“Let’s take the TV!” The effect of leadership emergence on the outcome of a virtual burglary

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Abstract

Most of the research on burglary decision-making was done on solo offenders. With this research, we aimed to inspect leadership emergence in co-offending burglaries, while considering the difference in speaking time and contribution of the participants as indications of leadership emergence. This paper aimed to give an implication on whether leadership emergence influences the outcome of the burglary. To measure this, a virtual burglary was carried out in a virtual environment while using VR technology. Hereby, two participants worked collaboratively as a pair to burgle the target house. Afterwards, participants were presented with a questionnaire, where, amongst others, leadership emergence and the quality of the cooperation were measured. We found that leadership emergence did not significantly affect the outcome of the burglary. The participants estimated their contribution to be evenly distributed. Moreover, the talk ratio slightly differed between the participants. Therefore, based on our used indicators of leadership, no leadership emerged. Moreover, the quality of cooperation was not influenced by the emergence of leadership, which also may be explained by the fact that no leadership emerged. Lastly, the virtual reality experience overall was satisfactory, in terms of high achieved presence and co-presence, but also because the experienced cyber-sickness did not negatively affect the participants' task performance. All in all, this study proves that VR can be an effective tool in examining the decision-making and leadership emergence of a co-offending burglary. The study was of value because it presents various measurements on how to inspect leadership emergence in a virtual burglary and we count on future research that implements and refines our used measurements, so that leadership emergence in co-offending burglaries can be further examined.

"Let's take the TV!" The effect of leadership emergence on the outcome of a virtual burglary

Most of the research on burglaries concerns solo burglars and the decision-making process of these burglars during a burglary is well-known and studied in the field of crime (Coupe, 2017). Less research, however, is done on co-offenders and their decision-making in committing a burglary. The main motivation of burglars co-offending which is stated by a variety of authors (Lantz & Ruback, 2017; Tillyer & Tillyer, 2014; Uhnoo, 2015; Weerman, 2003), is that offenders anticipate it would be easier, more profitable, and less risky to commit crimes with accomplices rather than on their own. This is in line with the main motivation for committing a burglary, namely, stealing the largest amount of financial value without being caught. Hereby, a burglary as well as a co-offending burglary may be described as an instrumental crime (Weerman, 2003). Hence, it is often the result of a rational thinking process and effective decision-making to achieve the goal of financial gains while avoiding the risk of being caught in the act (Catalano, 2010; Coupe, 2017; Meenaghan et al., 2018; Weerman, 2003). However, while choosing to involve accomplices in a burglary, the offender must share their financial gains with the other offenders and an increase in individual gain may be at risk (Tillyer & Tillyer, 2014). Next to that, there may be a risk of betrayal as well as the risk that accomplices turn out to be incompetent, hence, prone to making mistakes. Therefore, criminals tend to engage in co-offending less the older and more experienced they get (Lantz & Ruback, 2017; Tillyer & Tillyer, 2014). However, research about the decision-making during a co-offending burglary and what factors influence it remains unknown.

One of the reasons for young criminals to co-offend is the social support they receive from their other accomplices during the criminal act (Lantz & Ruback, 2017; Tillyer & Tillyer, 2014). Co-offending burglaries often involve groups of two to three burglars

(Weerman, 2003). The members of these groups cooperate to achieve the common, illegal goal of successfully burgling a target house without getting caught (Uhnoo, 2015). The co-offending is generally instigated by one of the criminals involved, namely, 80% of offenders involved in co-offending reported that one person was leading the group (Weerman, 2003). However, the consequences of one offender instigating on the success of the burglary remain widely unknown in research. Next to that, the type of communication between the instigator and their accomplices, which influences the decision-making process remains unclear. Lastly, while analysing their communication, one may be able to examine the group dynamics.

In this study, with the use of virtual reality (VR), pairs of participants will burgle a target house in a team effort while being able to communicate with each other. They will be instructed to try to maximize their success by taking as much financial value with them and spending as less time as possible engaged in the burglary. Hereby, it will be investigated who the participants themselves see as a leader of their pair and whether the emergence of leadership in the pairs impacts the success of their burglary attempt.

Theoretical framework

Burglary and Co-Offending

Burglary can be defined as an illegal entrance or attempted entrance to a residential house or other building, mainly with the final goal to steal possessions (Catalano, 2010). Moreover, a burglary decision can be considered as successful when financial gains were made as well as when the risk of being seen or caught was avoided in the process (Coupe, 2017). The decision-making of experienced burglars benefits from an instantaneous recognition of environmental cues which allows them to save time in preparation as well as during the act of the burglary (Meenaghan et al., 2018). Consequently, their decision-making may be described as automatic, while often being faster compared to inexperienced burglars (Meenaghan et al., 2018). Next to that, they benefit by making accurate estimations of

financial values. Experienced burglars' decision-making, therefore, aids them by maximizing their rewards while minimizing their gains of getting caught, hence, concluding in a high rate of criminal success and resulting in burglary being amongst the least solved crimes (Meenaghan et al., 2018). In addition, they spend less time in the target house and make more accurate estimates of the risk of getting caught regarding the target house and its neighbourhood, which also contributes to this high rate of success. (Coupe, 2014).

While a wide part of burglary research concerns solo offenders, some burglars, in contrast, decide to co-offend because of the perceived gains that will be discussed in the following. Namely, about one-third of residential burglars in the UK see themselves as co-offenders (Budd, 1999, as cited in Coupe, 2017), while 46% of offenders in another study stated being influenced by others was relevant to them committing a burglary (Lantz & Ruback, 2017). Co-offending, in general, can be described as committing a criminal act in a group of offenders (Coupe, 2017). The main motivations for co-offending burglars are that those offenders anticipate that it would be easier, more profitable, and less risky to commit burglaries with accomplices rather than committing the crime on their own (Lantz & Ruback, 2017; Tillyer & Tillyer, 2014; Uhnoo, 2015; Weerman, 2003). Therefore, co-offending can be described as the result of rational decision-making (Tillyer & Tillyer, 2014, Weerman, 2003). Hence, cooperation among criminals may be described as purposive.

In addition, the factor of experience can be mentioned that particularly goes in hand with co-offending. Eighty per cent of co-offending cases can be described by one of the offenders taking the initiative (Weerman, 2003). These so-called instigators are commonly more experienced and older than the other offenders joining. That is because when an offender was regarded as possessing relevant knowledge or experience, other offenders were more likely to obey them (McGloin & Nguyen, 2012). Moreover, younger, inexperienced offenders tend to co-offend more often and co-offend less the more experienced they get

(Carrington, 2009; Lantz & Ruback, 2017; Tillver & Tillver, 2014; van Mastrigt and Farrington, 2009 as cited in Coupe, 2017). It is suggested that these younger, less experienced offenders join the instigator to gain experience and skills themselves, but also to counteract discomfort or anxiety that is aided by the social support co-offending provides (Lantz & Ruback, 2017, Weerman, 2003). Hereby, the inexperienced offenders make the purposive choice to co-offend because of the main motivations of maximizing financial gains and reducing the risks involved. Moreover, co-offending involves a division of labour within the offender group, hence, cooperation within the group is evident (Uhnoo, 2015). In brief, less experienced burglars tend to engage in co-offending. Hereby, these burglars are mostly instigated by a more experienced offender taking the initiative and emerging as a leader of the group due to their relevant skills and expertise.

