“Let’s take the TV!”. Cooperation in Virtual Burglary and the Role of Personality.

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Abstract

Burglary is a prevalent crime in the Netherlands as well as worldwide. The impact of burglary on the victim can be immense, and either financial, physical, or psychological. Often burglary is committed in collaboration with another person rather than alone. Personality seems to impact involvement in crime, risk-taking, and collaboration which are all factors that could impact the outcome of the burglary. As little research has been done into co-offending in burglary and offender decision-making, this study attempted to explore the relationship between personality and the outcome of the burglary. An experiment, a between-subjects design, was set up with two people committing a virtual burglary. Thirty-five pairs were asked to work together while burgling a preselected house in a virtual neighbourhood. In the house, they could enter different rooms and steal multiple items of their choice. Post hoc questionnaires were filled in that included amongst others personality, presence, and cyber sickness. The outcome of the burglary was measured by; time spent in the house, the total number of items stolen, the total value of items stolen, and the number-value ratio. No impact was found of personality on the outcome of the burglary. However, this was a good proof of concept for future research and can form a foundation for research with actual burglars. Concluding, more research is needed on this topic as it is noticeable that personality and co-offending have not been thoroughly researched, while the majority of crime nowadays involves some kind of co-offending.

Introduction

In 2021 more than 2000 suspects were registered in the Netherlands for domestic burglary (Centraal Bureau voor de Statistiek, 2022). Although this number is already lower than it used to be, burglary still is a big problem in the Netherlands as well as worldwide (CBS Statline, n.d.). The impact of burglary on the victim can vary from short- to long-term and can be either financial, physical, or psychological (O'Brien & Burrel, 2020). Most often the emotional damage is worse than the material loss, victims of burglary lose their sense of security at home (Brown & Harris, 1989). Home is ought to be the place where a person should feel the safest, which is taken away by burglars.

Burglary is more often committed in collaboration with another person rather than acting solo (Farrington et al., 2019; Weerman, 2003). This collaboration in burglary is referred to as co-offending, the act of engaging in criminal activity with the help of or in collaboration with one or multiple partners (van Mastrigt, 2017). A sizable majority of criminals in general engage in co-offending at least once at a certain point during their careers in crime (van Mastrigt, 2017). Even though co-offending seems to be a common practice within crime, little research has been done to explore the relationship between criminal decisions making and partnering in crime (van Mastrigt, 2017). The company of others is thought to impact criminal decision-making, as group dynamics have been shown to intervene with behaviours and decisions (Viki & Abrams, 2013).

Decisions that burglars have to make include amongst others target selection, decisions to co-offend or act solo, how to get rid of stolen items, etc. Hence, the decision-making process for burglars is quite complex, as they decide on matters before, during, and after the burglary (Coupe, 2017). However, why do burglars decide to co-offend? There are several theories for co-offending, some indicating that there is a "choice" to co-offending, and other theories see co-offending as a social selection effect (Mastrigt, 2017). Lantz (2013) and Lantz and Ruback (2017) found a relationship between age and co-offending in burglary, the younger a person is the more likely they are to co-offend (and vice versa). Generally, criminals are relatively young and the likelihood of being convicted for a crime decreases with age (Farrington, 2019). This also goes for the age of burglars (Cromwell, 1994; FBI, 2018; Lantz, 2013). As younger people are more likely to co-offend and burglars are relatively young, the chances of co-offending in burglary are quite high. This is also shown by Farrington et al. (2019) and Weerman (2003).

Additionally, co-offending leads to a more successful burglary, and the value of the total theft increases when comparing co-offenders to solo offenders (Lantz, 2013). Also, Lantz (2013) found that co-offenders have a smaller chance of getting caught by either the residents

or the police, as they take less time to complete a burglary. All things considered, the prevalence and the success of co-offending in burglaries portray the need for more knowledge regarding this topic. To intervene and prevent burglary and (co-) offending, it would be vital to understand how co-offenders think, decide and behave while committing a burglary. Additionally, it is important to know which elements influence the decision-making process of burglars.

Personality and Involvement in Crime

There are many factors impacting the decision-making of committing a crime, and personality is one of them (Jones, 2017). Personality can be defined as the generally persistent and stable thought, emotion, and behaviour patterns that people display (Jones, 2017). Various models of personality have been developed, a relatively new model is that of Ashton et al. (2004), the HEXACO model. This model includes six domains: Honesty-Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness (Ashton et al., 2004). Several studies found that personality influences the decision-making process of a person (Lauriola & Levin, 2001; Riaz et al., 2012). Therefore, for understanding decision-making processes in crimes it is crucial to understand the role of personality.

Quite some studies have dealt with the role of personality in crime involvement. Ashton and Lee (2008) and van Gelder and de Vries (2012) have found a connection between the HEXACO model and anti-social behaviour. They identified a relationship between low Honesty-Humility, low Emotionality, low Conscientiousness, and the probability of making unlawful decisions. Next to this, van Gelder and de Vries (2012) and Jones (2017) found that those with low levels of humility and honesty are more likely to recognize possibilities for criminal conduct and act on them. People high on this trait strongly will refrain from participating in such activities because they feel uncomfortable doing so. Wilcox et al. (2014) discovered that low scores of conscientiousness and low agreeableness also lead to recognising more opportunities to offend. This last finding might be explained by the fact that individuals low in agreeableness may base their decisions on incomplete information or neglect the value of getting along with others (Jensen-Campbell et al., 2002).

Next to the single HEXACO traits having an impact on criminal involvement, Zuckerman (2007) found that individuals high on sensation-seeking (a combination of different trait facets) are more likely to decide to offend than individuals scoring lower on this trait. Additionally, Ashton and Lee (2021) looked at multiple personality traits at the same time and found that people high on both agreeableness and honesty-humility have altruistic tendencies. Hence, they are less likely to commit crimes such as burglary.

