Content Analysis as a Method of Researching Spatial and Social Presence

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Abstract. This paper is the continuation of previous research presented the forms which spatial, social and personal presence (self-presence) can take. Experiencing the presence phenomenon in virtual reality is accompanied by various contradictions and temporary distortions of the natural worldview. Earlier, phenomenological description of presence based on interviews with the participants of the test was obtained. This paper offers a quantitative content analysis of those same interviews. The categories of social virtual presence and absence have been introduced, as well as social presence and absence as relatively independent categories. Social virtual presence implies the feeling of somebody being next to you in virtual reality, while social virtual absence is when a person is under the impression that there is nobody there, even if there are indications of another person's presence. This paper will treat social presence as the feeling of another person's presence nearby, which also involves having a notion of the person's exact location. Social absence will be understood as the feeling of nobody being around. When in virtual reality, a person can simultaneously experience different combinations of these states and spatial presence, by which this paper implies the feeling of physically being in a virtual environment.

Keywords: Virtual Reality, Phenomenon of Presence, Spatial Presence, Social Presence, Content analysis

Introduction

The distinctive feature of a person's interaction with virtual reality is the fact that a person's perception of his or her location and the location of other people may change. A person's presence in the physical world is more or less devoid of contradictions; i.e. being in a space, a person has the idea of who is nearby, what he or she can touch and where he or she can move using certain means. Distortion of these perceptions is usually connected with an altered state of consciousness. Virtual reality presents bigger and smaller opportunities at the same time. A person can be underwater while standing on an underwater cliff, but cannot touch the objects located there. One should understand that, in a sense, a collision or even an injury resulting from it also relates to the opportunities that are present in the physical world and not present in the virtual one. When in virtual reality, people decide for themselves where they are, why they can do things they could not do in the physical world and cannot do things that

they could do in the physical world. They may conclude that none of this is real and, as a result, not experience the phenomenon of presence. They may assess the environment they are in as partially real, accepting its natural opportunities as certain rules of the game, may ignore their inability to perform certain operations, and, finally, may perceive the circumstances as if they can do all the things they are able to do in the physical world. All this relates to the variations in presence phenomenon experiences.

According to [3], when in virtual reality, a person cannot fully tune out the physical world because his or her body is in it. Experiencing the presence phenomenon in virtual reality is a kind of a personal choice, at times conscious, at times not [23].

Previous papers discussed these effects in detail through the example of participants' responses in a structured interview. The method of phenomenological analysis was used, which made it possible to demonstrate manifestations of spatial, social and personal presence (Self-presence) as the versatility of contradictive notions, impossible in the real world but possible in virtual reality.

The approach underlying the series of the conducted studies, described both in the previous papers and in this one, is connected with the description of the presence phenomenon experience manifestations. This approach includes the study of individual cases, the experience of presence by each particular person. Such an approach allows us to highlight the options of a person's interaction with the surrounding space and with other people, included in the virtual reality and/or present in the same physical room. Based on the elicited options of interaction, one can further determine both the state of a specific virtual reality environment user and the developed environment itself. In the latter case, the responses of the whole group should be evaluated collectively.

The goal of this paper is the description of manifestations of different types of presence in virtual reality participants, based on content analysis of their responses to the questions of a structured interview.

The question is raised regarding the applicability of the content analysis method for processing the participants' responses during a structured interview. Will content analysis of the responses allow us to detect spatial and social presence as separate types and describe their interaction with each other?

Further, the effects emerging in virtual reality are discussed, when a person includes or excludes the notion of other people in the same virtual environment that he or she is in, who did or did not have the opportunity to manifest themselves in this virtual environment. Manifestations of spatial presence are described quite simply: as a situation when a person perceives himself or herself as being in the virtual environment. Phenomena connected with the perception of other people are more complex in their description. For example, we should separate the situation in which other people are perceived as being in the same virtual environment and the situation in which a person perceives the presence of other people in the same physical space while interacting with a virtual environment. One can define the situation in which a person perceives another person as a participant of the same virtual environment as a social virtual presence. Equally important is social virtual absence, which is not simply a situation when a person does not perceive other people in the same virtual environment, but rather a situation when a person ignores the participation of other people

in the virtual environment. The perception of other people as being in the same physical room with the person participating in a virtual environment can be defined as social presence.