Leadership and Collaboration

As previously described, often the emergence of a leader is being described in burglary as well as in co-offending research. Hereby, a leader can be described as a person "who directs the activities of a group toward a shared goal" (Hemphill & Coons, 1957, as cited in Sarker et al., 2002). Emerging leaders, in general, take the initiative in influencing the other members of their social group, even though they are not formally assigned this position of authority (De Souza & Klein, 1995; Luria & Berson, 2013; Luria et al., 2019). In the social context, leadership emergence can be seen as a process that naturally happens (Yamaguchi, 2001; Yamaguchi & Maehr, 2004). In self-managing groups, the roles of the group members are flexible. Hence, different members of the group can emerge as leaders in various situations. In addition, even multiple group members or no group members can emerge as leaders in various situations. In summary, leadership emergence can be described as a process that happens naturally within the group when one of the members involved takes the initiative in influencing the other members of their group.

A member that intends to emerge as a leader can achieve this in different ways. Primarily, MacLaren et al. (2020) pointed out that a person is more likely to emerge as a leader in a small group, the larger their speaking time is in comparison to the other members. That is because they are, consequently, more likely seen by their group as a leader that also contributes more towards their group's efforts (Mast, 2002). The essence of these findings is described as the "babble-hypothesis" (Bass, 1990, as cited in MacLaren et al., 2020). Hence, it can be assumed that a larger contribution towards achieving the group's goal also predicts leadership emergence. Moreover, individual differences can be defined as factors that determine a person's tendency to emerge as a leader, such as personality, IQ, or demographics (Eagly & Karau, 1991; Luria et al., 2019; Smith & Foti, 1998; Taggar et al., 1999). All in all, the emergence of leadership can be predicted by the speaking time and contribution of the different group members. Moreover, individual differences also contribute to leadership emergence.

The joint approach of burgling a target house, where leadership is involved, can be described as a collaborative approach. While collaborating, different parties work together on a task by contributing new information to that given task in order to solve it (Walle & Hannay, 2009). This also applies to co-offending burglaries. Hence, co-offending can be seen as a collaborative approach because the burglars contribute their skills and knowledge to, together, accomplish the goal of burgling the house and stealing valuable items without getting caught. Shared goals of a group and its contribution to collective action, in turn, affect the establishment of cooperation in that group positively (Jin & Li, 2017) Next to that, as previously described, leadership emerges in groups naturally, as it is the instigator in the group of offenders co-offending. The emergence of leadership has consequences on the attainment of the shared goal. The behaviour and ratings of a leader influence their team's performance in face-to-face teams as well as in distributed teams (Bass et al., 2003; Elenkov,

2002; Hoyt & Blascovich, 2003; Russell, 2001; Xenikou & Simosi, 2006, as cited in Lisk et al., 2012). Moreover, leadership is important in virtual teams to ensure their productivity (Sarker et al., 2002). The effort of a leader can hereby improve the cooperation in the group by decreasing the risk of coordination errors, which, in turn, may harm the cooperation process as well as the goal achievement (Hooper et al., 2010). To sum up, the joint approach of burgling a target house is collaborative. Thereby, leadership is important because it improves the performance, productivity, and coordination of teams, which, in the end, may lead to a heightened success of the burglary when comparing cooperation in co-offending burglaries with cooperation in work teams. However, it is still uncovered by previous research, whether leadership influences the success of the burglary.

Virtual Reality, Virtual Environments, and Presence

The specific definition we will use to describe virtual reality (VR), in the context of this study, is:

> […] incorporating computer-generated, interactive and highly vivid environments that enable the user to achieve a state of immersion through the ultimate experience of telepresence and facilitate engagements in human encounters that are multi-sensorial, dynamic and resemble the user's perception and understanding of the real world" (Boyd & Koles, 2019).

A virtual environment (VE) is a virtually engineered world, either replicating an existing real environment or a fictional environment (Luciani & Cadoz, 2007). Hereby, using VR technology, the user is immersed and present within the virtual environment that was created. In VR, computer technology is used to create an interactive three-dimensional world in which the user experiences spatial presence, which means that the user feels they are physically there (Bryson, 2013; Wienrich et al., 2021). This achieved presence, in turn, can be seen as an indication of the experienced immersion and involvement of the participants

within the VE (Witmer & Singer, 1998). Hereby, we can describe immersion as an objective measure "[…] of sensory fidelity a VR system provides" (Bowman & McMahan, 2007). The achieved level of immersion, hereby, may depend on the technical aspects of the VR system that create and display the sensory output to the participant (Bowman & McMahan, 2007). For example, a high refresh rate, a low latency, and a high resolution of the display result in higher levels of achieved visual immersion. In contrast, involvement indicates how interested, enthusiastic, and motivated the participant is toward the VE (Gutierrez-Maldonado et al., 2010; Loureiro et al., 2022). All in all, VR technology and a VE will be used in this study because, thus, we can generate an interactive environment where the participants can engage in the presented task of burgling a target house together. Hereby, achieved presence will be of importance because it indicates the level of immersion that is achieved by the VE.

Furthermore, according to Casanueva & Blake (2000), presence may be defined as "[…] the psychological sensation of "being there", having a sense of being in the place specified by the virtual environment rather than just seeing images depicting that place". Besides that, both experienced involvement, as well as immersion concerning the VE, may constitute this evoked feeling of presence (Witmer & Singer, 1998). Witmer & Singer (1998) further elaborate that the more involved and immersed the user interacting with the VE is, the more the user experiences presence. The levels of presence a VE induces in its users may be used as an indication of its success (Casanueva & Blake, 2000; Slater et al., 1996; Witmer & Singer, 1998). That is because the presence of the user improves their task performance as well as their learning capabilities. After all, the user is better able to take in information, when they are experiencing more presence within the VE (Slater et al, 1996). In contrast to presence, co-presence, in the context of VR, can be explained as the experience of an individual that other persons are present in the VE and that they can interact with these real people within the VE (Casanueva & Blake, 2000). Consequently, an elevated level of co-

presence allows and enables participants to cooperate and interact with each other successfully in the VE. All in all, both levels of presence, as well as co-presence, are indications of the success of a VR experience and its VE and are, therefore, crucial to guarantee (Casanueva & Blake, 2000; Slater et al., 1995; Slater et al., 1996; Witmer & Singer, 1998). That is because the higher the levels on both, the more the participant's actions in the VE resemble their actions in the physical world which, in turn, results in a more replicable VE (Slater et al., 1996, as cited in Casanueva, 2001).

VEs and, in general, VR have a wide range of uses in research. One of the advantages of VR experiments is that they can be used to directly evoke cognitive and affective responses in the user, which was applied in recent burglar studies or other studies concerning crime (Meenaghan et al., 2018; van Gelder et al., 2016; van Gelder et al., 2019). This may be especially beneficial in the current study and burglar studies, in general, because due to the evoked cognitive and affective responses, which can be explained by the participants' felt immersion and presence, the behaviour the participant expresses may be comparable to a real-life situation (Slater et al., 1995; van Gelder et al., 2016). By solely focusing their senses on the VR and the displayed VE, the participant represses real-world input, which aids the process of achieving immersion (van Gelder et al., 2019). In addition, due to the immersion and presence the participant experiences, physiological responses like real-life situations are evoked as well, which can be examined by cardiopulmonary testing (van Gelder et al., 2016; van Gelder et al., 2019). Lastly, due to the replicability of the simulation to a real-life situation, one may use the VR experiments to examine the decision-making of the participants in an actual physical world situation, as it is in this study a burglary.