Personality and Risk Taking

Another field of research that might be relevant to crime research is risk-taking. Involvement in crime can be considered as risk-taking behaviour, as after considering the consequences involved with the illegal behaviour, people may choose to engage in it (Dhami & Mandel, 2012). Additionally, not only being involved in a crime is considered as risk-taking, but also the decisions made during the crime (Zuckerman, 2007). Several relationships have been found between personality and risk-taking behaviour. Nicholson et al. (2005) found a relationship between the combination of high openness and extraversion with low conscientiousness, neuroticism and agreeableness, and risk perception of the individual. These traits are Big Five traits, however, a large overlap was found between the Big Five and the HEXACO traits (Jones, 2007). Furthermore, Lauriola and Levind (2001) found that people high on openness to experience and emotional stability take more risks than people low on openness and high on neuroticism. Small effects were also found for agreeableness and conscientiousness, but only when not taking gender and age differences into account. Next to this, Zuckerman (2007) and De Vries et al. (2009) found that sensation-seeking is highly correlated with risk-taking behaviour. Meaning that these individuals who score high on sensation-seeking are in the first place more likely to offend, but also take more risks when they do so.

Personality and Burglary

Taking everything into consideration, it can be said that personality also seems to be an important factor when it comes to burglaries. For the reason that burglaries are most often committed in collaboration with another person and personality seems to impact the collaboration and the outcome of the crime (Farrington et al., 2019; Weerman, 2003). That personality is related to involvement in crime has been well researched, but little research was done into the relationship between the process of committing a crime and its success and personality. Analysing how personality influences criminal behaviour would increase researchers' scientific understanding of criminal decision-making and may serve as a foundation for interventions to stop such offenses (Van Gelder & de Vries, 2012). Van Sintemaartensdijk et al. (2022), made a first attempt to study the relationship between personality traits and a burglar’s scouting process. She found that personality differences affect how criminals move around neighbourhoods. Van Sintemaartensdijk et al. (2022) discovered that, only in the burglar sample, higher levels of honesty-humility, and self-control were linked to choosing and entering places where they are less likely to be detected (for example, entering the house via the back, which is likely to have a better outcome). Additionally, she found that choosing a home with a

ladder in the front yard was related to growing openness to experience. Thus, various methods used by burglars and perhaps other criminals to new illegal chances for financial gain may be explained by personality differences (Van Sintemaartensdijk, 2022). Moreover, according to findings by Van Gelder et al. (2017), conscientious individuals typically steal fewer things and are less successful burglars. This contradicted previous research that stated the opposite; people high on conscientiousness are systematic and therefore are likely to steal more items and spend less time in the house (Goldberg, 1990; Miller & Lynam, 2001). So, regarding conscientiousness, there are different findings, and it remains unclear what the specific effects are.

Personality and Co-offending in Burglary

Less is known regarding the impact of the personality of co-offenders. A few attempts have been made to study this topic, however, few insights have been found. As said most criminals engage in co-offending at least once in their criminal careers (van Mastrigt, 2017). Co-offending asks for a great amount of collaboration to make the outcome of the crime successful (Lantz, 2013). As task performance relies on cooperation and trust (McCarthy et al., 1998; Sugawara & Sano, 1997). It is interesting to see how personality influences this collaboration and thus impacts the outcome of the crime. According to Lykourentzou et al. (2016), teams with personalities that are evenly distributed perform much better on collaborative tasks. They have fewer disagreements, which leads to greater acceptance of one another, which improves cooperation and productivity. Adding to this, Jiang et al. (2023) found that a high level of heterogeneity in the personality traits of partners, is associated with a better shared outcome, but this did not go for individual performance. Jensen-Campbell et al. (2002) stated that people high on agreeableness are more accepted by peers and therefore better at cooperation. Hence, it can be expected that they are better at co-offending. Fuller (2012) only found a difference in agreeableness between solo- and co-offenders. Different from Fuller (2012), Rönnberg (2015) found a difference in extraversion between solo- and co-offenders. Besides the just-described studies, insufficient research was done regarding this topic, which is strange as co-offending is so common, especially for burglaries, and personality seems to have an impact on this. Therefore, more research is needed in this field.

Virtual Reality as a Method

So far research exclusively regards the decision to co-offend, little is known about the decisions during co-offending and the influence of personality. Crime is a hard topic to study, as it is unethical to study or observe a crime in real life (van Gelder et al., 2017). In the past, the most commonly used method to study crime was the hypothetical scenario method (van

Gelder et al., 2019). This involves a (hypothetical) criminal situation, which a participant has to imagine being in. However, this method had some limitations. The hypothetical scenario method has trouble capturing the physiological and emotional parts of actual criminal behaviour, also a narrative may not reflect real-life situations. Lastly, the hypothetical scenario method depends on people's capacity for self-imagination in hypothetical situations, and it is not sensitive to individual variations in this capacity (van Gelder et al., 2019). Virtual Reality (VR) has proven to be a useful tool to study crime in a simulated environment (van Gelder et al., 2017). Users of virtual reality (VR) can interact with three-dimensional (3D) worlds created by computers, e.g., car racing games are an example of immersive virtual reality that gives the user the sensation of speed and driving skills. (Mania & Chalmers, 2001). Using VR some constraints of traditional methods can be addressed (van Gelder et al., 2019). As VR can provide a lot of environmental detail, this aids in the level of perceived realism of a scenario. Additionally, VR situations may be better capable of eliciting the physiological and psychological processes generally associated with decision-making since they engage the senses more directly. Lastly, VR lessens worries about individual variations in people's capacity for imagination by perceptually positioning research participants at the centre of the scene (van Gelder et al., 2019). Considering this, using VR in crime research can aid in the understanding of criminal decision-making.

Nowadays, within burglary research, VR is a commonly used tool to study this topic. To assess the influence of various elements on burglars' decision-making, it is possible to create richly contextualized, virtual neighbourhoods (van Sintemaartensdijk et al., 2022). Furthermore, VR has been demonstrated to be an effective approach in the study of burglaries since it allows researchers to virtually transport offenders to the crime scene (Meenaghan et al., 2018; Nee et al., 2019). VR might also be a good opportunity to study co-offending. For instance, the ability to have numerous users in the same VR environment at once opens up opportunities for social interaction studies (Cornet & van Gelder, 2020). So, using VR co-offending could be studied similarly to individual burglary research. As stated earlier, little research has been done into co-offending and criminal decision-making, and likewise, research is lacking in the field of personality and committing crimes. Since co-offending in burglary is so common and the impact can be immense and long-lasting, burglary and co-offending have to be extensively researched.

