Gelfand and colleagues [3]. The measure captures the strength of norms in a nation and the tolerance for people who violate norms. The final dataset we constructed contains 59 countries (meaning 59 instances) with 11 features.

The dataset can now be related to the hypotheses: 1) for secondary hypothesis 1, extraversion will be used for correlation; 2) for secondary hypothesis 2, agreeableness will be used for correlation; 3) for secondary hypothesis 3, conscientiousness will be used for correlation; 4) for secondary hypothesis 4, individualism-collectivism will be used for correlation; 5) for secondary hypothesis 5, indulgence will be used for correlation.

4.2 Virus spread classes

We chose three distinct binary classes, each having two possible values: a country is considered positive if its infection rate, given the chosen metric, is faster than half the countries analyzed. The class value was always computed in country-specific time frame, starting when the testing was adequate in a country according to the recommendation given by the World Health Organization (WHO), and ending when at least 3 countermeasures of sufficient intensity were applied. This intensity was marked with an integer in the range from 0 to 4 in the Oxford Covid-19 Government Response Tracker [12], and we took value 2 as the threshold.

4.2.1 Daily number of infections (daily average). The first calculated metric was the daily number of infections, averaged over the appropriate time interval and normalized based on the country population. This metric is the most intuitive and commonly reported.

4.2.2 Reproductive rate. The reproductive rate R_0 is a metric commonly used by virologists to determine the severity of an infection. Simply put, it estimates how many new infected are generated by each currently infected.

To estimate the reproductive rate we used the SIR model [10]. For details on the computation of the values, we refer the reader to the original paper.

4.2.3 Exponential shape. The last metric we calculated was the shape of the infection time series. An exponential shape indicates that the number of infections is raising fast, and is likely to continue. To determine if the growth is exponential, we fitted both a linear and an exponential curve to the data. After both were fitted, the one with the lower error was chosen as the better fit. If the exponential fit was better, the class value for this metric was positive.

Once the class was determined, we could split the countries into infected, non-infected and those for which we do not have enough data, based on each of the three classes. An intuitive display of the split is shown in Figure 1, where countries are colored based on the number of positive virus spread classes.
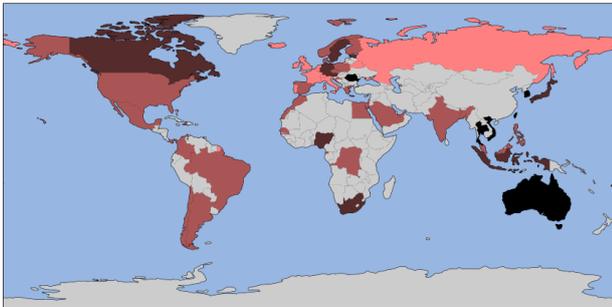

Figure 1: All countries, colored based on how many infection classes are positive. If all of them are positive, the color is light red, and conversely gets darker for every negative one. Countries without sufficient data are gray. Note that the data is from spring 2020, showing only the early spread.

5 METHODOLOGY

We first focused on testing our hypothesis of social psychology feature group being among the most important in the spread of COVID-19 compared to other feature groups describing a country. After confirming our initial hypothesis, we then investigated importance of individual features within this group.

5.1 Feature group importance

We obtained over 100 different country-describing features in order to compare them against the social psychology group, and to investigate our primary hypothesis, which was that the social psychology group is highly important. To do this, we first grouped all other individual features into the following semantic groups: weather, travel, health, economy, development, geography, countermeasures. We then evaluated the importance of each feature group using a Random Forest (RF) classifier. The model was trained using all the features and individual feature importances were obtained out of the box via the *feature_importance* property of the model, which is available in the scikit-learn implementation. In summary, this metric trains an RF classifier consisting of a number of different trees. When training a tree,

it computes how much each feature decreases the weighted impurity in this tree. This impurity decrease is then summed up over all the trees in the forest to form the feature importance. We then summed feature importances within each previously defined group to compare the aggregate importance of groups. This was done for each of the three virus spread classes.

5.2 Individual feature importance

Once we estimated feature groups importance, we turned our focus to analysis of individual features within social psychology group. We investigated whether an individual or small set of features dominate a group in regards to importance, or is the importance rather evenly spread. We did this for each of the three classes using three different methods. Additionally, this gives us information about specific best features within the group, which allows for potential expert interpretation.

(1) **RF feature importances**: First, we again used the out-of-the-box feature importances of RF to compare the importance of individual features.

(2) **Statistical testing**: Second, we used statistical tests depending on the type of feature (continuous, categorical, binary, normally distributed, non-normally distributed). The feature values of countries positive with respect to a class were compared to those negative with respect to a class. We used the T-test, Mann-Whitney U-test and Fisher-exact test, respectively, for continuous normal features, continuous non-normal features, and binary features.

(3) **Wrapper method**: Third, we developed a custom feature selection wrapper method similar to the one used in our related work [4], which did the following: the features were first sorted using RF feature importance (as before). Then, if two features were correlated (Pearson coefficient > 0.7) we discarded the lower ranking one. We started by using only the best feature for the classification. Then, we iteratively added the next best one, but only kept it if it did not decrease the classification accuracy by more than two percentage points. This method improves upon the first one by considering internal correlations between features.

The five secondary hypotheses were investigated using correlation analysis, by computing the correlation between the values of the selected individual feature relevant for the hypothesis, and the daily average class. We did this to get a deeper understanding and potentially new knowledge of exactly which features influence acceptance or rejection of our hypotheses.

6 EXPERIMENTS AND RESULTS

Aggregate RF feature importances for each group and each class are given in Table 1. Looking at the average importance, we see that the social psychology group of features proved the most important, alongside development, confirming our initial hypothesis.

The importances of top 5 individual features within the social psychology group for all three classes is given in Table 2. The importances were evaluated using the three different feature importance methods described previously.

Finally, the evaluation of our initial secondary hypotheses using correlation analysis is given in Table 3.

7 CONCLUSION

We investigated the cognitive, psychological and social influence on spread of COVID-19. Comparing against other semantic

Table 1: Aggregate feature ranking using RF feature score. Values are normalized (sum to 1).

	Repr. rate	Exp.	Daily avg.	Average
Weather	0.09	0.08	0.09	0.09
Social psychology	0.18	0.21	0.14	**0.18**
Travel	0.12	0.08	0.18	0.13
Economy	0.15	0.13	0.09	0.12
Development	0.16	0.18	0.12	0.18
Geography	0.12	0.06	0.11	0.10
Health	0.11	0.19	0.11	0.14
Countermeasures	0.04	0.02	0.06	0.04

Table 2: Individual feature ranking using RF feature score, statistical testing and wrapper method. Top 5 features and corresponding scores are shown.