Next to these implications of VR on criminal research, VR is used in work environments like manufacturing or design to aid the cooperation of work teams as well as the co-creation of products (Berg & Vance, 2016; Boyd & Koles, 2019). Hereby, VR

increases the responsibility of the co-workers towards achieving their shared goal as well as increasing their empathy (Boyd & Koles, 2019). It is easier to attend to the problem at hand, because of an increase in team engagement that was unhindered by distractions (Berg & Vance, 2016). VR in a work environment achieves that more team members actively engage in a discussion concerning design challenges and solutions as the defined common goal (Berg & Vance, 2016). To conclude, VR may contribute to heightened cooperation in the context of this experiment as a pair works together in collaboration to achieve the common goal of a successful burglary. VR achieves this, by increasing the responsibility of both partners towards achieving this common goal as well as by making it more likely that the partners communicate with each other while collaborating. Moreover, the participants can better blend out distractions and, therefore, better focus on the problem at hand because of invoked affective and physical reactions.

The Current Study

Effective leadership in a virtual workgroup tends to strengthen the overall performance of the group, by inducing a cooperative working climate and a sense of team responsibility towards achieving a common goal (Huang et al., 2010). Hence, we hypothesize that the emergence of a leader will increase the financial gain and reduce the time the participants spend in the target house which, in turn, results in heightened success. While assuming that, one may establish a link and partially explain why some offenders tend to co-offend despite the risks that co-offending may hold. In addition, in recent research, the term babble-hypothesis emerged proposing that the larger the speaking time, hence the contribution, of an individual in a group, the more likely it is that this individual is seen by others as the leader (MacLaren et al., 2020). Consequently, we hypothesize that the more the individuals estimate themselves to contribute or speak in comparison to their partner, the more likely is leadership emergence which, in turn, heightens the success of the burglary.

Lastly, as VR was not applied before to a collaborative burglary experiment, we explore the possibility of usage of this technology in the given context.

Methods

Participants and design

A total of 40 pairs, adding up together to 80 participants took part in this experimental study. Out of the sample of these 40 pairs, 5 were excluded because they experienced motion sickness and could not finish the burglary as intended. For another 5 pairs, the total time they spend doing the burglary was excluded from the analysis, because they experienced several bugs in the VR program that extended the time of the experiment to a major degree.

The 70 participants were primarily comprised of students from the University of Twente. The age of the participants ranged from 18 to 29, with an average age of 20.67 years (*SD* = 2.26). Fifty-two of the participants described themselves as female and 16 as male, while 2 of them described themselves as either non-binary or preferred to self-describe as "she/they". Around 49% of the participants were from Germany and around 29% from the Netherlands, while the remaining 23% were from other varying countries. Moreover, the participants were mostly recruited via the Sona webpage of the University of Twente, where they received two credits for participating in this experiment. To be able to take part in the study, the participants must not have epilepsy, because being exposed to VR may trigger a seizure in individuals suffering from photosensitive epilepsy (Epilepsy Society, 2019). Next to that, participants should be proficient in understanding and speaking English, so clear communication between the participants, but also between the researchers and participants, can be ensured.

The experiment that was carried out used a between subject's design. Hereby, two participants, so one pair, took part in the experiment at a time. The data of both participants was collected separately and, thereby, labelled as participants A and B. The independent

variables used were the difference in speaking time estimation, the total cooperation scale excluding its contribution subscale, the contribution subscale separately, cyber-sickness and presence. Hereby, presence and cyber-sickness were implemented to examine the implementation of the VR technology and its effect on the outcome. We used the remaining independent variables to examine our hypothesis on whether leadership emergence leads to a better outcome of the burglary. The two dependent variables that we used were the average value stolen per second and the average value of each item stolen, which aimed to indicate the success of the burglary.

Materials/Apparatus

The virtual environment

The virtual environment was programmed in Unity 2021.3.4fl and was based on a premade virtual environment displaying a neighbourhood including several houses. The premade environment was remodelled by removing USA flags and replacing fences with hedges to, consequently, make it look more like a Dutch neighbourhood. Within the environment, one house could be chosen to be burgled. This house had one floor comprised of six rooms, resembling an office, a living room, a kitchen, a bathroom, a bedroom, and a storage room. Inside the house, a total of 43 items of varying financial values could be burgled by dropping these items in certified “dropzones”. These dropzones were pronounced by a grey box that was distributed in each of the six rooms inside the house. When an item was dropped inside the dropzone, it was marked as stolen and vanished from the virtual environment. Both participants possessed their character, individually interacted within the virtual environment and were also able to see each other interacting within the virtual environment. For pictures that show the VE, including the house and various rooms, see Figures 3-5 in Appendix B.

The participants interacted with the virtual environment by wearing Oculus Quest 2 VR goggles and using the Oculus Quest 2 controllers, which were connected to separate computers on which, using the program Unity 2021, the virtual environment was processed. Moreover, the computers were used to audio as well as video record the participants and their actions inside the virtual environment.

Description of the scales used in the questionnaire

The participants completed a questionnaire after the completion of the VR part. In this questionnaire, several scales were implemented.

Cooperation. The cooperation scale was developed to, overall, examine the perceived quality of the cooperation that was established. It was created by taking inspiration from multiple studies concerning cooperation (Depping & Mandryk, 2017; Kaye, 2016; Kurzban & Houser, 2001; Lu & Argyle, 1991). The scale consisted of 18 items, which were rated on a 5-point Likert scale (*strongly disagree – strongly agree)* (e.g., "I am happy with the outcomes of the task we had to complete in the virtual environment"). Overall, the cooperation scale possessed satisfactory internal consistency ($\alpha = .63$). In the later analyses, the subscale contribution of this cooperation scale was used as an indication of leadership emergence. Therefore, this subscale consisting of two items was excluded from the overall cooperation scale. As a result, the cooperation scale used in the later analyses to indicate the quality of cooperation consisted of 16 items ($\alpha = .61$).

Contribution. The difference in group members' contribution towards achieving the common goal in a cooperative task could be defined as one of the predictors of leadership emergence (MacLaren et al., 2020). Therefore, the subscale contribution was left out of the overall cooperation scale during the analysis because it was used as an estimation of leadership emergence in one of the analyses. Hereby, the contribution subscale consisted of two items ("I contributed more than my partner to achieve the task", and "I perceived my

partner to be the leader while we were cooperating") and indicated the perceived contribution, but also the perceived leadership emergence of the participants. These items were scored on a 5-point Likert scale (*strongly disagree – strongly* agree). A higher overall score on the scale, hereby, indicated a larger perceived contribution of the participant. The internal consistency of the scale was low, but still satisfactory (α = .58).

Estimated talk ratio. The participants were asked to give an estimation of how much they contributed and spoke in comparison to their partner to indicate leadership emergence. This item was scored on a scale from 0 to 100. The higher the indicated score, the larger the participant's estimated talk ratio in comparison to their partner's. (*e.g., 0% = partner solely spoke, 50% = participant and partner spoke equally, 100% = the participant solely spoke).* In the later analyses, the distance of the scores from 50, so from equal talk ratios, was taken. This distance was used to indicate how much the talk ratios differed between the participants.

Cyber-sickness. An adapted version of the simulator sickness questionnaire by Kennedy et al. (1993) was used, to examine the participants' level of experienced cyber-sickness (Van Sintemaartensdijk, 2021). The original questionnaire consisted of 15 items, in contrast to this adapted version that consisted of 6 items, measuring the core symptoms of cyber-sickness like, for example, nausea or dizziness (e.g., "The virtual environment made me nauseous"). A shortened version of the questionnaire was used due to time constraints, but also because it still provided adequate internal consistency (α = .71). The scale's items were scored on a 7-point Likert scale (*Strongly disagree – Strongly agree*).

Presence. The level of presence was evaluated by using an adapted version of the Spatial Presence Experience Scale by Hartmann et al. (2016), which consisted of 7 items (Van Sintemaartensdijk et al., 2021). These items were rated on a 5-point scale. Moreover, the internal consistency of the scale was satisfactory (α = .69). The presence scale was used

to indicate the participant's felt immersion to the VE (e.g., "It felt like I could do anything I wanted in the virtual environment").