The Current Research

The current research is a first attempt to study how personality and combinations of the personality of co-offenders influence the outcome of a virtual burglary. The main focus will be

on the personality of individuals and how this will impact the outcome of the burglary. Furthermore, exploratory analyses will follow focussing on exploring the combinations of personalities of two people committing a burglary together.

Several hypotheses have been created concerning the involvement of personality in committing a burglary. Since literature has shown honesty-humility seems to be an important factor when it comes to crime the first hypothesis is: *H1*: People scoring low on Honesty-Humility are more successful in burglary, than people scoring high on this trait. This was predicted because, people low in honesty-humility seem to have no problem exploiting others and therefore, might steal more items/more valuable items.

Secondly, efficient cooperation leads to better task performance, and people scoring high on agreeableness are more accepted by peers and therefore are better at cooperation. Based on this the second hypothesis is: *H2:* People scoring high on Agreeableness are more successful in the burglary, than people scoring low on this trait.

Next, as studies have found contradicting results and the effect remains unclear the third hypothesis is: *H3:* People high on conscientiousness are more successful in burglary, than people scoring low on this trait. This was predicted because multiple findings have shown that conscientious individuals are systemic, therefore it is expected that they steal more items and spend less time in the house.

The fourth hypothesis is: *H4*: people high on sensation seeking take more risk during the burglary, than people scoring low on sensation seeking. They spent more time in the house and therefore the risk of getting caught is bigger.

Lastly, literature has shown that a high score on agreeableness and honesty-humility combined leads to an altruistic tendency. Therefore, the fifth hypothesis is: *H5*: People high on Agreeableness and Honesty-Humility are less successful in burglary, than people scoring low on these traits. This was predicted because these individuals might not feel comfortable exploiting others because they care for their well-being.

Method

Participants

In total, 70 participants took part in the study, 35 pairs. Inclusion criteria were being over 18 years of age, not suffering from epilepsy (because of potential flickering images in VR), and being proficient in English (for consistency). The mean age of the participants was 20.7 years (*SD*=2.3). Of the participants, 23% were male and 74% female and 3% of the participants identified as non-binary/third gender. 29% of the participant originated from The Netherlands,

49% from Germany, and 22% from another country. This study had an experimental between-subjects design in pairs.

Materials

Virtual Neighbourhood

A virtual neighbourhood was programmed in Unity, 2021.3.4f1. This was a premade environment, which was remodelled to make the environment resemble a Dutch neighbourhood. This was done for the sake of perceived realism and emergence, so people could identify with and recognize this as an actual neighbourhood in the Netherlands. The remodelling was done by removing the American flags and replacing fences with hedges. The neighbourhood contained several houses, but only one house could be burgled. This choice was made because this experiment was not about the scouting process of burglary, but about the decisions made during the act. Making it possible to choose the house would also have involved a lot more programming.

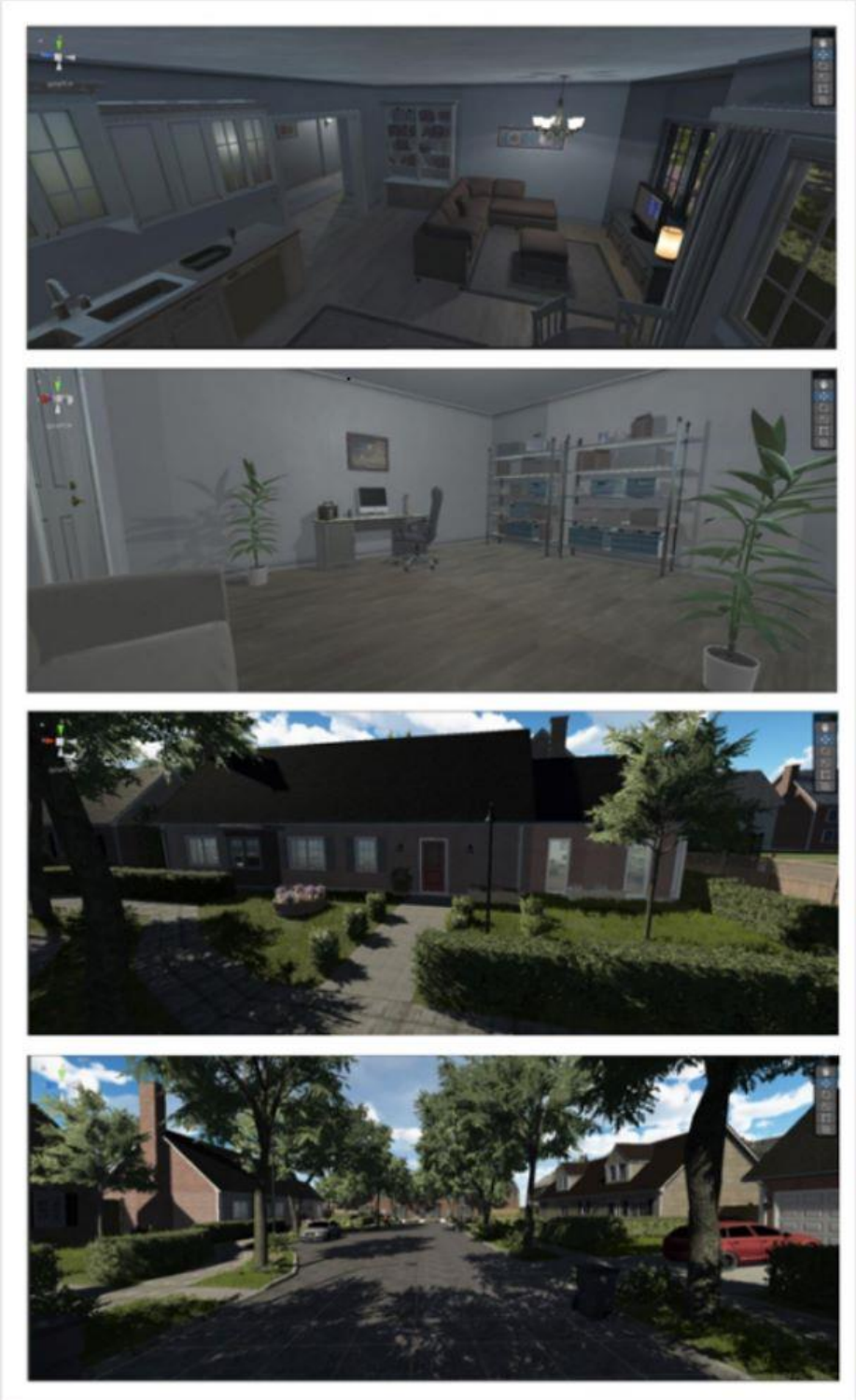
Figure 1 shows the virtual neighbourhood, the house to be burgled, and the inside of this house. This particular house only had a ground floor, so no upstairs. Furthermore, the rooms in the house were a study, living room, kitchen, bathroom, bedroom, and a room with tools in it. Within the rooms, items were laying around which could be taken, in total 43 stealable items. All items were different in value, examples of the items are a radio, a vase, paintings, tools, etc. For the full list of items see Appendix A.