RF feature importance (higher is better)		
Repr. rate	*Exp.*	*Daily avg.*
Tightness (0.071)	EST_perc (0.053)	AGR_perc (0.032)
EST_perc (0.014)	Masculinity (0.017)	Individual. (0.024)
OPN_perc (0.013)	Individual. (0.015)	OPN_perc (0.014)
Future ori. (0.013)	CSN_perc (0.015)	Future ori. (0.012)
Masculinity (0.07)	Tightness (0.014)	Masculinity (0.011)
Statistical significance (lower is better)		
Tightness (0.010)	EST_perc (0.076)	Individual. (0.030)
Future ori. (0.064)	Tightness (0.148)	AGR_perc (0.045)
OPN_perc (0.171)	CSN_perc (0.148)	Indulgence (0.112)
EXT_perc (0.259)	Uncert. avoid. (0.2)	OPN_perc (0.134)
AGR_perc (0.259)	Masculinity (0.241)	EXT_perc (0.147)
Wrapper method (higher is better)		
Tightness (0.071)	EST_perc (0.053)	AGR_perc (0.032)
CSN_perc (0.005)	Masculinity (0.017)	Individual. (0.024)
/	Individual. (0.015)	OPN_perc (0.014)
/	CSN_perc (0.015)	Future ori. (0.012)
/	Tightness (0.014)	CSN_perc (0.005)

Table 3: Correlation analysis of our secondary hypotheses in respect to the daily average virus spread class.

Hypothesis	Correlation	Accept/Reject
Higher extraversion correlates with higher virus spread	0.33	ACCEPT
Higher agreeableness correlates with lower virus spread	0.40	REJECT
Higher conscientiousness correlates with lower virus spread	0.04	REJECT
Higher individualism correlates with higher virus spread	0.46	ACCEPT
Higher indulgence correlates with higher virus spread	0.09	REJECT

groups of features describing countries, we showed that the social psychology group has the highest feature importance alongside development. Additionally, we found that there is no single dominant feature in our set of 11 in the social psychology group, but instead the importance is spread among several. We also used correlation analysis to confirm two out of our five hypotheses,

showing high correlation between extroversion and individualism and higher virus spread. This shows that the cognitive, psychological and social features are among the most important in relation to spread of COVID-19 and should be investigated more thoroughly.

ACKNOWLEDGMENTS

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Od orodja do umetnika

From Tool to Artist

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POVZETEK

V prispevku se ukvarjam z odnosom med umetnostjo in umetno inteligenco (v nadaljevanju tudi UI). Podrobneje se ukvarjam z odnosom med orodjem pri umetniškem ustvarjanju in samim ustvarjalcem. To me pripelje do vprašanja avtorstva ter primerjavo med umetniškim ustvarjanjem kot obrtjo ali kot produktom umetniškega genija (tudi Genij)1.

KLJUČNE BESEDE

umetnost, umetna inteligenca, avtorstvo, ustvarjanje, orodje

ABSTRACT

In this paper, I deal with the relationship between art and artificial intelligence (hereinafter also AI). I deal in more detail with the relationship between the tool in artistic creation and the creator himself. This brings me to the question of authorship and a comparison between artistic creation as a craft or as a product of artistic genius.

KEYWORDS

art, artificial intelligence, authorship, creation, tool

1 Umetna inteligenca na področju umetnosti

Sprva želim orisati zgodovinski preplet med umetniškim ustvarjanjem in razvojem umetne inteligence ter opozoriti na ključne mejnike na tem polju.

V osnovi umetniška dela temeljijo na fikcionalnosti in možnosti ustvarjanja dogodka, sveta, ki nastane pod točno določenimi, zapisanimi pogoji, kar definira literarna teorija. Da ne gre za željo po napovedovanju prihodnosti ali izdelovanju čim bolj natančnih modelov prihodnosti, ampak bolj za umetniško obdelavo informacij o družbi in svetu ter z domišljijo kreiranje najrazličnejših svetov. Zato tudi ne preseneča uporaba oz. povezovanje umetne inteligence z razvojem tehnologije in umetnosti, čeprav se na prvo roko zdi umetnost zelo konvencionalna. Takšno prepričanje je morda nekoliko naivno, saj je že samo risanje na stene, ohranjanje snovne kulturne dediščine zahtevalo uporabo *novih tehnologij*, zato morda ni

odveč razmišljanje s perspektive, da kot civilizacija nismo na povsem novem prelomu.

Na spletni strani združenja UI-umetnikov je kot začetnik na časovnici UI umetnikov naveden Thomas Bayes, ki je "z uporabo matematike razvil okvir za sklepanje o verjetnosti dogodkov, upoštevajoč pogoje ali druge dogodke, ki lahko na dogodek vplivajo. Zahvaljujoč njegovemu delu je Bayesov sklep vplival na pristope pri strojnem učenju in predstavlja enega najzgodnejših mejnikov na časovni premici umetne inteligence.(op. prev. p.) [4]" Njegova spoznanja so nato v 50. letih prejšnjega stoletja nadgradili in so vplivala tudi na razvoj računalništva – v tem času, in sicer leta 1950, pa je tudi pomemben avtor Isaac Asimov izdal zbirko kratkih zgodb *I robot*, v kateri se poigrava z možnimi scenariji inteligentnih strojev v prihodnosti.

V zadnjem času beležimo še nekaj pomembnih mejnikov, in sicer so leta 2018 na dražbi prodali sliko UI, ki se je učila od številnih umetnikov, za 432.500 $. AIVA velja za prvega virtualnega umetnika, čigar dela so registrirana kot avtorska (z avtorskimi pravicami) pri SACEM (Société des auteurs, compositeurs et éditeurs de musique – Združenje glasbenih avtorjev, umetnikov in založnikov). Dokončanje *10. simfonije* Ludwiga van Beethovna s pomočjo UI pa pričakujemo v letu 2020.

2 Umetna inteligenca – orodje ali umetnik

Slika 1: Shematični prikaz rekurzivne nevronske mreže, na kateri temelji delovanje UI. [16]

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1 Pri tem je genij razumljen po konceptu Denisa Diderota, ki ga je oblikoval v 18. stoletju. [11]

Za začetek se mi zdi za razumevanja samega koncepta binarne opozicije med umetnikom in orodjem potrebno izpostaviti temelje tega odnosa, ki nas lahko v nadaljevanju pripelje do natančnejše opredelitve razmerja med njima. V osnovi je pomembno, da umetniki vedo, s čim delajo in kaj so prednosti in slabosti tega. Nevronske mreže so danes najbolj napredni strojni "možgani" in osnova delovanja v razvijanju umetne inteligence, saj "imajo sposobnost razločevanja in izločevanja informacij iz kompliciranih in nejasnih vzorcev" [18]. Katarina Mramor opozarja tudi na njihove kritične točke – učni primeri, ki morajo biti zelo pozorno izbrani, saj je od njih odvisno, kaj bo končen rezultat nevronske mreže. Učne primere izbirajo ljudje, zato je treba biti pazljiv, da nenamerno ne vnesemo preveč črno belih primerov, ki bi temeljili na kupu subjektivnih predpostavk, ki se jih mogoče niti ne zavedamo in lahko vsebujejo problematične etične odločitve; česar se potem nauči tudi nevronska mreža in jih nadalje širi brez problematiziranja, dokler se v praksi (npr. pravu, varnosti …) odločitve ne izkažejo za problematične ali vsaj vprašljive.