Co-presence. The co-presence scale was adapted from De Kort et al. (2007), and consisted of 4 items (e.g., "It was easy to tell how my partner felt in the virtual environment"). The scale was used to indicate to what extent the participants felt immersed in the communication with their partner. Moreover, the initial internal consistency of the scale was very low (α = .19). Consequently, item 8 was excluded from the scale because its content did not indicate co-presence as well as the other items did (e.g., "I was easily distracted during the interaction"). This exclusion led to a slight increase in the internal consistency (α = .38), however, the internal consistency is still low. The scale was still further used, although it rated low on internal consistency, because the content of the remaining items (e.g., My partner was responsive towards me in the virtual environment"; "My partner's behaviour was often a reaction to my own behaviour in the virtual environment") validly measured co-presence, as was indicated in the earlier study by De Kort et al. (2007).

Self-control. The brief self-control scale by Tangney et al. (2008), was used to indicate how the participants scored on the trait of self-control (e.g., "I refuse things that are bad for me"). Hereby, the self-control scale consisted of 13 items that were scored on a 5-point Likert scale (*Strongly disagree – Strongly agree*). Next to that, the internal consistency of the scale was high (α = .76).

Hexaco-60 personality inventory. Moreover, the Hexaco-60 personality inventory (Ashton & Lee, 2009) was included, to examine the personality of the participant. The Hexaco-60 was comprised of 60 items and 6 different subscales, namely, honesty-humility (α = .71), emotionality (α = .84), extraversion (α = .82), agreeableness (α = .66), conscientiousness (α = .78), and openness to experience (α = .73). Hereby, each of the six subscales consisted of 10 items, measured on a 5-point Likert scale (*strongly disagree* –

strongly agree). The reliability measures were mostly in line with the original source (Ashton & Lee, 2009), and were all satisfactory, indicating adequate internal consistency.

Game experience. The scale on game experience was adapted from Van Sintemaartensdijk et al. (2021), and indicated the amount of video game experience, but also VR experience, that the participants possessed prior to this experiment (e.g., How many hours per week do you play VR games with a head-mounted display?). The scale was used to observe whether video game experience, especially VR experience, affected the behaviour of the participants in the VE. This was measured in 6 distinct levels, which indicated the number of hours played per week (*0 hours; 1-5 hours; 5-10 hours; 10-15 hours; 15-20 hours; 20 hours or more*).

Procedure

The first part of the experiment took place in one of the offices inside the Cubicus building, which is one of the buildings on the campus of the University of Twente. First, the participants were handed an information sheet about the study and its experiment, which can be seen in Appendix D. When they understood all information and agreed to take part, they then signed the informed consent sheet, which can be found in Appendix E, and handed it to the researchers.

After that, the participants were informed about the recording of their heart rates via the empatica armband and of their voices. It was explained that, throughout the experiment, the empatica armband will be pressed multiple times to set up multiple measurement points for the heart rate. This is done to later examine whether the heart rate increased at specific points during the experiment (e.g., when entering the target house), but also to be better able to compare the data, as each trial varied in time. Following, the empatica band was put on the wrist of the participants.

Before entering the VR experience, the researchers explained their role during the experiment and explained how they expected the participants to react. It was stated that the experimenters would clearly present the task and any further instructions prior to the experiment. Hence, they described that they would only interfere during the experiment when questions arose, or problems occurred. The participants were advised that if they began to feel nauseous or dizzy, they should communicate this to the researchers to think about a possible pause. Moreover, they were instructed that once they enter the target house, the experiment would start and that they should leave the house as soon as they were done.

After the successful connection of the empatica, the experiment was described to the participants. Following, the controls were explained, while being explicitly shown. The researchers demonstrated how the participants would pick items up and drop them, next to demonstrating how they would move around and look around inside the VE while using the controllers. It was further explained that they will first practice picking up an object in the neighbourhood, before starting with the experiment. After that, the participants went to the target house and started the burglary. Once they entered the house, the experiment started. In addition, the task was explained. Hereby, it was stated that the participants will commit a virtual burglary together. They were informed, that they were free to communicate with each other during the experiment, but also free to choose how long they would burgle the house and which items they would take.

Subsequently, it was explained that to steal items, they had to pick up the items and drop them in “dropzones,” which are grey cubes that were distributed in each room. This was also practised before the experiment. After the explanation, the participants were instructed to stand up. Hereafter, the VR goggles were put on and the controllers were given to the participants. Before loading the participants into the VE, the recording was started.

Inside the VR, the participants were directed to two candles with which they were practising picking up and dropping objects inside the VE. They were instructed to pick up the candles and drop them in the dropzone that was placed next to them. After completing that, the participants were directed to the target house. Subsequently, the empatica was pressed once more which marked the start of the experiment. During the experiment, the researchers would not intervene and wait for the participants to finish. In case something went wrong, the program would be restarted while any irregularities would be noted down on the experimenter sheet. During the experiment, in case a participant got nauseous, they were allowed to take off the goggles and take a short break. The other participant was instructed to continue burgling the house. The experiment finished when both participants left the target house.

After the VR, the participants were taken to separate rooms in the BMS lab. There they answered the created questionnaire. One of the researchers was present outside of the rooms to be there in case questions did arise during the completion of the questionnaire. Once they finished the questionnaires, the created debriefing was shown to the participants, which also can be found in Appendix C. The debriefing presented the goals of the study as well as, generally, explained what the study was about. Moreover, participants were informed how long their data was stored and who to contact if questions arose. After they read the presented debriefing, the participants were free to leave the room as the experiment ended. ended.

Results

Main Analyses

In the main analysis, the effect of the interaction between the emergence of leadership and the cooperation scale, excluding its contribution subscale, on the outcome of the burglary was analysed. We performed a linear regression analysis to examine this interaction effect, but also to examine the main effects of both the emergence of leadership and the cooperation scale on the outcome of the burglary. Thereby, two different dependent variables were used in two separate models to indicate the outcome of the burglary. Namely, the dependent variables average value stolen per second and the average value of each item taken were used to indicate the success of the burglary. Moreover, two independent variables were used in two separate analyses as an indication of leadership emergence, specifically, the estimated talk ratio and the contribution subscale. This led to four separate analyses. First, the interaction effect of the estimated talk ratio and the cooperation scale on both dependent variables indicating the outcome of the leadership was analysed. Thereafter, the interaction effect of the contribution subscale and the cooperation scale on both dependent variables was inspected. To improve the interpretability of the coefficients, all independent variables were centered prior to being included in the analyses.

Lastly, in all models, cyber-sickness and presence will be included as covariates. Hereby, first, the models will be analysed without the covariates and, after that, while including the covariates. Consequently, it will be inspected whether the covariates significantly affected the overall model. Thereby we will, first, examine whether there is a relationship between both covariates on the dependent variable outcome of the burglary. Furthermore, while including them as covariates, we will inspect whether they influence the independent variables and their interaction.

Descriptive statistics.

Before analysing the interaction effects in the following sections, we will first describe the two independent variables used as moderators in the interaction. Hereby, these two variables are the difference in estimated talk ratios, next to their perceived contribution measured by the contribution subscale of the cooperation scale. First, the skewness of the difference in estimated talk ratios was 1.07 (*SE* = 0.398). Therefore, as can be seen in Figure 1, the data of the sample is highly distributed to the right *M* = 11.09, *SD* = 12.53. As a result, most of the pairs estimated a minimal difference in the talk ratio during the experiment, so, generally, one of the participants spoke slightly more than the other.