To get into the virtual environment, Oculus Quest 2 VR glasses for head-mounted display were used. Within the virtual environment, participants worked together to burgle a house. They saw an avatar of the person they are cooperating with (see Figure 2). There were no time restrictions to the experiment, participants were told that could decide how long they stayed in the environment and the house. No further instructions were given regarding the time spent in the house. This choice was made since the time spent in the house said a lot about the perceived risk of getting caught, and also about the success of the burglary.

Several measures were taken in the virtual environment, these were the number of items stolen, the value of the stolen items, the time spent in the environment and each place, and a GPS location tracked. Heart rate was measured during the experiment using the Empatica E4 wristband tracker. The heart rate and GPS location were not used in the currently described study but could be used for a different line of research. Additionally, A screen and sound recordings were made with the use of a virtual camera in the program OBS Studio. This recorded the point of view of each participant during the burglary.

Figure 1

Visual Representation of Virtual Environment



Note. Picture 1 & 2: rooms inside the house, picture 3: outside of the house, picture 4: neighbourhood.

Figure 2

Visual Representation of Avatar

Questionnaires

Presence.

The first of the set of questionnaires was to measure the feeling of being present in the virtual neighbourhood. This was measured using a 7-item presence scale (α = .69) developed by van Sintemaartensdijk et al. (2021). Participants were asked to rate the items using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The average presence score was 3.6 (*SD*=.5). An example of an item from this scale is "I felt like I was actually in the virtual environment". To measure co-presence, which entails the feeling of another person being present in the virtual neighbourhood together with you, likewise, a co-presence scale (α = .19) was administered (de Kort et al. 2007). The scale contained 7 items that had to be rated using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). "My partner was responsive towards me in the virtual environment" is an example of such an item. The average copresence score was 3.0 (*SD*=0.5). Next to these items, there were two open questions regarding the virtual experience. These were "What did you like about the virtual experience?"

and “What could we improve about the virtual experience?”. The answers to these questions were used to improve the virtual experience in future trials. The answers from this scale were not used in this study.

Cyber-sickness.

A cyber-sickness scale (α = .71) was administered, as cyber-sickness was a potential consequence of the VR experience and needed to be controlled for. This was done using a 5-item scale from van Sintemaartensdijk et al. (2021) which was adapted from the simulator sickness scale (Kennedy et al., 1993). The participants were asked to rate the items using a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). “The virtual environment made me nauseous” is an example of such an item. An additional question was asked, “Did you take off the VR goggles during the experiment?”. This was also an indication of cybersickness. The average cybersickness score was 4.3 (*SD*=1.1).

Self-control.

For the sake of assessing participants’ self-control, as this seems to be an important factor in crime, a brief self-control scale (α = .76) was administered, which contained 13 items (Tangney et al., 2004). E.g. “I am good at resisting temptation” was scored on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The mean self-control score was 3.1 (*SD*=.5). The answers from this scale were not used in this study.

HEXACO.

The personality of the participants was measured using the HEXACO-60, a short measure of the 6 major dimensions of personality (Ashton & Lee, 2009): honesty-humility (α = .71), emotionality (α = .84), extraversion (α = .82), agreeableness (α = .66), conscientiousness (α = .78), and openness to experience (α = .73). The 60 items had to be scaled using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Each trait also has 4 sub traits referred to as facets, which were reflected in different sets of items. An example of such an item is “I worry a lot less than most people do”. Additionally, the sensation-seeking score was calculated similarly to de Vries et al. (2009), who used specific facets scores referring to sensation-seeking.

Game Experience.

To control for the game experience, a small questionnaire was administered which was developed by van Sintemaartensdijk et al. (2021). If the participant answered “Yes” to the question “Do you play video games?”, which was the case for 50% of the participants, another set of questions appeared asking about the method of gaming (keyboard, controller, or VR) and the number of hours played per week. Of participants playing video games, 53% played with a

controller, 26% with a keyboard, and 21% with both a controller and a keyboard. The answers to this questionnaire were used to see if having prior game experience influenced the success of the virtual burglary.

Cooperation Scale.