This paper puts forward a hypothesis that the use of content analysis will make it possible to elicit the descriptions of such phenomena as spatial presence, social virtual presence, social virtual absence, social presence and social absence as separate recognizable categories and to demonstrate their interaction with each other.

It is of importance that, for this paper, of interest are the individual cases, certain manifestations of the presence phenomenon experience. The responses presented here do not cover all the possible options of experiencing the presence phenomenon and do not profess to give exhaustive description.

1 Modern approaches towards studying presence

For the sake of this paper, of the most interest are the papers devoted to experiencing spatial presence and its connection to the plausibility of the events taking place, as well as to experiencing social presence.

Let us recall the types of presence discussed in the paper [12]:

- spatial presence, recognized as presence in a certain space; in earlier papers, for example, in [14] it is referred to as environmental presence;
- social presence, recognized as joint presence in a certain space, as well as the sense of other people's presence nearby;
- self-presence, probably, corresponds with the notion of personal presence from earlier papers, [10], [14], [11]. Self-presence is a type of presence occurring when a person perceives the body, emotions and/or identity of a technological version of themselves as their own.

Further, this paper will use these particular types of presence.

Some authors offer their own terms, in some respect close to the types of presence. The paper [12] provides a discussion about perceptual and social real ism, which are crucial aspects of presence. Perceptual realism occurs when an environment supports actions in it, when the environment's response is perceived as plausible and adequate. Social realism refers to a more general notion: when an event, taking place in an environment, is plausible, when it can happen in the real world. A virtual environment may have high perceptual and low social realism. It can also be the other way around.

The paper [22] offers the notions of social presence and co-presence, which imply the ability of being somewhere together, perceiving other people and being perceived by them, interacting with other people. The issue is raised regarding realism and authenticity – a crucial issue in terms of this paper's discussion. Authenticity does not necessarily mean realism.

Similar ideas are expressed by M. Slater, when he talks about place illusion and plausibility [13]. As it has been mentioned before [4], according to [25], there are three main approaches to the research of presence: a mediated-objective school of thought approach, mediated-subjective school of thought approach and inner presence school of thought approach.

The first two approaches describe presence as an essential element in mediated experience. The third approach describes presence as a phenomenon that does not require median systems (VR technologies etc.).

The schools of mediated presence define presence as a perceptual illusion of non-mediation. [25] criticizes this approach, whilst stating that mediated presence schools of thought provide valid definitions for a number of notions, such as immersion and involvement. According to [25], the mediated presence approach does not provide answers to the grand questions: why do we feel presence and what is its role? Similar questions are broached by S. Triberti and G. Riva, the inner presence school of thought exponents, in their paper [26]. They also discuss the schools of mediated presence, which, according to them, do not provide answers for the questions regarding the evolutionary reason for presence phenomenon emergence, regarding its causes and its function.

Exponents of the third approach define the presence phenomenon in their papers as a conscious feeling of being in the outer world, as a phenomenon controlling the differentiation between the inner and the outer [17], [28], [21], [18], [20], [27], [19], [29], [26]. They suggest viewing presence as presence in any environment, not necessarily created with VR technology. They regard presence as the central component of conscious mental life [29]. According to these researchers [26], the feeling of presence allows continuous adaptation of one's activities in an external environment. This approach relates to the notions of intentions and actions: the more intentions the environment enables to be fulfilled, turned into actions, the stronger is the feeling of presence is.

There are other papers as well, examining presence through a broader lens, not only as presence in virtual reality. For example, [15], suggest that presence is linked with successful execution of one's intentions, with a person perceiving himself or herself as a successful author of his or her own actions. In [8] presence is defined as a personal state occurring both in real and in virtual environments, while mediation is regarded as not only a means of creating virtual reality, but any situation in general, in which actions are executed indirectly. For this reason, presence is addressed through the example of driving a car, in order to demonstrate the flexibility of this approach.

An important aspect connected with the presence phenomenon is covered in the paper [16], namely, the issue of interconnection between presence and a person's perception of his or her own movements in a virtual environment. Unlike the researchers from the school of inner presence, who suggest that a virtual environment creates unlimited opportunities, the paper [16] specifies that virtual environments are limited in comparison with the real world; in particular, movements are highly encumbered. [16] links presence and illusory own movement in a virtual environment. Experimental materials demonstrate the connection of presence with a person's perception of his or her movements in a virtual environment.