Tudi združenje umetnikov UI se ukvarja s problematičnimi točkami v interakciji med umetno inteligenco ter človekom. Pri tem združenje nagovarja neodgovorjena vprašanja, kjer vidi izzive na področju definiranja vrednot (kaj so človeške in kaj so nečloveške), obdelavi oz. naboru podatkov, ki jih damo učiti nevronskim mrežam, varnosti osebnih podatkov ter samem delovanju nevronskih mrež. [5]

Nekateri znanstveniki na naštete izzive odgovarjajo zelo proaktivno in programirajo "okvirje" oz. načela, ki naj bi poskrbela za "samoodgovorno vedênje" UI. Primer slednjega je raziskovalni center "The Institute for Ethical AI & Machine Learning", ki je formalno stacioniran v Veliki Britaniji, vendar ga sestavljajo raziskovalci, prostovoljci različnih strok (inženirji strojnega učenja, podatkovni znanstveniki, pisci pravilnikov in profesorji skupine STEM[2], humanisti in družboslovci). Njihova vizija je: "Minimizirati tveganja **UI** in omogočiti njeno polno delovanje znotraj okvirjev, ki zagotavljajo **etični** in **zavedni** razvoj projektov, povezanih z UI na vseh področjih delovanja, v vseh industrijskih panogah" (The Institute for Ethical AI & Machine Learning).

2.1 Vprašanje zavesti in svobodne volje – kako preseči *orodje*

Kljub izjemnemu tehnološkemu napredku še vedno ostaja odprto vprašanje, ki si ga znotraj kognitivne znanosti zastavljajo znanstveniki, programerji, filozofi …, če bomo lahko kadar koli umetno inteligenco razumeli povsem samostojno, neodvisno, samozavedno. Torej, če bomo vedno lahko govorili le o vse bolj dodelanih, izboljšanih in uporabnih orodij (človeka) ali dejansko o nečemu/nekomu, ki je zmožen tega "samoustvarjanja", ustvarjanja iz sebe v ideji bolj kot v izvedbi, saj takoj, ko preidemo na zmožnost nečesa izvesti, že govorimo o (bolj ali manj samostojnem) orodju. Kot najbolj znan primer poskusa odgovora na to vprašanje je Turingov test, kjer naj bi se stroj obnašal tako "človeško", da bi pretental samega človeka.

Na področju filozofije tako pridemo do problema (upravičenja) zavesti. Odgovor na to je v pričujočem prispevku

pomemben z vidika, da nam dejstvo, da *nekaj* lahko okličemo za zavestno entiteto, takoj preseže pojmovanje *tega* kot samega orodja. Z drugimi besedami, če lahko UI v katerem koli smislu jemljemo za kaj več kot le orodje, predhodi vprašanju, če lahko UI okličemo za umetnika, za nekoga (nekaj), ki ustvarja iz lastnega navdiha oz. predvsem lastne želje po ustvarjanju. Pri tem tudi ni zanemarljivo vprašanje, ki si ga je zastavil Hartman, profesor angleškega jezika in kreativnega pisanja na Connecticut College New London, in sicer: "*čemu* in *komu* bi bil tak program [ki bi generiral poezijo samostojno (iz nič)] sploh potreben" [15].

V združenju UI-umetnikov na vprašanje, če so lahko stroji kreativni, odgovarja umetnik Ahmed Elgammal, ki se ukvarja s točno tem področjem. Ahmed Elgammal izhaja iz ideje, da strojev ne moremo imenovati za inteligentne, dokler ti ne bodo razumeli in ustvarjali tudi "kulture" (vizualno, zvočno umetnost, literaturo in šale).

Izhodišče za stroje se loči od človeka po tem, ker lahko UI prečeše čisto vse, kar je kadar koli nastalo, v nasprotju s človekom lahko pozna čisto vsa dela ter ve informacije o nastanku, kritike in razlage, ki so ob tem nastale. Vendar se Elgammal zaveda, da ta baza in potem posnemanje še ne pomeni ustvarjanje nečesa novega, kar želi doseči s svojimi projekti. Nadalje pa na vprašanje, kako želi to doseči ponudi odgovor, ki pravzaprav ponovno vodi k razvoju orodij. UI predstavi predvsem kot partnerja (z moje perspektive še vedno orodje), ki bo umetniku (človeku) odkrivalo nove umetniške poti in ideje. To utemelji s primerom fotoaparata, ki je pomenil zelo pomembno revolucijo sprva v vizualni umetnosti, kasneje pa veliko širše – zvok, film, fotografija … Tako naj bi tudi tehnološki razvoj v prihodnje nudil revolucije v umetnosti, vendar če natančno beremo, še vedno govorimo o pripomočkih, ki jih upravlja in si jih želi, razvije, potrebuje človek. [1]

Ob tem, ko smo s pomočjo namere in želje po umetniškem ustvarjanju skušali pokazati, da je za to potrebna zavest; se pri tem kot še bolj problematično pokaže pomembno filozofsko vprašanje svobodne volje. Na tem mestu moj cilj ni raziskovati širine tega vprašanja, ampak na podlagi petih Hodgsonovih trditev ugotoviti, v kolikšni meri te veljajo za sodobno umetno inteligenco.

"Kaj torej pomeni 'govorjenje o svobodni volji'? Kakšne so zdravorazumske intuicije o svobodni volji? Intuicije človeka, ki ni filozof ali kognitivni znanstvenik, in ni pristranski. Hodgson (2005) meni, da bi taka oseba podala naslednji fenomenološki opis, kako je biti svoboden, zavesten akter (Hodgson, 2005, p. 3):
- Zavedamo se izbiranja odločitev.
- Imamo občutek, da smo mi začetniki naših dejanj.
- Včasih tehtamo alternative, včasih sledimo navadam.
- Zavedamo se posledic dejanj, ki smo jih storili.
- Imamo se odgovorne za svoja dejanja" [17].

Na podlagi zapisanega ne moremo najnovejšim nevronskim mrežam pripisati niti ene od petih trditev zares, saj se nevronska mreža še vedno niti ne zaveda, ampak skuša čim bolj učinkovito

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[2] STEM je angleška kratica za Science (naravoslovne znanosti), Technology (tehnologija), Engineering (strojništvo) and Mathematics (matematika).

izvršiti ukaz, opraviti nalogo. Po drugi strani, pa bi zelo težko sploh v umetnosti lahko rekli, da ne gre pri ustvarjanju za svobodno voljo umetnika.

3 Kje se konča programiranje in začne umetnost?

Če se na tem mestu ne ukvarjamo s tem, kako čustva vplivajo na odločanje, ne moremo prezreti dejstva, da je v umetnosti v ozadje postavljeno samo razumsko reševanje nalog, saj postane zgolj racionalnost v okviru umetnosti banalna. Na umetnost se že dolgo več ne gleda zgolj obrtniško, ampak se ji pripisuje estetsko vlogo in vpliv "čustev na čustva". Pravzaprav je včasih merodajna uspešnost prevoda ustvarjalca, da čim uspešnejše preda svoja občutja. Razvoj UI zaenkrat temelji na prepoznavanju človeških čustvenih odzivov na podlagi fizičnih znakov (prepoznavanja gest, obraza, glasu, …), kar je še daleč od človeške empatije in predvsem daleč od čustvenega doživljanja oz. odzivanja same UI.