Cooperation during the experiment had to be measured, however, no scale existed for measuring cooperation in a virtual burglary. Therefore, a cooperation scale ($\alpha = .16$) was developed by the research group (see Appendix B). This was done by performing a literature review and items were formulated on the most relevant aspects, e.g. rated success (Depping & Mandryk, 2017; Gorsic et al., 2019; Kaye, 2016; Kurzban & Houser, 2001; Lu & Argyle, 1991). Based on this literature review items were formed for different aspects, e.g. rated success, contribution, mood, trust, etc. "I contributed more than my partner to achieve the task" and "I trusted my partner while we were completing the task" are examples of the 18 items that had to be rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The average cooperation score was 3.0 (*SD*=.3). Additionally, "What percentage of the time during the times you and your partner spoke during the task? How much did you contribute (50% being you and your partner spoke equally, 10% means mostly partner talking and 90% mostly you talking)", was the last question that was part of the cooperation scale. This question was used to measure if a leader emerged during the task. The answers from this scale were not used in this study.

Procedure

Participants were recruited using SONA Systems, which is an online research management system to recruit participants. This is a commonly used recruitment system by the University of Twente and also serves as a way of getting research experience by obtaining SONA credits. The study was promoted using informational posters, which had been put up throughout the campus of the UT. Additionally, potential participants were directly approached to participate.

The written informed consent ensured confidentiality and the right to withdraw or withhold information from the participants. The empatica was set up at the beginning of the experiment, this was done by putting it on the wrist of the participants and aligning the middle finger with the short part of the wristband. Once this was done, the controllers used to navigate in the virtual environment were explained and an explanation of their assignment was given. If no questions remained the participants were instructed to stand up and put on the goggles. Time was given to ensure that the goggles were comfortable and the view was clear. The controllers were handed to the participants, after which the empatica was pressed to indicate the start of

the VR. To start the VR, the screen recording (virtual camera) was started and in Unity, the participant was moved into the virtual neighbourhood.

While in the virtual neighbourhood, a practice session followed with picking up candles from a trashcan and dropping them in the drop zone. When both participants felt comfortable with picking up objects they were directed to the house they were going to burgle. Before entering the house they were instructed that once they entered the house the real experiment started and that if they were done they simply had to walk out of the house to indicate the end of the experiment. Participants were free in their decisions to approach the burglary, meaning how many and which items they wanted to steal and how to proceed in the house. At the end of the burglary (both participants were out of the house), Unity, as well as the screen recording, was stopped and participants were instructed to hand over the controllers and take off the goggles.

After the VR experiment, participants completed post hoc questionnaires. Participants were brought to the BSM Lab, to fill in the questionnaires in flexperiment rooms. The Qualtrics contained the questionnaires described above with additional questions about demographics. Lastly, a debriefing sheet was shown at the end of the Qualtrics, which contained a summary of the project, further guidance, and the opportunity to withdraw or ask additional questions. Once the Qualtrics was completed the end of the study was reached and participants were thanked for their participation. No further debriefing was given regarding the nature of the study, besides the debriefing sheet after the questionnaires.

Results

Missing Data

Of the initial 40 pairs (80 participants) who signed up for the study, 5 pairs were not able to complete the serious game in the virtual environment. This was due to motion sickness for 4 of the pairs and 1 pair experienced malfunctioning of the program Unity, which could not be fixed at the moment of the experiment. This resulted in a final total of 35 pairs (70 participants) which were operable for data analyses. For the total time that the participants spend in the virtual house, data from 5 pairs had to be removed due to several restarts. The program Unity contained several glitches, which caused problems for some pairs (e.g. not being able to pick up items or suddenly standing on the roof). When such a glitch was experienced and the participant could not continue the virtual burglary, the program had to be restarted. Therefore, the total time in the house would not be accurate anymore, so the total time for these 5 pairs was removed to prevent inaccurate data, and additional useable data remained.

Descriptive Statistics

To test whether the six HEXACO personality traits influenced the outcome of the virtual burglary, in line with Van Gelder et al. (2017) the outcome was operationalized in four ways: the total time spent in the house in seconds, the total number of items stolen, the total value of items stolen, and the number-value ratio. For each participant, a number-value ratio was calculated by dividing the total value of items by the number of items stolen. Additionally, a variable was created for the HEXACO sensation-seeking score derived from combined scores of different factors of the personality traits which were related to sensation-seeking. In table 1 you can see the distribution, means, and standard deviations of the six HEXACO personality traits, the sensation-seeking scores, and of the outcome variables across the sample.

Table 1

Distribution of HEXACO Traits and Outcome Variables Across Sample

	N	Minimum	Maximum	Mean	SD
Honesty-Humility	70	1.8	4.8	3.4	0.6
Emotionality	70	1.7	4.8	3.5	0.8
Extraversion	70	1.0	4.5	3.3	0.7
Agreeableness	70	2.3	4.3	3.3	0.5
Conscientiousness	70	2.3	4.8	3.6	0.6
Openness to Experience	70	2.2	4.9	3.5	0.6
Sensation Seeking	70	2.1	3.9	3.1	0.4
Total Time in House	60	256	1234	645.4	285.7
Total Number of Items	70	4	24	12.6	5.7
Total Value of Items	70	255	4126	2709.6	1054.0
Number Value Ratio	70	63.8	468.9	230.4	91.6

Main Analyses

The parametric assumptions were checked and there were no issues found with the assumptions. Therefore, the main analyses could be conducted, which focussed on individual personality. A General Linear Model[1] was performed with the HEXACO personality traits as the independent variables and total time spent in the house in seconds, the total number of items stolen, the total value of items stolen, and the number-value ratio as dependent variables (*H1*,

[1] *This model was also run with cybersickness as a covariate but this did not impact the results.*

H2 & *H3*). Additionally, another General Linear Model was performed with HEXACO Sensation Seeking as the independent variable and the time spent in the house as the dependent variable (*H4*). After this, the interaction effect between Honesty-Humility and Agreeableness was tested using a General Linear Model (*H5*). With the centred variables of Honest-Humility and Agreeableness and the interaction between those two as independent variables. The dependent variables were the total time spent in the house in seconds, the total number of items stolen, the total value of items stolen, and the number-value ratio. After the main analyses, exploratory analyses were performed looking at combinations of personalities.

Personality and Burglary Success.