Next to that, the pairs estimated their contribution to mostly be around the middle of all values as can be seen in Figure 2, indicating symmetrical data *M* = 2.35, *SD* = 0.41. Consequently, the pairs observed an overall even contribution of the participants towards their shared goal. Some outliers were apparent when inspecting both mentioned figures, but overall, the estimated talk ratio of the participants slightly differed, next to the perceived contribution of the sample being evenly distributed amongst the participants. The two variables difference in estimated talk ratios and the contribution subscale were not correlated, *r* (33) = .11, *p* = .523.

The cooperation scale, without its contribution subscale, was used as the additional independent variable interacting with the moderator variables in all models and indicated the perceived quality of the established cooperation *M* = 3.51, *SD* = 0.32. The skewness of the distribution was -0.74 (*SE* = 0.398). Thus, the data was moderately skewed to the left, indicating that most of the participants estimated their quality of cooperation to be of high levels, while only 8.6% of all pairs scored equal or lower to three out of five on the cooperation scale. The estimated difference in talk ratio significantly correlated with the cooperation scale *r* (33) = -.43, *p* = .01. Thus, a higher estimated difference in the talk ratio

indicated a lower quality of the perceived cooperation. This indicated collinearity of the two independent variables will be counteracted by centering both variables before including them in the models. Moreover, the other moderator, namely the contribution subscale, did not correlate with the cooperation scale r (33) = -.05, p = .785.

Moreover, the covariates included in both models will be described. First, as depicted in Table 1, the pairs experienced medium to high levels of cyber-sickness during the experiment M = 4.24, SD = 0.82. Moreover, only 25% of the pairs scored moderate to low (<3.70) on the cyber-sickness scale, while around 50% of the pairs scored moderate to high (>4.50). In contrast, the pairs experienced medium to high presence M = 3.58, SD = 0.37. In addition, the achieved co-presence was medium to high as well M = 3.58, SD = 0.37. The skewness of these three distributions was symmetrical. These values may be used later as an indication of the achieved immersion of the VE and VR technology in this experiment.

Finally, the dependent variables measuring the outcome of the burglary will be reported. The skewness of the average value of each item taken was 0.58 (SE = 0.4), indicating that the data was moderately skewed to the right. Hence, 80% of the participants burgled an average value of around 288 or lower M = 229.22, SD = 94.64. Next to that, the skewness of the other dependent variable, namely average value stolen per second, was 0.92 (SE = 0.43), also indicating a moderate to high skewness of the distribution to the right. Eighty per cent of the participants scored around 6.54 or lower, while the remaining 20% burgled an average value of higher than 6.54 up until 13.83 M = 4.88, SD = 3.07.

Table 1

Individual and pairwise Values of Cyber-sickness, Presence, and Co-Presence

Variables	Minimum	Maximum	*M*	*SD*
Cyber-sickness A	1.00	6.40	3.92	1.07
Cyber-sickness B	1.40	7.00	4.57	1.15
Cyber-sickness Pair	2.50	6.30	4.24	0.82
Presence A	2.71	4.43	3.53	0.48
Presence B	2.71	4.86	3.64	0.52
Presence Pair	2.71	4.50	3.58	0.37
Co-presence A	1.50	4.00	2.90	0.55
Co-presence B	2.00	3.75	3.04	0.49
Co-presence Pair	2.71	4.50	3.58	0.37

Table 2

Descriptive Statistics and Correlations for the variables included in the analyses

Variable	*n*	*M*	*SD*	1	2	3	4	5	6	7
1. Difference in talk ratio	35	11.09	9.64	—						
2. Contribution subscale	35	2.35	0.41	.11	—					
3. Cooperation scale without contribution	35	3.51	0.32	-.43*	−.05	—				
4. Cyber-sickness	35	4.24	0.82	.07	.04	-.08	—			
5. Presence	35	3.58	0.37	-.09	.43*	.09	.16	—		
6. Average value stolen per second	30	4.87	3.07	-.19	.17	.16	.12	-.10	—	
7. Average value of each item taken	35	229.22	94.64	-.25	.05	.22	−.15	.03	.54**	—

*$p < .05$. **$p < .01$

Main Analysis: Estimated talk ratio

Average value stolen per second. The main effect of estimated talk ratio on the average value per second was insignificant B = -.04, SE = .08, t (29) = -.55, p = .585. Hence, it can be said that the difference in estimated talk ratios did not affect the average value stolen per second. Moreover, the cooperation scale did not significantly affect the average value stolen per second B = .65, SE = 2.13, t (29) = .31, p = .762. Consequently, it can be stated that a heightened score on the cooperation scale did not lead to an increase in the average value stolen per second. Moreover, as both independent variables significantly correlated with each other before being centered, tests were carried out to examine whether the data met the assumption of multicollinearity. The tests indicated that multicollinearity was not apparent (Cooperation scale, Tolerance = .71, VIF = 1.41; Difference in talk ratio, Tolerance = .62, VIF = 1.61). Lastly, the interaction effect between estimated talk ratio and the cooperation scale on the average value stolen per second was non-statistically significant R^2 = .04, F (3,26) = .38, p = .865. The estimated talk ratio thus did not interact with the cooperation scale on the outcome of the burglary as measured by the average value per second as hypothesised.[1]

Average value of each item stolen. The main effect of estimated talk ratio on the average value of each item stolen was insignificant B = -2.53, SE = 1.94, t (34) = -1.3, p = .202. As a result, participants did not steal more valuable items the larger the difference in estimated talk ratios was. In addition, the main effect of the cooperation skill on the average value of each item stolen was insignificant B = 49.22, SE = 56.47, t (34) = .87, p = .39. Hence, the items that were stolen by the participants were not of averagely higher value the better the perceived quality of their cooperation. The tests on multicollinearity indicated that multicollinearity was not apparent (Cooperation scale, Tolerance = .79, VIF = 1.23;

[1] Both cyber-sickness as well as presence were included in a separate model as covariates, to check whether they relate to both independent variables or act as confounding variables for the relationships between both independent variables and the dependent variable. Both covariates related insignificantly to the dependent variable and the inclusion of both did lead to an insignificant change in the model's estimated effects as well as in the model's overall significance.

Difference in talk ratio, Tolerance = .737, *VIF* = 1.36). Finally, the interaction effect that emerged between the estimated talk ratio and the cooperation scale insignificantly affected the average value of each item stolen R^2 = .11, *F* (3,31) = 1.27, *p* = .292. Consequently, the relationship between the perceived quality of the cooperation with the average value of each item stolen was not influenced by the differences in estimated talk ratios of the participants.[2]

Main Analysis: Contribution Subscale

Average value stolen per second. The value of the contribution subscale did not significantly interact with the average value stolen per second *B* = 1.43, *SE* = 1.46, *t* (29) = .98, *p* = .338. The more the participants perceived to contribute, thus, did not influence their average value stolen per second. Next to that, the main effect of the cooperation scale on the average value stolen per second was insignificant *B* = 1.64, *SE* = 1.8, *t* (29) = .91, *p* = .369. Hence, the perceived quality of the cooperation did not influence the average value stolen per second. Lastly, the interaction effect of cooperation and contribution on the average value stolen per second was insignificant R^2 = .06, *F* (3,26) = .55, *p* = .866. Therefore, the participants' perceived contribution did not impact the relationship between their perceived quality of cooperation on the average value stolen per second.[3]

Average value of each item stolen. No significant main effect of the contribution subscale emerged when analysing it with the average value of each item stolen *B* = 13.12, *SE* = 42.94, *t* (34) = .31, *p* = .762. Therefore, the participants' perceived contribution did not affect the average value of each item stolen. In addition, as a second main effect, the cooperation scale did not significantly affect the average value of each item stolen *B* = 64.86, *SE* = 52.06, *t* (34) = 1.25, *p* = .222. Hence, the average value of each item stolen was

[2] Here, both cyber-sickness, as well as presence, were also included as covariates in a separate model. They related insignificantly to the dependent variable. Next to that, the inclusion of both covariates led to an insignificant change in the model's estimated effects as well as in the model's overall significance.