Je pa razvoj umetne inteligence poleg inovativnosti v umetnosti prinesel tudi ogledalo, saj nam nudi reflektivni premislek o tem, kdaj umetnost preseže obrtniškost, kdaj preseže programiranje, do katere mere so ljudje, ki ustvarjajo z UI programerji, kdaj pa postanejo umetniki oz. ali lahko tudi umetno inteligenco okličemo za umetnico? Kdaj delo upraviči estetsko funkcijo[3], da ga lahko imenujemo umetnost?

Konkretno lahko odgovore iščemo pri samih dosežkih UI zadnjih let. Oktobra 2018 je bil v *Timu* objavljen članek, kjer piše, da so na dražbi Christie's prvič prodali delo, sliko, ki jo je ustvarila UI. Prodali so jo za 45-kratnik izhodiščne cene (za 432.500 $). Slika nosi naslov *Portret Edmonda Belamyja*. Algoritem se je učil na 15.000 portretih različnih slikarjev od 14. do 20. stoletja, v desni spodnji kot pa se je tudi podpisal – v ležeči gajici je izpisal svoj algoritem [21]:

$$\min_{G}\max_{D}\mathbb{E}_x[\log{(D(x))}] + \mathbb{E}_z[\log{(1 - D(G(z)))}]$$

Nadalje predstavljam projekt AIVA (Artificial Intelligence Virtual Artist). V opisu piše, da gre za virtualno umetnico, ki je zmožna komponiranja glasbenih podlag za filme, video igre, oglase in nasploh prosti čas. Algoritem se je učil od številnih del klasičnih skladateljev (Mozarta, Beethovna, Bacha, …), iz česar se je razvil model, ki naj bi razumel, kaj je glasba. Ta model uporablja Aiva za komponiranje povsem edinstvene glasbe. Aiva je postala prvi virtualni umetnik, katerega stvaritve so avtorsko priznane s strani združenja SACEM. Na uradni spletni strani dodajajo, da ti dosežki ne pomenijo, da bo Aiva zamenjala glasbenike, skladatelje, ampak gre za nadaljevanje sodelovanja med človekom in strojem. Ustvarjalci menijo, da komponiranje z UI omogoča nove pristope v glasbi. Zato jo tudi oglašujejo za primerno za vse vrste uporabnikov (od preprostih poslušalcev, novincev v komponiranju do profesionalnih glasbenikov) – AIVA asistira pri kreativnih procesih človeka, tako kot so v zgodovini veliki umetniki imeli svoje učence, lahko imajo zdajšnji umetniki UI pomočnike, ki jim pomagajo skrajšati čas za dokončanje skladb. Aiva lahko komponira v že ustaljenih stilih ali po vzoru "vpliva", ki ga naložimo sami [3]. Če kritično presodimo prebrano, lahko ponovno ugotovimo, da ne govorimo

o umetniku, ampak o človeškem pripomočku, ki ga razvijalci razumejo kot del razširjene kognicije (človeka), saj ima podobno funkcijo delovanja pri pisanju glasbe, kot jo lahko ima npr. zemljevid na telefonu pri orientaciji.

Trenutno najbolj znan projekt je dokončanje Beethovnove desete simfonije, kar bodo naredili s pomočjo umetne inteligence. Informacija o tem se je razširila konec leta 2019, simfonijo pa naj bi izvedel simfonični orkester 28. aprila 2020 v Bonnu (rojstnem mestu skladatelja). Zaradi pandemije je bil koncert odpovedan, novic o tem, kako napreduje ta projekt, pa mi ni uspelo zaslediti. Nekaj vzorcev komponiranja UI je moč slišati na spletni strani: telekom.com/de/konzern/themenspecials/special-beethoven-jahr-2020/beethovens-unvollendete. Pri projektu sodeluje oz. je sodelovalo (poleg vseh strokovnjakov UI) veliko število muzikologov in poznavalcev Beethovnove glasbe in obdobja, zato je projekt skrbno nadzorovan in voden tudi s strani umetniške stroke, ki opozarja na nepogrešljive dele. Želja je namreč pokazati, da je pri tovrstni uporabi stroj lahko tako dober in učinkovit kot človek, saj tovrsten pristop predstavlja za številne konvencionalne klasične strokovnjake zelo grob poseg, ki nima možnosti za uspeh.

Na tem mestu se lahko vprašamo, zakaj smo prepričani, da bi človeški obrtniški prepisovalci, dokončevalci umetniških del bili uspešnejši od UI, saj gre v obeh primerih za zelo podoben način učenja (nadaljevanja vzorca glede na pravila in vhodne podatke), pri čemer lahko strojni algoritmi hkrati obdelujejo in delajo z veliko več (specifičnimi) podatki kot učenci, ki so to počeli pred stoletji. Ob tem se ne ukvarjamo z vprašanjem Genija – torej, v čem je genialnost samega Beethovna in zakaj on to je, medtem ko ostalim njegovim sodobnikom to ni uspelo – ampak povsem obrtniškim vprašanjem, nadaljevanje glasbenega vzorca, kjer mnogokrat ni nujno potreben kreativni proces, ampak predvsem natančnost. Zato sem mnenja, da se mora včasih tudi človek zavedati svojih omejitev oz. egoizma. Z uporabo UI lahko tudi v umetnosti odkrivamo nove, še nepoznane svetove, pri čemer se moramo tako, kot se zavedamo vseh omejitev UI, zavedati tudi svojih, človeških.

4 Zaključek

V prispevku sem orisala veliko podpodročje kognitivne znanosti – umetno inteligenco – in jo umestila v kontekst umetniškega ustvarjanja. Ugotovila sem, da z vključevanjem UI v umetnost postaja ta interdisciplinarna v širšem smislu, kot je bilo to do sedaj, saj zahteva tudi veliko tehnološkega, programerskega znanja. Vračajo se številni etični pomisleki, do katerih se je treba opredeliti, ter filozofske predpostavke, ki se jih mora zavestno sprejeti, zato da se lahko UI nadalje uspešno razvija.

Ključno in osrednje vprašanje prispevka je bilo, ali je lahko umetna inteligenca, ki ustvarja, že sama po sebi umetnik? Ali smo že presegli uporabo stroja kot orodja ali je ta še vedno v domeni človeka in njegovega uporabljanja?