The General Linear Model found no evidence for the prediction that people scoring low on Honesty-Humility are more successful in burglary than people scoring high on this trait. (*H1*). For Honesty-Humility on all of the four different outcome variables, non-significant results were found; total time spent in the house (B = 58.25, $t(59) = 0.90$, SE = 64.59, p = .371, R^2 = .015), the total number of items stolen (B = 0.65, $t(69) = 0.54$, SE = 1.20, p = .592, R^2 = .005), total value of items stolen (B = -135,33, $t(69) = -0.61$, SE = 221.99, p = .544, R^2 = .006), and number value ratio (B = -16.16, $t(69) = -0.83$, SE = 19.44, p = .409, R^2 = .011).

The second prediction was that people scoring high on Agreeableness are more successful in burglary than people scoring low on this trait (*H2*). After running the General Linear Model no significant effect emerged for this prediction on the four outcome variables; total time spent in the house (B = 38.18, $t(59) = 0.45$, SE = 84.47, p = .653, R^2 = .004), the total number of items stolen (B = -1.80, $t(69) = -1.16$, SE = 1.54, p = .249, R^2 = .021), the total value of items stolen (B =-455.14, $t(69) = -1.60$, SE = 284.63, p = .115, R^2 = .039), and number value ratio (B = -21.33, $t(69) = -0.86$, SE = 24.92, p = .395, R^2 = .011).

Thirdly, the model found no evidence for the expectation that people high on conscientiousness are more successful in burglary than people scoring low on this trait (*H3*). For Conscientiousness on all of the four different outcome variables, nonsignificant results were found; total time spent in the house (B=106.22, $t(59) = 0.32$, SE= 76.15, p = .169, R^2 = .035), the total number of items stolen (B = -0.91, $t(69) = -0.70$, SE = 1.30, p = .488, R^2 = .008), total value of items stolen (B = -164.47, $t(69) = -0.69$, SE = 240.19, p = .496, R^2 = .007), and number value ratio (B = -0.66, $t(69) = -0.03$, SE = 21.03, p = .975, R^2 = .000).

Next to this, no significant effect emerged for the prediction that people high on sensation seeking to take more risk during the burglary, than people scoring low on sensation seeking (*H4*). This was checked using a general linear model with sensation seeking as the

independent variable and total time spent in the house as the dependent variable. The results of this model were not significant (B = -78.57, t(59) = -0.81, SE = 97.08, p = .422, R^2 = .011).

Lastly, it was predicted that people high on Agreeableness and Honesty-Humility are less successful in burglary than people scoring low on these traits. This was tested by running a linear regression with an interaction effect of the independent variables Agreeableness and Honesty-Humility, and the four outcome variables as the dependent ones. The results however were not significant for all of the outcome variables; total time spent in the house (B = -145.01, t(59) = -1.24, SE = 116.69, p = .219, R^2 = .027), the total number of items stolen (B = 0.59, t(69) = 0.26, SE = 2,29, p = .796, R^2 = .001), the total value of items stolen (B = -70.62, t(69) = -0.41, SE = 418.65, p = .685, R^2 = .003), and number value ratio (B = -30.27, t(69) = -0.82, SE = 36.84, p = .219, R^2 = .010).

Exploratory Analyses

To see if certain personality traits of an individual would complement their partners' traits when committing a burglary, some combinations of personalities between the participant pairs were explored. This was done by running a General Linear Model[2] with an interaction effect on two independent variables (one trait of participant A and one trait of participant B), and the four outcome variables as the dependent ones. First of all, the interaction of Honesty-Humility of participants A and B was explored. However, nonsignificant results were found for the four dependent variables; total time spent in the house (B = -145.50, t(29) = -0.94, SE = 155,23, p = .357, R^2 = .033), the total number of items stolen (B = -2.50, t(34) = -0.83, SE = 3.01, p = .411, R^2 = .022), total value of items stolen (B = -320.41, t(34) = -0.57, SE = 563.32, p = .574, R^2 = .010), and number value ratio (B = 22.24, t(34) = 0.45, SE = 49.39 p = .656, R^2 = .006).

Another interaction effect was tested, which was the interaction between the sensation-seeking score of persons A and B on the total time spent in the house. The linear regression with an interaction effect of the two scores showed nonsignificant results for the total time spent in the house (B = 436.39, t(29) = 1.29, SE = 339.61, p = .210, R^2 = .060).

Furthermore, the interaction between the Agreeableness of person A and the Conscientiousness of person B was tested. The results of the General Linear Model with the interaction effect were not significant for all outcome variables; total time spent in the house (B = -259.94, t(29) = -1.07, SE = 242.37, p = .293, R^2 = .042), the total number of items stolen (B = 4.22, t(34) = 0.83, SE = 5.09, p = .413, R^2 = .022), total value of items stolen (B = -308.75,

[2] This model was also run with reversed combinations e.g. agreeableness of person B and conscientiousness of person A, but this did not impact the results.

t(34) = -0.34, *SE* = 909.25, *p* = .736, R^2 = .004), and number value ratio (*B* = -94.78, t(34) = -1.20, *SE* = 78.75, *p* = .238, R^2 = .045).

Lastly, the interaction between the Agreeableness of person A and the Emotionality of person B was tested. The General Linear Model with the interaction effect showed nonsignificant results for all outcome variables; total time spent in the house (*B* = -112.58, t(29) =-0.57, *SE* = 196.10, *p* = .571, R^2 = .013), the total number of items stolen (*B* = -2.01, t(34) = -0.53, *SE* = 3.77, *p* = .597, R^2 = .009), the total value of items stolen (*B* = -323.72, t(34) = -0.471, *SE* = 687.85, *p* = .641, R^2 = .007), and number value ratio (*B* = -23.98, t(34) = -0.40, *SE* = 60.53, *p* = .695, R^2 = .005).

Discussion

This study has aimed to explore the effects of personality on the outcome of a virtually committed burglary. Personality traits of an individual were investigated, but also combinations of personality traits with that of another person were explored. The results of this study showed that possessing certain personality traits did not make a significant difference in the outcome of this virtual burglary. Additionally, no significant combinations of personality with that of another person were found, which influenced the burglary. Due to these nonsignificant results, all hypotheses had to be rejected and no significant effects were found when it comes to the exploratory analyses.