The phenomenon of presence, independent of which school's definition a researcher utilizes, is a subjective experience which involves a person interacting, in one way or another, with the surrounding reality (for the representatives of the mediated presence school of thought this would be virtual reality).

Of interest for this paper are papers by Slater devoted to transitions from the state of presence in virtual reality to presence in the real world. The paper [24] describes a new measure for presence in immersive virtual environments (Ves), based on the number of transitions from virtual reality to the real world, which are reported by the participant while his or her interaction with virtual reality. According to [23], presence may be looked at as a selection mechanism that organizes the stream of sensory data into an environmental gestalt or perceptual hypothesis regarding the current environment. The environment hypothesis is continually reverified or else a break in presence occurs.

For the purposes of measuring presence, quantitative methods are mostly used, for instance, those described in the paper [6].

The paper [5] provides a description of qualitative methods, including that of content analysis. Paper [9] uses content analysis to look for topics connected with experiencing spatial and social presence.

Paper [7] describes the results of a qualitative content analysis of immersive virtual environments (IVEs). It discusses experience acquired by a person in virtual reality, which is significantly structured by agency, when virtual reality experience causes self-directed affect, thus somewhat unintentionally engaging a player's body as a feedback site.

2 Methodology

2.1 Participants

Eighteen people were chosen for the study of the connection between presence and intellectual task accomplishment and exhibited experiencing presence in the course of the study [1].

A more in-depth description of them can be found in [2] and [4].

The experimental group included:

- 11 people (4 males and 7 females) in the experimental group, solving the task in virtual reality.
- 7 people (1 male and 6 females) in the control group, solving the task on a computer screen.

The majority of the selected participants have manifested themselves as being able to experience the presence phenomenon [2] and [4].

2.2 Study protocol: virtual environment, equipment, procedure

As was already mentioned in [2] and [4], a popular 'Grand Theft Auto: San-Andreas' game was chosen, which features both a sufficiently rich game world and the opportunity to fly a helicopter with a reasonably realistic 'behavior'.

The image was broadcasted onto Emagin Visor Z800 head-mounted display.

The participants were offered a flight over a virtual city, forest or lake, in slightly overcast weather conditions, at time scale of 1 hour = 1 minute, starting at noon and ending at 10 pm (so that the duration of stay in VR would not exceed 10

minutes). A ThrustMaster Top Gun Fox 2 Pro USB joystick was used as the controller.

For the participants to feel included into the environment they were given an opportunity to act in first-person mode, i.e. during the flight, participants did not see the helicopter or the character, as if they were 'flying over the city themselves'.

For the purposes of providing the naturalness of control, many excessive control functions were blocked (exiting the helicopter, shooting etc.), with the exception of the relatively obvious ones: joystick tilts, controlling forward – backward moves and left – right moves, and the ascending button, which, when pressed, enables you to gain altitude and when released – to go down.

The participants were also able to move through the fog and clouds, which helped intensify the sensation of movement through the environment [2] and [4]. Emagin Visor Z800 does not provide full isolation, so the overhead lights in the physical room where the test took place were turned off to minimize the number of distracting visual stimuli.

Special conditions were also created, in which the effect of these factors was intensified, and the conditions in which the effect of these factors was mitigated (except the realism, which remained at the same level throughout the entire test: the level provided by the 'Grand Theft Auto: San-Andreas' game).

The participants were offered two episodes, with a small break in between. In one of the episodes, they were piloting the helicopter themselves, and in the other episode, the operator piloted the helicopter. The choice of delivery order was random.

In addition, some of the participants (randomly chosen) had the opportunity to give commands to the operator during the passive episode. In the active episode, some of the participants were intentionally exposed to difficulties with joystick control: its response level to tilts dropped, which led to delayed reaction of the system to the participant's actions.

These episodes will be further referred to as:

- 'fully functional activity' (an active episode with controlling the flight without additionally introduced obstructions),
- 'activity with reduced sensitivity' (an active episode, where flight control was hampered by reduced sensitivity of the joystick),
- 'flight with oral control' (a passive episode, where a participant could give commands to the operator regarding the direction of flight for the helicopter; if a participant did not give commands, the helicopter remained at one spot) and
- 'flight without control' (a fully-passive episode, where the operator made his own decisions in directing the virtual flight).