V samem bistvu še ne moremo govoriti o samostojni umetni inteligenci, ampak govorimo o vse bolj in bolj izboljšanih orodjih, človeških pripomočkih, katerim v vsakem primeru predhodi človek (kot programer ali s podatkovno bazo, iz katere

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[3] Sklicujem se na definicijo estetske funkcije po Romanu Jakobsonu, ki jo je opredelil v *Lingvistiki in poetiki*.

se UI uči), pri čemer lahko dopustimo misel, da so tudi ta orodja že del *razširjene kognicije*, saj odpirajo tudi v svetu umetnosti povsem nove pristope, načine dela in svetove, ki jih do sedaj še nismo videli. Karas v svoji diplomski nalogi:

"smiselnost računalniških generatorjev poezije vidi predvsem v obliki 'pametnih orodij', s katerimi človeški pesnik ustvarja poezijo, narejeno *s pomočjo računalnika:* 'Kot povsod drugje, hibridni pristop združuje (domnevno) najboljše vseh različnih svetov. Računalniki kljub napredku UI še ne 'razumejo' jezika, kot ga *razumemo* ljudje, toda po isti logiki se ljudje težko primerjajo (z računalniki, op. p.) po lahkotnosti igranja na polju jezika.'" [15]

Ob tem je takoj sledilo še vprašanje, kdaj lahko govorimo o resnični umetnosti, o umetniškem delu. Čeprav je to vprašanje prisotno, odkar rečemo nečemu umetnost oz. od začetka človeštva, se je pokazalo, da nam nudi svež pogled ravno umetna inteligenca, saj se kot očitno pokaže, da ne moremo soditi samo po končnem izdelku, da lahko UI ustvarja določene generične izdelke enako dobro ali še boljše kot ljudje. Zato moramo odgovore ponovno iskati v sami funkciji umetniškega dela in avtorja, iskati moramo pri izvoru in namenu ustvarjanja in ne zgolj presojati rezultata. V luči tega se je v zaključku izrisal še en premislek, in sicer po ponovni človeški samorefleksiji – ali je sploh nujno, da UI jemljemo kot konkurentko in nanjo gledamo kot človek na človeka, ali gre mogoče za nov odnos?

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Social Media Use & Digital Stress Among Adolescents

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ABSTRACT

This is a case study presenting ways in which adolescents perceive social media as a stressor, at the empirical example of Snapchat. Despite the overall positive or neutral reception of social media, in semi-structured expert interviews (N=6), Viennese adolescents shared about various stressful experiences that can be summarized under the following categories: feeling smothered by peer pressure to be constantly available online/ respond to messages; being upset over losing a streak or being scolded for it; being annoyed when receiving pointless content and feeling as if they spend too much time online. These stressors are discussed with regard to existing digital stress and Snapchat Streaks literature, with a particular focus on the issue of maintaining closeness between peers online.

KEYWORDS

social media, digital stress, Snapchat, gamification

1 INTRODUCTION

By removing ''*spatial and time constrains that were inherent in traditional methods of communications*'', social networking sites (SNS) are nowadays becoming the primary medium for a plethora of activities, such as accessing information, passing time, working on one's representation of reality and communicating with peers [1]. SNS such as Facebook, Instagram and Snapchat are attracting billions of daily active users of all ages and shape communication cultures especially among the so called "*digital natives*" [2] - adolescents growing up with social media as one of the default ways to connect to others. Adolescence is a particularly sensitive period for ''*personal and social identity formation*'' [3], and, nowadays social media are being integral part of this development and teens' social experience in general. Seeking to shed light on the role social media play in the emotional life of youths, we investigate which aspects of gamified social media [4] are perceived as stressful by them. Based on an analysis of six semi-structured expert interviews with Viennese adolescents, this paper presents situations, in which adolescents experience social media as a source of stress, which could potentially lead to experiencing psychological distress and various negative effects or emotions connected to it [5][6][7][8].

2 THEORETICAL BACKGROUND

2.1 Social media as stressors

A stressor can be described as a trigger that afflicts an organism and is capable of causing internal physical, mental and emotional responses. Social media can be understood as a social stressor defined as any environment that an individual considers demanding, challenging, or in any way threatening [9].

A growing body of literature on the intersection between social and clinical psychology shows possible connections or correlations between the new information and communication technologies – social media platforms, and an increased risk of emotional problems, e. g. psychological distress [5][6][7][8][10]. Considering SNS's pivotal role in the life of adolescents, it is crucial to scrutinize the effects of social media usage on youth (SMU), as well as their evaluations of their own SMU.

2.2 Social media & psychological distress among teens

The term psychological distress refers to an ''*unpleasant feeling or emotion often characterized by symptoms of depression and anxiety*'', e. g. loss of interest, sadness, restlessness [11]. Usually described as ''non-specific mental health problem'', it covers a wide spectrum, ranging from ordinary feelings of vulnerability and negative emotions to fears or problems that can become disabling [12].

The section below describes evidence from psychological research that social media platforms, may be experienced as stressors potentially leading to psychological distress and various negative effects associated with it [10].

Keles et al. did a systemic review of the influence of social media on depression, anxiety and psychological distress in adolescents [7]. Although the link between social media usage and mental health problems is not always straightforward, their research clearly indicates ''*a meaningful relationship between social media use and depression*'' [13]; ''*a statistically significant relationship between social media use and depressive symptoms in children and adolescents*'' [14]; ''*a correlation between problematic use and psychological distress in adolescents and young adults*'' [15].

A combination of various causes such as unrealistic expectations of one's own performance, heavy SMU, specific changes in adolescents' brain linked to ''*limited capacity for self-regulation*'' and ''*vulnerability to peer pressure*'' makes teens particularly vulnerable group for potential experience of negative

effects or emotion, e. g. lack of control, sadness, frustrations, fears etc. [7].

Agrawal and Singh did a systematic review of research related to social media and psychological distress among adolescents. They conclude that the results ''*clearly indicate that* (frequent) *use of social networking sites is directly related to psychological distress among youth*'' [5]. With that in mind, we believe it is crucial to investigate youth's social media experience and to analyze the ways in which they may perceive social media as a stressor.

3   METHODS

The analyzed data is a randomly selected subset (N=6, 15-18 years old, the average age of participants was 16.33, SD=1.10) of a larger set (N=26) of semi-structured expert interviews with Viennese adolescents in which they reported on their social media use, with a focus on Snapchat. The interviews focused on the practice of participant's daily routine with social media: their specific actions, skills and SMU experience. The participation in the individual interviews (60-90 minutes) was voluntary and a signed parent consent form was collected from each informant. The data were anonymized and relevant quotes were translated to English for the purposes of this publication. The interviews were coded (in Atlas.ti) using a modified grounded theory approach [16]. The analysis then focused on the codes related to ways in which youths experiences social media as stressful.

4   RESULTS

In line with previous research [17], our data reveals the near omnipresence of social media use in our participants' daily lives, and especially to communicate with their peers. All participants regarded social media use as regular means to connect with others daily, be it about school obligations, setting up meetings, passing time, or bonding with peers. Their overall impressions about social media usage were positive or neutral. Connecting with others on social media was seen as one of the main ways to communicate and as such its fundamental functions remained largely unquestioned. However, in agreement with previous research [18], our data also indicates that youths reported about both positive and negative experiences on the platforms. Participants associated SNS, and Snapchat in particular, with mostly positive effects on their everyday life, e.g. as digital media enable their daily communication with peers outside of school or with friends from other countries. Nevertheless, five out of six participants reported experiencing stress related with their use of social media. We will now present the main categories of SMU related stressors that we encountered in our data (with respective empirical examples): feeling smothered, losing Streaks, receiving pointless content and feeling they spend too much time online.