Personality and the Outcome of the Burglary

First of all, scoring low on honesty-humility has not affected the success of the burglary (H_1). Jones (2017) found that a person low in honesty-humility will when given the opportunity exploit another person, and thus will most likely be successful at committing a burglary. Van Gelder and de Vries (2012) found similar results, and add to this that people low in honesty-humility are more likely to spot opportunities for criminal activity and take action when they do so. People high on this trait will not engage in such activities as they have an unpleasant feeling associated with it. Based on these findings the first hypothesis was formed, however, our results show a nonsignificant effect. This suggests that whereas people low in honesty-humility are more likely to commit a burglary, it might not be the case that this affects the way burglars behave during the offense.

Secondly, the success of the burglary was not dependent on the score of agreeableness (H_2). The findings of Jensen-Campbell et al. (2002) stated that people high on agreeableness are more accepted by peers and therefore better in cooperation. Sugawara and Sano (1997) stated that cooperation is essential for task performance. Based on this the second hypothesis was formulated, as better cooperation due to high agreeableness would likely also lead to a

successful outcome of the virtual burglary. Nonetheless, no effect was found of agreeableness on the outcome of the burglary. Suggesting that high agreeableness might be a factor influencing cooperation, but this does not necessarily mean that this also leads to a more successful burglary. Also, being low on agreeableness may influence the found opportunities to burgle, but it may not explain the decision-making during the crime.

Thirdly, scoring high on conscientiousness did not lead to a more successful burglary (H_3). Van Gelder et al. (2017) found that people scoring high on conscientiousness generally stole fewer items and therefore were less successful in committing a burglary. Complementary, Wilcox et al. (2014) found that people scoring low on conscientiousness find more opportunities around them that make them decide to offend. Contradictory, Goldberg (1990) and Miller and Lynam (2001) found that people high on conscientiousness are systematic and therefore are likely to steal more items and spend less time in the house (Goldberg, 1990; Miller & Lynam, 2001). Based on the combination of these findings it was hypothesized that scoring high on conscientiousness would lead to a better outcome than scoring low on this trait. Contrary to our expectations, non-significant results were found. These results together with previous contradicting results imply that more research is needed regarding conscientiousness and its role in criminal decision-making.

Furthermore, the amount of risk taken during the burglary was not dependent on the level of sensation seeking (H_4). De Vries et al. (2009) found that sensation seeking is highly correlated with risk-taking and some HEXACO personality traits. It was therefore hypothesized that individuals high on sensation seeking would take more risk during the virtual burglary. This was operationalized as spending more time in the house which would increase the risk of getting caught. Next to this, Zuckerman (2007) stated that not only do individuals high on sensation-seeking take more risk once committing a crime, but they are also more likely to commit a crime in the first place. Yet, the findings of this study were nonsignificant. Suggesting that sensation seeking might influence the amount of risk taken and the chances of committing a burglary, but it may not be related to the chances of getting caught (time spend in the house). Furthermore, the operationalisation of risk-taking during the burglary may not be accurate causing it to influence the results.

Lastly, scoring high on both agreeableness and honesty-humility did not lead to a worsened outcome of the burglary (H_5). Ashton and Lee (2021) stated that an altruistic tendency was formed out of high agreeableness and honesty-humility. Therefore it was expected that people scoring high on these two traits would have a worse outcome in the burglary as they would have problems exploiting others for personal gain. However, the results of this study

were nonsignificant and thus we cannot say if this is true. This implies that although scoring high on agreeableness and honesty-humility leads to altruistic tendencies, this may not be an important factor in the outcome of a burglary.

A reason for insignificance could be confounding variables. In this case, cybersickness could have been a confounder, although running the model with the cybersickness score as a covariate did not significantly change the results. Further, VR skills could be a confounder, some people are not good at playing games with a controller and others are highly skilled in this. When one is having trouble moving in the environment this will also influence the results of the burglary. The opposite is also true, when one is used to navigating in a virtual environment a practice effect emerges, meaning that for every trial in VR, one gets better at it due to practice (Walker & Lindsay, 2003). Another possible explanation for the non-significant findings is the operationalisation of success in burglary. It might be that the outcome variables did not measure the success of the burglary, but were separate aspects that together form success. Lastly, the possibility that the participant felt no real danger, due to no time restriction for the burglary, could have influenced the results.

Lykourentzou et al. (2016) stated that performance improves significantly on a collaborative task when the personalities of teams are balanced. They experience fewer conflicts and therefore accept each other more which leads to better cooperation and better performance. Based on this and a review of the literature some exploratory analyses were performed to look at combinations of personalities with that of the person one is cooperating with. For all of these combinations, nonsignificant results were found, this may partly be due to potential confounders. Which could be whether or not the participants already knew each other before the study. Cummings and Kiesler (2008) stated that prior experience with a collaborator partly influenced the collaboration. Steed et al. (2003) found that when collaborating with a stranger there is little awareness of each other's intentions, compared to collaboration with friends. However, they did not find similar results for other aspects of collaboration, e.g. enjoyment and complement of tasks.

Strengths and Limitations

During this study, a lot of data was collected, but it was beyond the scope of this research to look at all the data gathered. The untouched data can be used for future studies or by colleagues in a similar field. Not only can the data be used for future research, but also this study was a proof of concept that contributed to the understanding of studying offender decision-making using VR. This study was part of a bigger ongoing research and therefore was and will also be useful for the other researchers in the project. Some might say that being part

of a bigger research group is a kind of limitation as you are very dependent on each other, but this is not how I experienced it.