Participants were given a task to fly around the city following the special marker rings that were located in the sky; however, if they got off track and lost the rings or flew in the other direction, this was not considered a failure. The main goal was the flight itself and observation of the views [2] and [4].

2.3 Interview: questions and discussion

When both episodes were completed, the participants were interviewed and asked questions relating to their impressions, their expectations and fears connected with the virtual environment.

In general, the interview is divided into several main blocks. The first block is conditionally labelled as environmental or spatial and includes questions connected with expectations regarding the environment (for instance, whether the participant had expected the opportunity to touch virtual objects or the possibility of these objects touching him or her). The first block also includes questions connected with the participant's notion of his or her own location: in the virtual environment, in the physical room where he or she really is, or, possibly, both at the same time.

The second block, conditionally labelled as social, refers to other people or a person in the same room. Depending on the possibilities of the environment, this block may include only questions of whether the participant had remembered about the location of other people in the room, or it may also feature questions about the notion of other people in the virtual reality.

As part of this research, the participants were asked about their perception of their own location: whether they were in the air, in the helicopter, in the real room (where the test took place), or simultaneously in the room and in the helicopter. In their opinion, who controlled the helicopter (in cases where the helicopter was controlled by the operator): the operator, a character from the environment, or did the helicopter act on its own? In what way was the operator controlling the helicopter perceived: as an environment character; as a person from another (real) world, controlling the helicopter from there; as an instrument; or did the participant not think about it? Where, in participants' opinion, was the experimenter (or the experimenter together with the operator) in case of the independent flight? Nearby in the helicopter? Nearby in the real room? Did the participant think of them at all? Were they nonexistent at all to him or her? The questions were asked in no particular form, in the course of conversations with participants, with reference to the events occurring while interacting with the virtual environment.

The participants' responses have been subjected to phenomenological analysis the results of which are described in [2] and [4], as well as to content analysis, the outcomes of which are given below.

2.4 Content analysis

Quantitative content analysis of the participants' responses to the structured interview has been performed. Content analysis was performed by a group of experts including a specialist in the field of method conformance inspection, with vast experience in analyzing texts, and a specialist in the field of computer psychology.

The procedure of the analysis involved several stages.

The first stage involved experts determining which elements can be ascribed to the topic of spatial and social presence. The decision was based on the context that had been created by the participant's preceding words or questions from the experimenter

in the course of the interview. At this stage, experts defined the categories within which word count was to be carried out:

- Spatial presence, which covered all the responses where participants directly confirmed their feeling of being in the virtual environment, and responses in which they reported their location being in the sky, in the helicopter, their expectations when touching virtual objects etc. – Social virtual presence, which included all the references to other actors of the virtual environment, regardless of whether the participant associated them with real people or not.
- Social virtual absence, which included all the cases when the participant directly denied the presence of other people in the virtual environment, even though he or she had interacted with them. For instance, the participant claimed giving voice commands directly to the helicopter, not to the operator, or asking questions, but claimed he or she had been doing that into the void.
- Social presence, including all the cases when the participant noted the presence of other people nearby in the real world ('You were here, in the room'.).
- Social absence, when the participant forgot about other people present nearby in the room (maybe, for a while).

The difference between social virtual absence and social absence is that in the case of social virtual absence other people influenced the events in the virtual environment (in our test, the operator was piloting the helicopter and obeyed commands), but the participant 'forgot' about their participation; while in the case of social absence, the participant simply 'forgot' that other people were in the same room with him or her.

The third stage involved counting the observation units included in a certain category. A word from the fragment of a response, dealing with the chosen topic, was considered a unit of measure; whether the word is a noun, an adjective, a verb, a particle, a conjunction or a preposition was of no significance.

For instance, in the following dialogue, the 'spatial presence' category featured seven words (the experimenter's questions in this case are not considered an element of the text, although they may provide context): *Did you have any expectations of the environment? Headwinds, branches grazing?*. – 'With the branches – yes'. – *Like what?* – 'That they will lash, or there will be a sound'.

Some words fell into several categories at the same time; for instance, the information about the experimenter seen with peripheral vision belonged simultaneously to the negative statements of spatial presence, being a part of the real world, and to social presence, because the participant admitted the presence of another person near. A number of controversial cases, when it was impossible to determine, for example, whether these words really describe spatial presence or are a description of the virtual environment as a picture, were not included into any category.