[3] Both cyber-sickness as well as presence were included in a separate model as covariates. Both covariates related insignificantly to the dependent variable and the inclusion of both did lead to an insignificant change in the model's estimated effects as well as in the model's overall significance

unaffected by the participant's perceived level of cooperation. Ultimately, the interaction effect of cooperation and contribution on the average value of each item stolen was insignificant $R^2 = .05$, $F(3,31) = .545$, $p = .957$. Consequently, no interaction effect between the participants' perceived cooperation and contribution emerged that influenced the average value of each item stolen.[4]

Discussion

First and foremost, this study aimed to examine leadership emergence in the context of a co-offending burglary. To inspect this leadership emergence, an experimental study was carried out, in which pairs collaboratively burgled a target house in a VE. Hereby, leadership emergence was observed by investigating the estimated talk ratios as well as the perceived contribution of the participants. Our hypothesis states that leadership, which is represented by talk ratio and contribution, leads to a better outcome of the burglary. Consequently, more financial gains and less time spent in the target house. This hypothesis cannot be supported based on our findings, due to insignificant results.

Furthermore, as this was a VR experiment, we carried out explorative analyses to give further implications on the possibility to examine collaborative decision-making while using VR as that research environment. Hereby, the results indicate that the VR experiment was satisfactory in terms of replicating a real-life scenario for the participants that were involved. Although the levels of experienced cyber-sickness were moderately high, they did not negatively affect the outcome of the burglary. In addition, the participants experienced medium to high levels of presence as well as co-presence. These can be stated as satisfactory levels, so we can assume that the participants felt immersed in the virtual environment of the VR experiment.

[4] In this analysis, the inclusion of both cyber-sickness and presence as covariates led to an insignificant change in the model's estimated effects as well as in the model's overall significance.

Implications of the results on the emergence of leadership

First of all, contrary to our hypothesis stated, but also to the babble hypothesis (MacLaren et al., 2020), an increased difference in estimated talk ratios, as well as in estimated contribution, did not lead to a more successful burglary outcome. Overall, the contribution was evenly distributed amongst the participants. In addition, the perceived talk ratio difference was low amongst the sample. Therefore, one could assume that the two indicators of leadership we used could not give any accurate implications on their relationship to the outcome of the burglary. Emergent leaders generally communicate more within a group setting compared to the other individuals in a group (Bass, 1990, as cited in McLaren et al., 2020; McLaren et al., 2020, Riggio et al., 2003). However, when considering leadership emergence in small groups, both quantity as well as the quality of communication matter (Bass, 1990, as cited in McLaren et al., 2020). Moreover, although the quantity of communication improves leadership evaluations, this effect only emerges when the content of speech is of high quality (Jones & Kelly, 2007). Especially in task-oriented groups, as is the pair involved in the virtual burglary, the quality of the communication may be of larger importance than its quantity when considering leadership emergence (Riggio et al., 2003). Lastly, the task performance of a small group may be related to the quality of its communication (Tschan, 1995) Thus, the quality of the communication may be a better predictor for leadership emergence, but also the task performance, in the context of this virtual burglary, as solely examining the estimated speaking time and contribution differences did not lead to evident outcomes. The quantity, as well as the quality of communication, need to be examined when considering the effect of leadership emergence on the outcome of the burglary.

The quality of cooperation was not influenced by the emergence of leadership. Therefore, we could presume that no effective leadership emerged for the largest part of the pairs. This assumption can be further strengthened by the descriptive statistics pointed out in

the results, which indicated the perceived contribution mostly being distributed around the middle values, next to the perceived speaking time differences being minimal. Therefore, participants saw themselves as equally contributing as well as speaking during the burglary attempt, so no effective leadership, based on our variables used, did emerge. That may also explain why there was no interaction of speaking time or contribution with cooperation on the outcome of the burglary because no leadership did emerge for most of the pairs as indicated by the mentioned distributions of speaking time and contribution.

Lastly, cyber-sickness did not affect the presence established nor the outcome of the burglary. Next to that, the level of experienced presence did not influence the outcome of the burglary. We can assume, based on these findings, that the VR experience was satisfactory. That is because the experienced cyber-sickness did not negatively affect the presence as well as the outcome. High levels of experienced cyber-sickness may reduce task performance (Farmani & Teather, 2020). However, contrary to this assumption, cyber-sickness did not prevent the participants from burgling the house effectively in this study. Moreover, it did not prevent the participants to experience presence in the VE. However, what needs to be mentioned is that some pairs, which experienced high levels of cyber-sickness and, therefore, needed to pause multiple times or could not continue, were excluded. This may have influenced the accuracy of this assumption, as the time measurement of these pairs was inflated. Moreover, as the achieved presence, which was moderate to high, did not influence the outcome of the burglary nor did it significantly affect the interaction between the outcome of the burglary and cooperation, we can assume that immersed participants did not burgle more efficiently and effectively than others. This is contrary to the assumption that a high presence within a VE leads to increased task performance (Slater et al, 1996).

Limitations and Strengths of this Study

As before mentioned, the sample contained 40 pairs of participants, from which five pairs were excluded completely due to the amount of experienced cyber-sickness. Next to

that, for another five pairs, the total time they spent in the VE was disregarded and, hence, was not incorporated in further analyses. So, with respect to the analysis of the emergence of leadership, for one of the dependent variables measuring the outcome of the burglary, namely the value stolen per second, data could only be effectively gathered from 30 pairs. One may conclude that a total of 30, respectively 35 for the other dependable variable, may have negatively influenced the results of the analyses in terms of reliability and validity which, in the end, led to insignificant results. In addition, regarding the explorative analyses, the exclusion of these five motion-sick participants could have negatively affected the results of the analyses of cyber-sickness on task performance as well as the overall cyber-sickness score.

Another limitation that can be mentioned is that, overall, many of the pairs experienced small technical issues which led to delays that may have caused the dependent variable incorporating time, namely value per second, to be unprecise, hence, invalid. As time can be named as one of the variables that define a successful burglary attempt, not only in the experiment but also in real life, one can state that the outcome of the burglary could not be validly measured.

Next to that, the independent variables that were used in the analysis to measure the emergence of leadership, namely the variable estimated speaking time but also the contribution subscale, can be named as an additional limitation. The variable speaking time consisted of an estimation of the participant's speaking time, but also of their partner's speaking time. As this was an estimation that was made by the participants themselves, one could assume that this is subjective and, hence, leads to unprecise or invalid data that the variable contains which was later used in the analysis. We still decided to use this variable because of time constraints and logistic reasons. The estimation made by the participants, hereby, saved time in the data collection period.

Moreover, the internal consistency of the contribution subscale was unsatisfactory, which may have negatively affected the results of the analyses in terms of reliability. All in all, this might have led to the even distribution of contribution as well as to the minimal differences in perceived speaking time, which was previously noted. That is because the participants could not accurately estimate their speaking time as well as their contribution, next to the lacking internal consistency of the contribution subscale.

Lastly, a limitation to mention is that the recorded moderate to high amounts of cyber-sickness may have interfered with the results of the analyses by negatively affecting the outcome of the burglary. The assumption that cyber-sickness negatively impacts task performance could not be justified in the explorative analysis of this research. However, the negative impact of cyber-sickness on task performance could be justified in other research. Cyber-sickness can be described as bodily discomfort, characterized by nausea and disorientation symptoms, which are caused by exposure to VR (Weech et al., 2019). Cyber-sickness is negatively correlated to the presence in the VE which, in turn, may negatively impact overall task performance (van Gelder et al., 2016; Weech et al., 2019). Hereby, the sense of presence is disrupted because the individual becomes inattentive to the VE and, in turn, more internally focused on the symptoms and causes of the cyber-sickness (Weech et al., 2019).