- feeling "smothered" [17]: the pressure of compliance in the form of being constantly available to others. The pressure to be available is also linked to expectations of "responding immediately" and, should this expectation not be met, peers would also actively comment on it: "people have already told me that I don't answer". Hence, our informants were stressed out by the pressure for instant availability in form of in-short-time replying to texts or snaps. It also seems critical to note that in

order to offer this availability, "some are on the phone all the time" which irritated our informants. A participant reported that she was feeling stressed out because friends insisted on maintaining the Snapchat streaks, counting the consecutive days of snapping, which requires the conscious effort of recalling to snap at least once per day with no preset expiration date – the streak partners are trying to keep the streak going for as long as possible, often reaching years of ongoing maintenance. Our informant shared that the feeling of compulsion spoiled her appreciation for Streaks: "in the end I didn't feel like it and felt compulsion, I thought it was stupid".

- losing streaks: adolescents report being mildly upset themselves when losing a streak, as well as their peers being upset by a streak loss: "One was already mad that he had lost the streaks. It wasn't with any of them that they would never speak again, but yes, there was something". "Losing" the gamified challenge is reported to incite frustration though it is rather game-related than full-blown negative emotions. Commonly, the intensity of the reaction is proportional to the height of the streak - the higher the streak, the more severe the loss: "With two friends of mine, one was really very pissed off, she had 300 streaks or something, abnormal, and the other didn't send back".

- receiving "pointless" content: feelings of annoyance and frustration upon receiving boring or pointless content. Adolescents complained of annoyance at receiving pictures of floors, walls, good morning / good night pictures and black pictures, all mostly are aimed at keeping Snapchat Streaks. Since the Streaks counter only quantifies the number of days of snapping, but has no criterion as to the quality of content sent, our informants said that they receive pictures containing "just the ground or something like that. Just to keep the streak, they sends something stupid", "just take the cell phone and take pictures of what's there, floor, table, it doesn't matter". According to them, this happens because "you don't have much to communicate about and you only do it because of the streaks". Although they send and receive such messages, adolescents conclude that "those are the unnecessary snaps", "they think it s stupid but still do it".

- too much time spent online: Participants reported being aware that time spent on social media platforms corresponds to less real-life activities involvement and school disturbance, due to e.g. the constant checking for new messages or content. When asked how much time he spends on social media, an informant answered "Far too much, I don't know, six or more hours a day. I use it far too much". Another adolescent shares that, although they were still active on social media, SMU was proven to be too much for them in their busy daily life: "That was the time with the school work, I had to learn a lot and in the evening I was already very tired, and with the last of my strength I was able to snap but it was too much for me". Yet another contemplates to limit her SMU time: "Maybe I would restrict it, I like YT very much, but it takes a lot of time. With IG there are videos that will be presented to you, 30 min + I should stop that. YouTube and Instagram rob me most of the time. Time is actually wasted because I could use it better … I often think the day could be more productive".

In addition to these main categories, individual participants also mentioned feeling: envious of others' streak count and social status; disappointed over inappropriate videos or pointless arguments online, or being bored by receiving pointless

repetitive content. In the following section, we are going to discuss the main categories in more detail.

5 DISCUSSION

The main types of stress we derived from the data – such as feeling smothered, losing Streaks, receiving pointless content and spending too much time on social media – highlight different relational aspects of online communication with peers. It is evident that informants' experience of stress sprouts not from hostile interactions with peers (e.g. cyber bullying) but are commonly caused by aspects of ''*maintaining closeness in digital space*'' [17]. **Feeling smothered** is caused by excess in the extent to which one is or should be making themselves available for communication with peers: how quickly they should respond to messages, how often should they check the phone, whether one should try to commit to longitudinal projects such as Streaks that require daily effort [4] [19]. Weinstein & Selman [17] discuss this stressor in its duality – as controlling and expressing desire for closeness. They report that while closeness is mutually desired and the content of messages is not problematic, "*the sheer quantity of the messages is itself described as a burden*" (ibid).

Being upset because of **losing streaks** or being scolded at for it are reactions to losing the shared project in which the daily effort was invested. Keeping a streak consciously is a task that requires both partners' devotion and daily effort and can, hence, spark a sense of solidarity and intimacy [19]. That is why, the abandonment of the gamified challenge of maximizing the Streak count might be seen as a sign of not caring about the other person's importance or feelings, which then requires the negotiation of the relation between peers (e.g. apologizing, breaking contact).

Youths are not only concerned when relations prompt constant availability and "overdoing communication" till one starts feeling smothered. Conversely, they express concerns over the drop in the quality of communication such as the one signaled by **reciving "pointless" content**. Being annoyed at boring or meaningless content one receives can be hedonic (being annoyed that the content one views is not entertaining) or relational (being upset over the inadequate communication which that signals disrespect towards the relationship). The latter may cause worries over interpreting the signs or the need to re-negotiate the relationship (by discussing it, dropping contact online or offline, or both). Hristova et al. report that the so called "streak snaps" (an umbrella term for black pictures, goodnight pictures etc. sent not as a part of conversation but for the purposes of gamification) are perceived as less valuable than snaps sent within a conversation. They report that adolescents often drop their streak with people who send them the gamified snaps without being involved in a conversation or asking one how they are doing [19].

Adolescents exhibit metacognition concerning the extent of their social media use, as exemplified by their worry over **spending "too much time" on social media** and realizing that this robs them of their time for other tasks they would find more "productive". This type of psychological distress is connected to an estimated excessive personal investment (time, effort, attention), leading SMU to be perceived as threatening [9]. It is somewhat similar to worrying over the time and effort needed for maintaining a long streak, that was already mentioned earlier in the discussion. The discussion about how much digital media is too much [20] seems to perpetuate itself to contemporary discussions of how much time makes up for a balanced social media use [21]. The adolescents in our sample go one step further by contemplating actively changing their social media consumption to mitigate aforementioned excessive expenditure of time resources.

To sum up, the aforementioned types of stress are sparked by the desire to form a close relationship on social media and by its implications: the time, effort and quality of involvement needed for this. The need or wish to be involved in their peer's online social life daily likely comes from adolescents' offline desires to ''*attract others*'', ''*gain acceptance*'' and ''*fit in*'' and ''*keep in touch*'' [22][23][24][25]. In this, the very principles may be considered an extension of pre-existing concerns over the ways and extent of closeness to peers.

However, specific social media features such as Snapchat's gamification element Streaks impose further specific constraints on rules of social conduct. In order to preserve the streak, one needs to snap and receive or view at least one picture or video within the frame of each day (24 hours), thereby adding further time pressure to the communication. While our participants do get involved with Streaks, the practice also adds more stress to their already complex temporal landscape of online interaction, requiring them to be available round the clock and respond right away after receiving a message. These contemporary challenges structure daily routines and experiences and, hence, need to be studied in more detail by researchers.