The responses of one of the female participants were excluded from the content analysis because they were recorded as a summary, not a verbatim transcript.

During the fourth stage, for the purposes of evaluating spatial presence, the coefficient of imbalance was calculated, where all the statements confirming the presence hypothesis were considered positive, and all the statements relating to the feeling of being in the real world (from direct claims to references of circumstances,

such as a knock on the door or catching a glimpse of the screen or even the experimenter with peripheral vision) were considered negative.

In order to assess social virtual presence, social virtual absence, social presence and social absence, the specific weight was calculated.

The fifth stage was the interpretation of the results and it is described in the following section.

3 Results and discussion

Results of content analysis can be observed in Table 1. As previously noted, the coefficient of imbalance was calculated for spatial presence, defining the representation of statements in the text relating to this type of presence. Positive meanings correspond with those self-reports in which the participants mainly claimed having experienced spatial presence. Negative meanings correspond with self-reports in which the participants mostly claimed not having experienced spatial presence, either by stating it directly or by describing impressions from the real world. It should be noted that social virtual presence and the state which we will refer to as 'social virtual absence', in the same way as social presence and social absence, are not directly opposed to each other. For this reason, specific weight is calculated separately for each of them. It is assumed that, to ignore another person's presence nearby, efforts are required, probably, non-conscious ones, that is why absence should be considered a special state, not just a negation of presence.

As this paper focuses on individual cases, neither the coefficient of imbalance, nor the specific weight of certain categories was calculated for the group – only for each participant separately. However, in other studies, when evaluating the intensity of the feeling of presence (be it spatial or social presence) caused by the environment, the calculation of these coefficients for the group as a whole may be carried out.

The numeration of participants in Table 1 corresponds with the numeration used in previous research [2] and [4].

The participants' responses differed in the total number of words. Some responded briefly, others gave detailed answers. Table 1 shows that both the coefficient of imbalance ratios, calculated for the spatial presence category, and the specific weight ratios, connected with the sphere of social presence, are relatively low. This can be explained by the fact that participants not only answered the questions regarding their presence experience given by the experimenter, but also expressed their impressions, associations, gave examples from personal experience, not connected directly with the events happening during the experiment.

Before analyzing the acquired ratios, mean values should be calculated, as well as the relative range of variability, see Table 2. Before the calculation, the ratios of those participants, whose coefficient of imbalance, calculated for spatial presence, turned out to be below zero, were excluded from the selection, because negative ratios indicate the prevalence of responses stating the fact that they had not experienced spatial presence.

Table 1. Content analysis results

#	Total number of words uttered during the interview	Coefficient of imbalance, c	Specific weight, K			
		Spatial presence	Social virtual		Social	
			Presence	Absence	Presence	Absence
1	1213	0.241	0.070	0.012	0.013	0.007
2	428	-0.112	0	0	0.033	0.026
3	794	0.135	0	0	0.106	0.016
4	389	0.115	0.044	0.039	0.062	0.018
5	970	0.073	0.026	0.005	0.019	0.004
6	498	0.454	0	0.026	0.032	0.038
7	519	0.430	0	0.104	0.037	0.008
8	351	0.033	0.020	0	0.011	0
9	534	-0.202	0	0	0.099	0
10	177	0.021	0	0.073	0.040	0
11	144	0.090	0.014	0	0.042	0.160
12	658	-0.041	0.076	0	0.102	0
13	–	–	–	–	–	–
14	114	0.087	0	0.088	0.018	0
15	770	-0.085	0.003	0.031	0.009	0.004
16	655	0.280	0	0	0.108	0.070
17	418	0.013	0.017	0	0	0.012
18	565	0.108	0.156	0.014	0.062	0.021

Table 2. Statistical processing of the content analysis results

Statistical ratios	Coefficient of imbalance, c	Specific weight, K			
	Spatial presence	Social virtual		Social	
		Presence	Absence	Presence	Absence
Average	0.160	0.027	0.028	0.042	0.027
Max	0.454	0.156	0.104	0.108	0.16
Min	0.013	0	0	0	0
Max-min	0.441	0.156	0.104	0.108	0.16
Relative range of variability, %	36.3	17.1	26.7	39.2	17.0

A low level of the relative range of variability of the measured parameters indicates sufficient conformance of the sample group selection with all the parameters: the coefficient of imbalance, calculated for the spatial presence, and the specific weight for the social virtual presence, social virtual absence, social presence and social absence.