Although, it has to be noted that this study has some limitations. The first of which was the access to participants. It is very difficult to get two people and a researcher at the same time in the lab, therefore the sample was limited. However, it was possible to get 38 pairs to come and finish the experiment. This was done in a very limited amount of time, so with the time constraint and the difficulty to get two people in, the number of participants was higher than we expected. The nonsignificant findings may be due to this relatively small sample size. With a small sample, it is hard to detect an effect, especially if the effect is small to start with (Faber & Fonseca, 2014). Another limitation is the representativeness of the sample, as it mostly consisted of students. Students are not generalisable to the burglar population, as they most likely have not experienced burgling and therefore might not think like a burglar (Wild et al., 2022). These results may therefore be explained by the fact that a student sample was used, these students did not decide to commit an offense but they were asked to commit a burglary. So their personality did not influence the likelihood of committing the burglary and possibly also did not impact the decision-making process as they do not think like burglars. Nevertheless, this was a proof of concept that was necessary before starting research with actual burglars. The last limitation to be mentioned is data loss. Some data had to be removed from the data set because of incomplete data, cyber sickness, and malfunctioning of the materials. After all, this was expected with this kind of research, this cannot be prevented. The only way to make this as little as possible is by writing up clear protocols, but cybersickness and technical malfunctioning unfortunately are beyond our control.

One of the biggest limitations of this study was the violation of the assumption of independence of data. The choice was made to treat the data of the couples regarding the outcome of the burglary as separate data. Meaning that participants A and B had the same outcomes but were treated as if they were individual outcomes. This was done because the relationship between personality traits and the outcome of the burglary was looked at. The outcome variables were combined scores of the items taken by participants A and B added up. The assumption of independence entails that the data collected from one study participant are separate from the data collected from other study participants (Grawitch & Munz, 2004). This assumption was thus violated, however, for the scope of this thesis, it was chosen to ignore this.

Future research

In this topic a lot of future research is needed as so little is known about co-offending in burglary and decision-making. When one would do a similar study I would recommend doing

so with a bigger sample that is more representative of burglars. Ideally, future research will be conducted with a sample of actual burglars as from them we will gain the most insights when it comes to burglary decision-making. Studying active burglars would be hard and unethical (van Gelder et al., 2017). Therefore, the only option to study burglaries is with the help of convicted burglars. An idea would be to do research in multiple prisons in the Netherlands, which has to be achieved by a collaboration of researchers and the DJI (Dienst Justitiële Inrichtingen). A system has to be set up to get convicted offenders to participate in the research. A prison reward system could be a way to do so. Elbers et al. (2022) stated that rewarding prisoners is a way to get compliance, e.g. by giving them opportunities to earn extra recreation or visitation. An experiment could be set up in prison with the use of portable VR equipment with potentially a bigger and more representative sample.

An alternative suggestion for future research is the use of guardianship in the virtual neighbourhood. Van Sintemaartensdijk et al. (2021) found that guardians can act as a deterrent to domestic burglary by just being around. Human guardians unintentionally supervise a certain place by performing routines like walking the dog. Intentional guardians include security cameras or alarms that deter burglars. When such guardians would be placed in the virtual neighbourhood, burglars might be scared of or rushed into committing the burglary, which may influence the outcome of the burglary and therefore possible results. Anthropomorphism (human likeness of an avatar) also seems to impact the sense of realism in virtual reality (Latoschik et al., 2017). Future studies may want to examine the specific effect of this element and include more anthropomorphic avatars to increase the feeling of presence and immersion in the virtual scenario.

Another idea for future research came from a participant of the study who commented that having surround sounds would cause more presence and emergence and a feeling of being rushed and having to be silent. Kern and Ellermeier (2020) found that sounds to go with images significantly impact presence, realism, involvement, and distraction in the virtual environment. Sadowski and Stanney (2002) state that within virtual reality, presence affects how well a task is performed. It might be good to test whether surround sounds to make a difference in felt presence and thereby impacts the outcome of the burglary. As stated a lot of data is left untouched by me, but in the future, it might be interesting to study this. For instance, the data that was gathered on presence and co-presence might contribute to the just-described future line of research. Also, data was gathered regarding self-control, which seems to be a huge factor in crime and can be further researched.

Conclusion

Burglary is an often occurring crime that is mostly done in cooperation with at least one other person. This study aimed to explore the role of personality in burglary and co-offending. Even though, the results of this study were not significant this study was a good proof of concept for future research. It is noticeable that personality and co-offending have not been thoroughly researched, while the majority of crime nowadays involves some kind of co-offending. It is crucial to further understand co-offending to be able to prevent it.

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Appendices

Appendix A. *Stealable Items VR.*

- TV
- Candle holder
- Radio
- Plants
- Paintings
- Vases
- Lamps
- Bowl
- Casserole
- Hand soap
- Shampoo
- Alarm clock
- Candle
- Newspaper
- Saw
- Axe
- Screwdriver
- Wrench
- Hammer
- Drill
- Guitar amp
- Guitar
- Briefcase
- Xbox controller
- Xbox console
- Black ops 2 game
- Tablet
- Wallet
- iMac
- Car keys
- Handheld console
- Wine glass
- Picture frames
- Plate

Appendix B. *Cooperation Scale.*

(rated on a 5 point Likert-scale, 1(strongly disagree) to 5 (strongly agree))

We would like to know how you experienced cooperating with another person for the task of a virtual burglary

- My partner and I were successful in the task we had to complete in the virtual environment
- I believe I would have been more successful without my partner in the task we had to complete in the virtual environment
- I am happy with the outcomes of the task we had to complete in the virtual environment
- I often find it difficult to work together with people
- Teamwork is always the best way of getting results
- I contributed more than my partner to achieve the task
- I perceived my partner to be the leader while we were cooperating
- I had a good idea how well my partner and I were performing the task
- My partner had relevant knowledge and skills about the task we had to perform
- I felt excited after completing the task
- I felt frustrated after completing the task
- I was not dependent on my partner to complete the task
- I feel as if my partner and I had a shared goal and in completing the task
- I trusted my partner while we were completing the task
- I felt stressed due to the actions of my partner during the task
- The technology enabled me and my partner to cooperate effectively
- I believed the chances of getting caught together with my partner during this task was low
- I think the quality of the communication with my partner while completing the task was low

What percentage of the time during the times you and your partner spoke during the task? How much did you contribute (50% being you and your partner spoke equally, 10% means mostly partner talking, and 90% mostly you talking)