Although some measurements were not satisfactory, the number of other measurements that we used ensured that we still collected considerable amounts of valuable data. For example, the heart rate, voice, and screen recordings could be further used to gain qualitative data to be analysed to improve the design of the VE and the VR experience overall. What could be further used to enhance this experience are the open questions we asked in the questionnaire that aimed at receiving positive feedback and points to improve.

Although the sample may have not been replicable to real burglars, the population of the sample was still ideal for this study. Hereby, it was not replicable to real burglars, as in

most of the co-offending burglaries, the leader is already established (Weerman, 2003). However, this already established leader is generally more experienced and older than the other co-offenders (McGloin & Nguyen, 2012). Still, we could further examine whether leadership emerges due to differences in contribution and speaking time in a virtual burglary, where all the presumed co-offenders possessed equal amounts of burglary expertise, namely, the students had no burglary experience. Therefore, this study established a link between general research on leadership emergence, which mostly concerned workgroups or other contexts different to co-offending, and leadership emergence in the criminal context of a co-offending burglary. Thereby, it could be pointed out that a co-offending burglary contains a purposive collaboration of the co-offenders, which aims to achieve the criminal group's common goal of successfully stealing valuables without getting caught. In this context, the quality of the communication may have been of more importance than its quantity. Furthermore, as this study is explorative, the sample of students was easy to recruit and their data can still be used to improve the overall design of the experiment to, in the future, carry it out with a sample that is suitable to study co-offending burglar behaviour and decision-making, namely actual convicted burglars.

Lastly, previous to this study, there was no research conducted that examined co-offending burglaries and the decision-making involved in the way we did, namely, in the context of a collaborative virtual burglary. Therefore, one important strength of this study is that it tested the possibility to examine this decision-making in a created virtual environment, thereby, replicating a neighbourhood and a target house that is burgled. What can be concluded from this study is that VR technology can indeed be used to inspect the decision-making processes, but also the emergence of leadership effectively. This was indicated by the high amounts of presence and co-presence that were achieved, which led the participants to feel involved as well as immersed in the VE.

Directions for future research

This study we carried out on collaborative decision-making in the context of a VR burglary gave insights into how a pair engages in a collaborative burglary, as well as into leadership emergence and the suitability of VR technology to analyse these factors. We can point out some directions for future research, to further build upon our research. Firstly, the measurement of the emergence of leadership could be improved upon because resulted in too subjective results. To improve upon this, one may directly inspect the speaking time by measuring the speech ratios of each participant. By doing this, one could further evaluate the babble hypothesis (MacLaren et al., 2020) which states that the more a member of a group speaks in comparison to the others, the more likely it is for them to be seen as the leader. Furthermore, while analysing the speech of each participant, the contents of the speech as well as the verbal coordination of the participants can be further examined. Since verbal communication serves as one of the main predictors of the emergence of leadership, (Jones & Kelly, 2007), this study would have benefited from the creation of speech transcripts and, consequently, from an evaluation of these transcripts. An evaluation of speech transcripts would be beneficial because, first, the quantity of the speech of each participant can be validly measured. Secondly, contrary to the assumption of the babble hypothesis, the quality of the content that is being said is also of importance while inspecting leadership emergence (Bass, 1990, as cited in McLaren et al., 2020; Jones & Kelly, 2007). This necessity of communication quality is especially apparent in small groups, like the pairs in the virtual burglary (Bass, 1990, as cited in McLaren et al, 2020). So, while refraining from solely using the babble hypothesis and its quantity of communication measurement, but also pay attention to the quality of the content that is verbally exchanged. Hereby, it is essential to pay attention to these aspects of the communication of the group members, by creating and further analysing verbatim transcripts of the participants' dialogues.

Regarding the overall layout of this study, it may be possible and valuable to not use pairs but also larger groups that collaborate in the virtual burglary. By using larger groups, one may be able to further inspect group dynamics and leadership emergence in groups that are larger than a pair. Furthermore, it may provide interesting results regarding the distribution of tasks, and one could examine whether an increased group engaged in the burglary leads to increased burglary success. In contrast, it could be inspected whether there is a maximum in terms of the group size that can be reached, where an increase leads to a less efficient and less productive burglary. As the number of co-offenders rises, it is less financially profitable for individual robbers to participate in the robbery (Tillyer & Tillyer, 2014). Next to that, it is more likely for co-offending robbers to get caught the larger their group, so small groups are usually preferred. Hence, it would be interesting to also examine these findings with individuals carrying out a burglary and examine whether there a difference can be noted when comparing robbers and burglars.

Conclusion

To conclude, the purpose of this study was to examine whether leadership emergence in a co-offending burglary impacts the success of the burglary attempt. Hereby, we hypothesized that an increased difference in speaking time as well as in contribution, as suggested by the babble hypothesis (MacLaren et al., 2020), leads to an improved outcome of the burglary. This hypothesis could not be supported based on our findings. Therefore, the question remains unanswered whether leadership emergence, in the context of a co-offending burglary, leads to better burglary outcomes. Overall, this study helps in further examining the decision-making processes as well as group dynamics in co-offending burglaries, as it, primarily, presents the possibility to do so via conducting a collaborative virtual burglary in a VE. Hereby, VR was an effective tool to conduct this virtual burglary and it may be beneficial to be further used in future research that concerns overall co-offending burglars' decision-making. Furthermore, this study presents various measurements on how to evaluate the

leadership that emerged. Therefore, we count on future research that implements and refines these measurements, so that leadership emergence in co-offending burglaries can be further examined.

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Appendix A – Graphs showing the pairs' scores on the moderator variables used