Of principal interest during the analysis of the results are, obviously, the participants with the maximum level of spatial presence. There were two such participants: participant 6 (female), with c = 0.45, and participant 7 (female), with c = 0.43, fol-

lowed by participant 1 (female), with $c = 0.24$ and participant 16 (female), with $c = 0.28$. All the four participants demonstrated the coefficient of imbalance above average.

Some participants show negative values for the coefficient of imbalance calculated for spatial presence. This is participant 2 (male), with $c = -0.11$, participant 9 (female), with $c = -0.20$, participant 12 (male), with $c = -0.04$, and participant 15 (female), with $c = -0.09$. This means that denial of spatial presence prevailed in their responses over the statements indicating them having experienced spatial presence.

Participant 1 (female) demonstrated the specific weight for social virtual presence $K_{\text{social virtual presence}} = 0.07$, which is significantly higher than the average in the group. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0.012$, which is below average. This shows that participant 1, mostly perceiving herself as present in the virtual environment, included other people into the virtual environment as well and did not forget about their influence on the virtual environment events. The specific weight of social presence was $K_{\text{social presence}} = 0.013$. This is significantly lower than the average in the group. The specific weight of social absence was $K_{\text{social absence}} = 0.007$, which is significantly lower than the average. This means that in the participant's responses the presence or absence of other people nearby did not take a lot of place.

Participant 6 (female) demonstrated the specific weight of social virtual presence $K_{\text{social virtual presence}} = 0$, which is significantly lower than the average. Her specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0.026$, which is proximal to the average. This means that participant 6, perceiving herself as significantly present in the virtual environment, did not include other people into this virtual environment, but did not ignore their influence on the events either. The specific weight of social presence was $K_{\text{social presence}} = 0.032$, which is below average in the group. The specific weight of social absence was $K_{\text{social absence}} = 0.038$, which is above average in the group. This means that participant 6 forgot about the fact that other people were near her in the physical room.

Participant 7 (female) demonstrated the specific weight of social virtual presence $K_{\text{social virtual presence}} = 0$, which is significantly below average. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0.104$, which is significantly higher than the average and is the top value in the group. This shows that participant 7, while perceiving herself as present in the virtual environment, did not include other people into this environment and ignored their influence on the events in this environment. The papers [2] and [4] demonstrate that the participant thought that she was giving commands directly to the helicopter. This case is one of the examples of contradictory experiences when interacting with virtual reality. The specific weight of social presence was $K_{\text{social presence}} = 0.037$, which is slightly lower than the average in the group. The specific weight of social absence was $K_{\text{social absence}} = 0.008$, which is significantly below average in the group. This shows that participant 7 noted the presence of other people in the same room but did not pay much attention to them.

Participant 16 (female) demonstrated the specific weight of social virtual presence $K_{\text{social virtual presence}} = 0$, which is significantly lower than the average. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0$, which is signif-

icantly below average. This shows that participant 16, while perceiving herself as present in the virtual environment, did not include other people into this environment, and did not ignore their influence on the events of the environment either. The specific weight of social presence was $K_{\text{social presence}} = 0.108$, which is significantly higher than the average and is the top value in the group. The specific weight of social absence was $K_{\text{social absence}} = 0.07$, which is significantly higher than the average in the group. This shows that, while perceiving herself as present in the virtual environment, she did not include other people into this environment, feeling their presence nearby at one moment and forgetting about them the next moment. This result is an example of contradictory experiences when interacting with virtual reality.

Participant 18 (female) demonstrated the top value of the specific weight of social virtual presence in the group. Her values of spatial presence are below average, with $c = 0.108$. Her specific weight of social presence was also above average, with $K_{\text{social presence}} = 0.62$. This means that, despite the fact that participant 18 perceived herself as not strongly present in the virtual environment, she simultaneously included other people into the virtual environment and remembered about their presence in the same physical room. This is another example of contradictory experiences when interacting with virtual reality.

Further, we are going to examine the correspondence between the negative values of the coefficient of imbalance, calculated for spatial presence, and the types of social presence. Participants 2, 9, 12 and 15 gave responses indicating the fact that they had perceived themselves as present in the real, physical room more than in virtual reality.