6 CONCLUSIONS

In post-industrial cultures, social media and its use are nowadays becoming a days-to-day feature in the life of individuals and especially adolescents. These online platforms represent an important tool of communication with their peers, as well as a major part of youth's social experience.

The goal of the study was to better understand SMU aspects which can be perceived as stressful by adolescents. While our research was based on self-report measures, posing the risk of bias, and was limited by small sample size, which cannot be representative and generalized to a larger adolescent population, it offers a categorization of stressors: feeling smothered, losing Streaks, receiving pointless content and feeling they spend too much time online; all of which stem from the wish to uphold closeness online. Based on the importance of the role that social media plays in most adolescents' lives nowadays, we emphasize the importance of further exploration of the stress-inducing aspects of maintaining online closeness.

7 ACKNOWLEDGMENTS

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Special Sciences: Still Not Reducible after All These Years

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ABSTRACT

The paper introduces the problem of multiple realizability (MR), followed by the examination of conditions for MR, as presented by various philosophers working on it. They arrive at opposing conclusions regarding MR despite accepting similar criteria for it. The paper analyses their conditions and compares them to Fodor's original motivation for MR. An alternative solution to the Fodor's problem, which also explains the aforementioned different conclusions, is introduced.

KEYWORDS

Multiple realizability, special sciences, reductionism, metaphysics.

1 HISTORY AND CRITERIA FOR MULTIPLE REALIZABILITY

The most influential argument of the 20th century against psycho-neural identity theories in philosophy of mind is probably the multiple realizability argument. The argument, first advocated by Putnam [1][2] and later by Fodor [3][4], can be succinctly summarized as the thesis claiming that the same mental kind can be realized by different physical kinds (or more simply, that the same mental state can be realized by different physical states). The ubiquitous example in philosophy of mind is the example of pain: pain can be realized by some neural/brain state in humans, by some other neural/brain state in reptiles, by some other neural/brain states in Martians etc. So, according to proponents of the multiple realizability thesis (MRT), the mental kind pain can be realized by various physical kinds. The kind pain therefore, cannot be reduced to a single neural kind, and it follows that identity theory regarding the mind-body problem is false.

The MRT seemed to go unchallenged throughout the second part of the 20th century; however, it has recently been problematized by various authors in philosophy of mind (Kim [5], Bechtel and Mundale [8]; Shapiro [9] [5], Polger [6]). There are many approaches to argue against MRT, but the most important one seems to be defining when kinds are in fact multiply realized. Two sets of authors (among others) have presented their criteria for multiple realizability (MR), with both coming to opposite conclusions. The first pair, Shapiro and Polger [10] come to the conclusion that MR is very rare in nature, whereas Aizawa and Gillet [11] come to the conclusion that MR is rather omnipresent. How is this possible? Throughout the paper, we will use Shapiro and Polger's (S&P) example of corkscrews to illustrate the mentioned curiosity. In the end we will introduce an explanation of it which is in the same time also an alternative solution to the Fodor's original problem of MR.

2 SIMILAR CONDITIONS: DIFFERENT CONCLUSIONS

In short, S&P argue that for MR to be an obstacle to psychophysical reduction, the realizers have to be "different in ways that are relevant to their performing the same function" [10]. What this means is that not just any difference will do. They develop criteria for MR that are comprised of four necessary and jointly sufficient conditions (As and Bs represent the two candidates for MR, e.g. pain in Martians and pain in humans, and S1 and S2 designate distinct taxonomic systems, e.g. psychology and neurophysiology): "(i) As and Bs are of the same kind in model or taxonomic system S1. (ii) As and Bs are of different kinds in model or taxonomic system S2. (iii) The factors that lead the As and Bs to be differently classified by S2 must be among those that lead them to be commonly classified b S1. (iv) The relevant S2-variation between As and Bs must be distinct from the S1 intra-kind variation between As and Bs" [10].

We can illustrate how these criteria work in practice using corkscrews, a paradigmatic example used by S&P [10]. To fulfill the first two criteria, the MR candidate corkscrews A and B have to be classified as the same by one taxonomic system, and as distinct by a lower-level taxonomic system, thus being 'same but different' [10]. The third criteria is not as straightforward: two differently coloured corkscrews are not MR because colour is not causally relevant to performing the function of the corkscrew (does not meet condition iii). On the other hand, two different kinds of corkscrews, a winged and a waiter's corkscrew, which use different mechanisms to remove a cork, do count as MR, because they perform the desired function in different ways. So, to fulfill the third criterion, the corkscrews A and B have to perform the same function in different ways. The fourth condition is a safeguard that prevents intra-kind realizer differences to count as MR, namely, if, e.g. two winged corkscrews had levers that were of a different length, then the differences in length would translate into differences in function – perhaps a really sturdy cork could only be removed by a corkscrew with a longer lever.

However, Aizawa and Gillet (A&G) developed different criteria for MR, namely: "A property G is multiply realized if and

only if (i) under condition $, an individual s has an instance of property G in virtue of the powers contributed by instances of properties/relations F –F to s, or s's constituents, but not vice versa; (ii) under condition $* (which may or may not be identical to $), an individual s* (which may or may not be identical to s) has an instance of a property G in virtue of the powers contributed by instances of properties/relations F* –F* of s* or s*'s constituents, but not vice versa; (iii) F –F ≠ F* –F* ; and (iv), under conditions $ and $*, F –F and F* –F* are at the same scientific level of properties" [11].

The first two conditions are similar: two corkscrews are in a certain state, removing corks (property G), which is, in the first subject, realized by some physical realizer (F –F), and by a different physical realizer (F* –F*) in the second (or the same) subject. The third condition states that the two realizers are not the same (F –F ≠ F* –F*). Since G is realized 'in virtue of the powers contributed' by F –F or F* –F*, this excludes irrelevant properties (similar to S&P's approach, the colour in the aforementioned cases). The first three conditions are roughly the same as in S&P's criteria. Furthermore, the fourth condition only states that the analysed physical realizers should be at the same scientific level of properties. This criterion is, of course, "usually implicitly accepted as a shared background condition in earlier discussions of multiple realization in the sciences" [11].

Even though the criteria are similar, the conclusions could not be more different: one side argues that two corkscrews made of different materials, e.g. aluminium and steel, are not multiply realized, whereas the other side says that they are. Why? One possible answer is offered by Gillet [12], where he argues that S&P, compared to A&G, use a different view of realization. Namely, S&P adopt the *flat* view of realization, whereas A&G adopt the *dimensioned* view.

Shapiro concludes that, "Steel and aluminum are not different realizations of a waiter's corkscrew because, relative to the properties that make them suitable for removing corks, they are identical. The fact that one corkscrew is steel and the other aluminum is no more reason to characterize them as different realizations than the fact that one might be yellow and the other red"[7]. Whereas Gillet argues that, "For with one corkscrew the properties/relations of steel molecules result in the powers individuative of the property of removing corks, while in the other corkscrew the distinct properties/relations of aluminium atoms play this role. We should carefully mark that this judgment accords with the criterion-for only properties/relations that result in the powers of the realized property are taken to be relevant to MR" [12].