Figure 1

The difference in talk ratios for each pair

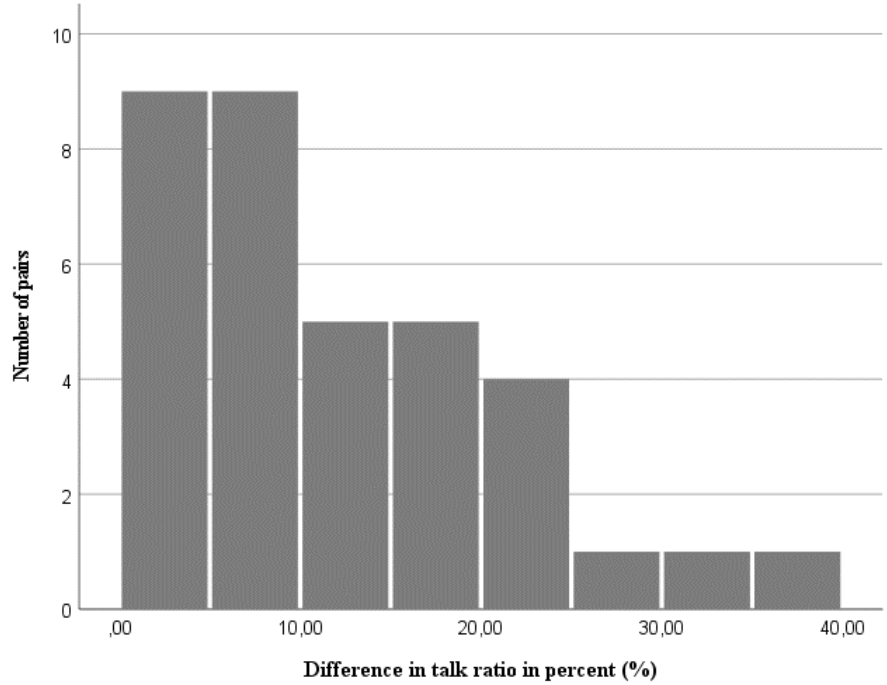
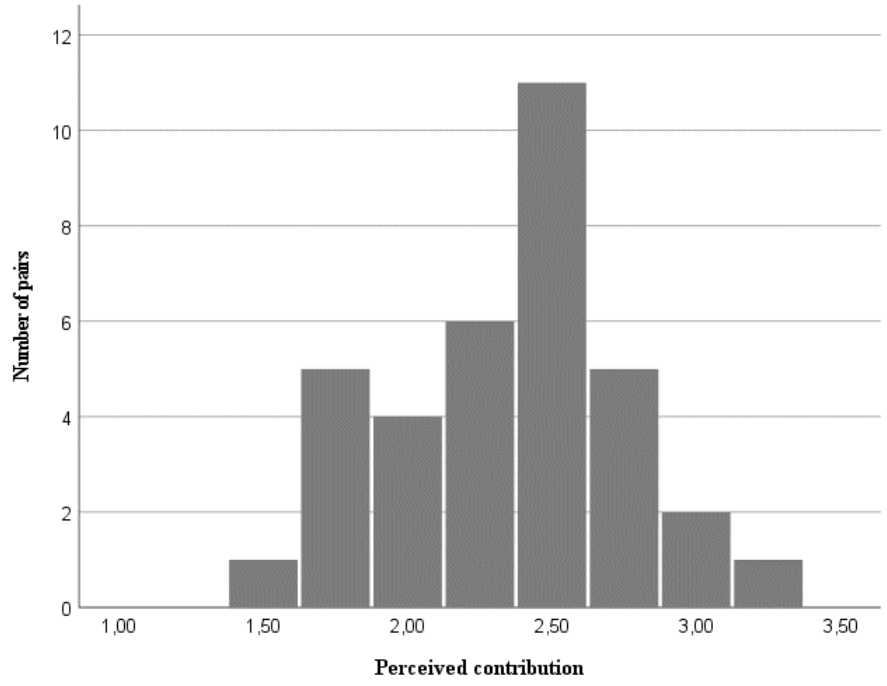


Figure 2

The estimation of perceived contribution by each pair



Appendix B – Figures illustrating the virtual environment

Figure 3

The layout of the living room including its dropbox

Figure 4

One of the character models interacting with objects in the office

Figure 5

The front of the target house and its neighbourhood

Appendix C – Debriefing Sheet

Debriefing Sheet
"Let's take the TV!" Collaborative Virtual Burglary.

Summary of Project

Thank you for participating in our experimental study. We have received useful information regarding collaboration in a virtual burglary. The goal of this study was to explore the possibility of investigating co-offending in residential burglary with the usage of virtual reality. In this experiment, we evaluated the overall success of your burglary attempts based on the time spent in the house, next to the financial value stolen. We expected that certain personality type combinations, next to the emergence of leadership, would influence the overall success of the burglary. These factors were examined in the questionnaire.

Further Guidance

It is possible that you feel nauseous, dizzy, or have a headache after the experiment. If that is the case, we advise you to abstain from looking at screens for some minutes and rest your eyes, while taking long, deep breaths. Focusing your eyes on something rather than on a screen like going for a walk may also help.

Keeping in Touch

After the experiment, all your data will be anonymized and stored to, later, be analysed after the period of carrying out the experiment. We will inspect your success in the burglary and analyse the impact that your personality types as well as the emergence of leadership had on the outcome.

You have a right to withdraw from this study throughout the time the experiment is active, hence until the 30th of November. As a result, your data will be deleted. To withdraw from this study, contact one of the researchers via email. Their address will be given below.

Any More Questions?

If you have any questions about this study, please contact one of the researchers involved.

(Contact details of researchers and supervisor)

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In case you want to discuss your rights as a research participant, please contact the BMS Ethics Committee (ethicscommittee-bms@utwente.nl).

Thank you again for your time and cooperation!

Appendix D – Participant Information Sheet

Participant Information Sheet
"Let's take the TV!" Collaborative Virtual Burglary.

Study Background
You are being asked to take part in a research study on collaborative virtual burglary. Thank you in advance for your participation. This project is a collaboration between the University of Portsmouth and the University of Twente. Part of the research group are Felix Bonekamp, Melissa Griemink and Damion Renes. Iris van Sintensmaartensdijk is supervising this research group.

We are exploring whether a multiplayer virtual reality world is suitable for investigating residential burglary. Additionally, we are exploring the impact of personality combinations and leadership on the outcome of the crime.

What You Are Being Asked to Do
The experiment will take approximately 60 minutes to complete. You will be instructed to put on the virtual reality glasses and pick up the controllers. With these, you will be transported into the virtual world where you will be instructed to break into a virtual house. You will be able to walk in and around the house and pick up and carry various objects. During this activity, different data will be collected, namely a video recording of your virtual activities and audio recordings of the communication with your co-participant. Furthermore, a wristband will also collect data referring to levels of arousal. In addition, specific data will be recorded about what you did, where you went and what you took with you. After you leave the virtual environment, you will complete questionnaires relating to demographics (age, gender, etc.), personality, degree of presence and immersion during the simulation (feeling of being "there" and involvement in the VR environment), prior game experience, and questions about interaction with your coparticipant

What Are the Risks and Benefits of Taking Part?
There are no specific risks to this study over and above those experienced in everyday discounters. It might be that you feel nauseous from the environment. If that happens let us know.

When taking part in this study one will receive 2 SONA credits, also some sweets will be handed out by the researchers present.

Your Right to Withdraw and Withhold Information
At any time during this research and experiment (during or after) you can withdraw without any reason. If you experience any discomfort, mental or physical, during the experiment, you may also remove the VR headset and end your participation. At any time during this study, your anonymity will be guaranteed. Audio recordings will be stored securely and deleted as soon as possible. The data is confidential and will be processed anonymously and will not be accessible to third parties. Only if you consent to the use of your data will it be used in the research. In the case of an epileptic condition, unfortunately, you cannot participate in the study. When this is the case, please inform the researcher present.

Appendix E – Participant Consent Form

Participant Consent Form
"Let's take the TV!" Collaborative Virtual Burglary.

Brief Summary of Project
Research into burglars using VR has only used simulations where one person could break into a house. However, most burglars do not work alone. In this research, two participants will be in the simulation at the same time and will be working together instead of one.

After an instruction, you put on the VR goggles and take the controllers. With these, you will be transported to a virtual environment where you will burgle a residence. You will have limited time to search for objects together with your fellow participant and take them with you. While you are doing this, several things will be measured like your heart rate and the value of the items you took.

After completing your time in the simulation, you will be given questionnaires that measure your immersion, presence (feeling of 'being there'), personality and that evaluate the interaction with your peer

In order to participate in this sturdy, we need to ensure that you understand the nature of the research, as outlined in the participant information sheet. Please tick the boxes to indicate that you understand and agree to the following conditions:

☐ I confirm that I have read the participant information sheet for this study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

☐ I understand that in order to take part in this study, I should be at least 18 years old and have no epilepsy.

☐ I understand that personal data about me will be collected for the purposes of the research study (e.g. name, gender and audio recordings), and that these will be processed in accordance with data protection regulations.

☐ I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected.

☐ I understand that my data is anonymous and will be stored on secure university servers. I understand that I will only be used by the investigators for research purposes and that there is a possibility this research will be presented to other researchers or staff members.

☐ I understand that an audio recording will be made during this research.

☐ I agree to take part in this study.

Participant's name

Participant's signature

Date

For any additional information or questions, please ask the researcher present or contact a member of the research team:

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