Participant 2 (male), with $c = -0.11$, demonstrated the specific weight of social virtual presence, $K_{\text{social virtual presence}} = 0$, which is significantly below average in the group, and the specific weight of social virtual absence $K_{\text{social virtual absence}} = 0$, which is significantly lower than the average. This means that participant 2 did not perceive himself as present in the virtual environment, did not include other people into it, but did not ignore their influence on the events of the virtual environment. The specific weight of social presence was $K_{\text{social presence}} = 0.033$, which is below average. The specific weight of social absence was $K_{\text{social absence}} = 0.026$, which is proximal to the average in the group. Thus, despite the fact that participant 2 did not perceive himself as present in virtual reality, he was inclined to ignore the presence of other people nearby.

When analyzing the responses of participant 9 (female), a contradiction arises between the results of the phenomenological analysis and the content analysis. She, see [2] and [4], gave responses regarding spatial presence, from which it was clear that she perceived herself at times in the virtual world and at times in the real world; however, the results of the content analysis indicated the negative values of the coefficient of imbalance, $c = -0.202$. The specific weight of social virtual presence was $K_{\text{social virtual presence}} = 0$, which is significantly lower than the average in the group, and the specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0$, which is significantly lower than the average. This means that participant 9 did not include other people into the environment either and ignored their influence on the events of the environment. Her specific weight of social presence was $K_{\text{social presence}} = 0.099$, which is significantly higher than the average in the group. The specific weight of social absence

was $K_{\text{social absence}} = 0$, which is significantly lower than the average. Thus, participant 9 did not forget about the presence of other people near her.

Participant 12 (male), $c = -0.041$, demonstrated the specific weight of social virtual presence, $K_{\text{social virtual presence}} = 0.076$, which is significantly higher than the average in the group. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0$, significantly lower than the average in the group. This means that participant 12, although mostly perceiving himself as present in the physical room, not in virtual reality, included other people into the virtual environment and did not ignore their influence on the events of the virtual environment. The specific weight of social presence was $K_{\text{social presence}} = 0.102$, which is significantly higher than the average in the group. The specific weight of social absence was $K_{\text{social absence}} = 0$, which is significantly lower than the average. Thus, participant 12 did not forget about the presence of other people near him.

Participant 15 (female), $c = -0.085$, demonstrated the specific weight of social virtual presence, $K_{\text{social virtual presence}} = 0.003$, which is significantly lower than the average in the group. The specific weight of social virtual absence was $K_{\text{social virtual absence}} = 0.031$, which is above average in the group. Thus, we can assume that, although participant 15 did not perceive herself as present in the virtual environment and did not include other people into it, she mostly ignored the influence of other people on the events of the virtual environment.

It should be mentioned that participant 11 (female) demonstrated the highest specific weight of social absence in the group, although her other indicators do not stand out. We can assume that the fact of forgetting about other people itself is not necessarily connected with intense spatial presence.

It should be noted that by no means all the participants" responses can be regarded as striking examples of the presence phenomenon experience. This is because not all the participants of the experiment had intense or contradictory experiences.

Another outcome of this paper is the division into social virtual and social presence. Social presence is a phenomenon that does not require immersion into virtual reality; it occurs when a person feels there is somebody else near. Social presence is a crucial phenomenon that, essentially, allows communication between people. It does not always correspond with reality. A person may be involved in his or her work, may even be in virtual reality, feeling somebody nearby, while the other person has already left the room. Experts testing computer games in virtual reality demonstrate how often the feeling of another person's presence nearby fails them, when they are about to point out an important element of virtual reality, but the colleague, who had been present at the beginning of their work, has already left.

There is one more crucial aspect of social presence, understood here as the feeling experienced by a VR user of another person's presence in the same real-life room as he or she is. It lies in the fact that experiencing social presence indicates at the same time a low level of spatial presence experience. This is due to the fact that another person is, undoubtedly, a part of a physical world, and realizing his or her presence nearby 'yanks' the person out of the virtual environment. However, this connection is indirect, which is indicated by the results of the previous papers [2] and [4]

and is supported by the results of content analysis (participant 3 shows high level of spatial presence and big specific weight for social presence).

Social virtual presence, as the name suggests, occurs only in virtual reality. As shown by these and further experiments, to experience social virtual presence it is not necessary for a real or virtual partner to be present in virtual reality. The paper [3] shows the way a participant imagined the presence of another person in virtual reality.