3   FODOR'S PROJECT

The case is analogous to Putnam's famous example of mammalian and octopus's eyes. Putnam [2] claims that the differences in materials are not relevant to the realized function

(the structures of the eyes is virtually the same, only the material is different), and Shapiro (and Polger) [10] would agree that it is not a case of multiple realizability, whereas Fodor and Block [13] (and Aizawa and Gillet [11][12]) would argue that it is.

Gillet further argues that the flat view, which S&P adopt, is not what some proponents of MR, Fodor and Block, had in mind. If that is the case, then S&P's argument, so says Gillet, is moot, as it rests on the wrong view of realization (i.e. flat instead of dimensioned). That is obviously correct: if Fodor had the dimensioned view in mind, then S&P's attempts to refute the flat view of MR is sterile.

However, things are not as simple as they seem. A&G allegedly adopt the 'correct' view of realization, yet their conclusions about special sciences are far from that of Fodor's. Namely, they imply that "multiple realization simply does not establish the methodological autonomy of cognitive science" [11]. This is a strange consequence, considering that the Fodor's project as stated in his article, "Special Sciences: Still Autonomous After All These Years" was to show that special sciences are autonomous [4[4]. Of course, just because A&G's conclusions differ from Fodor does not mean that their account of MR is incorrect, but claiming that they interpreted Fodor correctly should be taken with a grain of salt: especially considering that Fodor's main conclusion, the autonomy of special sciences, does not follow from their account. However, one could argue that a case that would satisfy S&P's MR criteria would probably secure autonomy in psychology in Fodor's sense. S&P otherwise argue for a modest identity theory, partly because no positive case (regarding mental kinds) that would pass their criteria has been presented so far. [10] What, according to them, their position implies for the autonomy of psychology is a different story, beyond the scope of this article.

Nevertheless, the purpose of the paper is not to dwell in exegetical debates. However, revisiting the problem behind the motivation for Fodor's project might be instructive. Fodor has two reason why special sciences are (probably) MR and autonomous. First, there are natural kinds that do not correspond to physical kinds, because we can make interesting generalizations about events that have distinct physical descriptions; moreover, the physical descriptions of these events, whether they are similar or not, are entirely irrelevant to the truth of the generalizations [3]. Second, the problem for reductionism is that physical laws are exceptionless, and laws of special sciences are not. If special sciences are reduced to physical sciences via bridge laws, and physical laws and bridge laws are exceptionless, how can the laws of special sciences have exceptions? "In short, given the reductionist model, we cannot consistently assume that the bridge laws and the basic laws are exceptionless while assuming that the special laws are not" [3].[1]

It seems that Fodor tries to solve the following problem: how can the laws of special sciences be reduced to physical laws, if the former are not exceptionless, whereas the latter are? Fodor

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[1] Fodor defines natural kinds in terms of laws, "roughly, the natural kind predicates of a science are the ones whose terms are the bound variables in its proper laws" [3].

offers two solutions, "we can give up the claim that the special laws have exceptions or we can give up the claim that the basic laws are exceptionless" [3]. Both options are undesirable: obviously, special laws have exceptions, and going down the path of physical laws having exceptions also seems like a very dangerous path. However, we believe that there is a third path: to deny that special sciences predicates pick out natural kinds (i.e. to deny that they are genuine laws).

4 THE GRANULARITY PROBLEM AND SPECIAL SCIENCES

Bechtel and Mundale [6] offered an explanation of why MR seems so intuitive in philosophy of mind. They claim that philosophers have used different grains when establishing MR, i.e. they used a coarse grain in identifying mental kinds and a very fine grain when identifying physical kinds. Whereas Bechtel and Mundale claimed that this is only characteristic of philosophers, we would like to expand the claim and argue that using coarser grains for higher order sciences is literally what enables us to make interesting and useful generalizations about the world. Let's illustrate this with corkscrews. Both camps (S&P and A&G) seem to be familiar with the granularity argument, yet their approaches do not seem to reflect that. Both use a very fine grain to identify physical kinds, but neither pays much attention in setting the conditions for identifying the same mental kinds.

Take the two different kinds of corkscrews (of which both S&P and A&G agree that they are MR). Are they functionally isomorphic, i.e. do they perform the *same* function in all contexts? Imagine we have to work in very low spaces, say you want to open a bottle of wine in a box that is only 5 cm taller than the bottle: the winged corkscrew will not do the job, whereas the waiter's corkscrew will. Even though the corkscrews perform a similar (or even the same) function in most situations and contexts, they differ in some. And if they differ in some, they cannot be functionally isomorphic. Similar for the aluminium and steel corkscrew: they differ regarding the temperature of the cork removal (e.g. at 800 ºC) The melting point of steel is 1370 ºC, whereas the melting point of aluminium is 660.3 ºC. Therefore, the two corkscrews will not be functionally isomorphic in all contexts, which, if they are natural kinds, should be the case. Yes, the differences are extremely small, one could say irrelevant, but they do exist. However, we ignore them (or we use a coarser grain) *because* they are so minute and rare that they are completely irrelevant compared to the extreme usefulness of the powerful generalizations that we acquire, if these differences are cast aside. They are similar enough, which enables us to use these generalizations with great proficiency.

This is not exclusive to corkscrews (or to special sciences). Even the most textbook example of MR is vulnerable to such granularity. Take a mechanical and an electronic computer, which are both realizing a Turing machine, i.e. they are functionally isomorphic. Note that we are again applying a very narrow context in which they are functionally isomorphic. If we add a massive magnet to both computers, the mechanical computer will still perform the function, whereas the electronic will not. Take two distinct electronic computers: one might have

a faster processor and will realize the program faster (this does not mean that we cannot imagine, or that there do not exist, any circumstances where two distinct computers can perform the same aspect of a program in the same way, but the totality of their functions in various contexts will not be isomorphic).

The same seems to hold for generalizations in special sciences: instead of listing countless similar but minutely different laws/kinds, psychologists ignore some details that are irrelevant and idealize others to develop powerful generalizations that are extremely useful. The very fact that they idealized and abstracted (or coarse grained) means that they are no longer describing natural kinds (as there are too many to describe), but they gain in simplification and generalization. This also explains why special science laws have exceptions: they do not always work precisely because they are abstracted and idealized laws of countless similar but not identical phenomena, and finding out which details are irrelevant and which important is an extremely difficult task.

5 CONCLUSION

Does this mean that special sciences do not accurately describe the world? Yes, and no. Yes, because, strictly speaking, they disregard details and idealize others to form powerful, informative, and useful generalizations. No, because the world is too complex to talk about it accurately. Are special sciences reducible to physical sciences, i.e. are type identical psychological states reducible to type identical neurological states? No, but not because they are multiply realized, but because there are no type identical psychological states: psychological states (and other special sciences predicates) are useful abstractions (as Davidson has shown, but for another reason [14]), that enable us to generalize about states that are minutely distinct, but, for all intents and purposes, identical.

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Indeks avtorjev / Author index

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Kognitivna znanost

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