No less remarkable is the distinction of social virtual absence and social absence as independent terms. Our previous paper [2] and [4] has already discussed 'social absence', but this term included both social virtual and social absence. However, it is crucial to separate them. Social absence can be described as a feeling of nobody being around. It can be explained as 'a person not noticing anyone around them'. As can be seen from the example of participant 11 (and everyday life experience indicates the same), social absence is not necessarily connected with high spatial presence. Perhaps, it can be caused by intense involvement. Social virtual absence is a feeling when a person denies the presence of the other person with whom he or she is interacting, as demonstrated in [2] and [4].

Conclusion

The method of content analysis applied to analyzing the responses of the participants in the structured interview has shown interesting results, supporting and extending the outcomes of the phenomenological analysis. It is important to realize that not all people who have experienced interaction with virtual reality will necessarily report experiencing the presence phenomenon. This explains the fact that not all the participants provided results with high coefficients of the types of presence in question. It should be noted, that content analysis provides results not only in the form of acquired coefficients. In the process of distinguishing categories, one can elicit crucial notions, uncovering the details of experiencing the presence phenomenon. In this case, the notions of social virtual presence, social presence and social absence have been identified as separate, stand-alone experiences.

The specific feature of this paper is the fact that another person (the operator), physically present in the same room as the participant and not visually presented in the virtual environment, influenced the events of the environment by controlling the virtual helicopter in one of the two episodes. In a number of cases, participants interacted with him, giving him oral commands; in other cases, they were deprived of the possibility to give commands. Social virtual absence can be applied to this research: it is the denial of the fact that the helicopter was controlled by the operator, not a mechanism or a program. In other environments, it can manifest itself in other ways or not manifest itself at all.

This paper uses content analysis individually, because the experiences of each separate participant are under the magnifying glass. As can be seen from previous papers and from the content analysis results, each person reacts differently to the same environment: what may disturb and distract one person, may have no influence on another person's experiences.

However, changes in the environment and in the interaction scenario may alter the experiences, increasing the probability of experiencing certain types of presence. In order to understand the extent to which changes in the environment and in the interaction scenario differ, content analysis has been applied to the responses of the whole group.

Based on the defined categories, one can see manifestations of both contradictory experiences, such as in participants 7, 16 and 18, when a person's notion of his or her location contradicts his or her notion of the location of other people, and non-contradictory experiences, as in the other described examples.

Content analysis has shown that a person can perceive himself or herself as present in the virtual environment and, while interacting with other people who influence the virtual reality but are not presented there as an avatar, ignore this influence and his or her own interactive actions. While perceiving himself or herself in the virtual environment, he or she can at the same time understand that there are other people nearby, in the same physical room. A person can simultaneously include other people into the virtual environment and remember about their presence nearby, in the physical space.

In the course of content analysis, such phenomena have been detected as experiencing spatial presence, social virtual presence, social virtual absence, social presence and social absence; interaction between them has been demonstrated, which proves the hypothesis put forward in the introduction.

Obviously, applying content analysis to the responses of a structured interview devoted to virtual reality experiences has its limitations and issues that need to be addressed. First, the question arises of what should be regarded as one message subject to analysis. In this case, the summation of all the responses of a participant in the course of the interview was chosen as one message. That is why presence values calculated in the course of the content analysis turned out to be quite low. Another important issue is the absence of clear criteria for high and low values. In this paper, the results of each participant were compared to the average value. Apart from that, in those cases when participants noted perceiving themselves in the virtual environment and in the room where the experiment took place, the results of the content analysis could indicate the fact the a participant had not experienced spatial presence.

This paper does not discuss the influence of the program providing the virtual scene, the VR devices, and the scenario of possible events and individual features of the participants on experiencing the presence phenomenon, because the focus is on the method that allows detection of ways in which a person can interact with space and perceive other people. One cannot suppose that users of other virtual environments will necessarily experience the same effects as described in this paper. However, one can be sure that this method makes it possible to detect manifestations of the effects connected with spatial interactions and perception of other people. Naturally, when evaluating the developed environment by means of content analysis, be it educational, academic or entertaining virtual reality, requirements are raised for the selection of a participants sampling group, for its representativeness and compliance with the environment's target audience.

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