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IS THE SHOPPING LIST A GUARANTEE FOR RATIONAL CONSUMER BEHAVIOUR?

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Abstract: *Consumers may undertake various steps in order to increase the rationality of their choices. One of the options involves drawing up a shopping list. The study presents an innovative method of analysing consumer behaviour during shopping. Modern technologies were used to set up a virtual environment within which a store was created. A combination of methods was employed to assess the subjective opinions expressed during in-depth interviews. Another step focused on analysing the internal stimuli of the research subjects with the use of neuroscientific tools to evaluate the behaviour of the research participants. The aim of the study was to verify the impact of a shopping list on consumer rationality. The research results presented constitute a part of a broader research project, within the scope of which research method triangulations enabled an in-depth analysis of conscious and unconscious aspects of the subjects' behaviour (Borawski et al. 2021).*

Keywords: *EEG, VR, price sensitivity, consumer behaviour, consumer rationality*.

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INTRODUCTION

Global economic and social development results in changes in the standards of living and in the arrival of new goods and services on the market. Accordingly, the models of consumer behaviour and decisions made by consumers are subject to changes as well. Reference books on consumer behaviour stipulate that the principle of rationality lies at the foundation of actions taken by consumers (Hall, 1990; Hartman, Doane, & Woo, 1991; Peck, 2012). However, this principle is not always put into practice (Galbraith, 1938; Jacoby, 2000; Wang, Shen, & Gao, 2018). The objective of the paper is to assess consumers' rationality / irrationality, depending on whether or not they have drawn up a shopping list. The article features theoretical deliberations which are based on the existing relevant reference books and supported by the research. Methods and research tools used in the study made it possible to analyse both conscious and unconscious aspects of consumer behaviour, which allowed for a wider look at the subject matter under analysis. The assumptions were verified with the use of an interview (dyads and triads) and an experiment carried out in virtual reality, for which neuroscientific tools, such as EEG were employed. The research hypothesis was worded as follows: 'Having a list influences shopping behaviour on site'. There were also three supporting hypotheses: (h1) the shopping route of individuals with a shopping list is shorter in comparison to those without the list; (h2) individuals with a shopping list buy products more quickly; (h3) individuals doing shopping without a list demonstrate more positive emotions than the ones with the list. Consumers and their behaviour have been studied for many years (Ferber, 1977; Jacoby, Szybillo, & Berning, 1976; Triandis, 1979). Contemporary research of consumer behaviour demonstrates the complexity of the subject and incorporates multiple academic fields, such as, inter alia, economics, sociology, psychology, or medicine (Ferber, 1977; Szwacka-Mokrzycka, 2015; Xiao, Ford, & Kim, 2011). The studies provide information not only on why customers buy, but also on the course of a decision-making process, as well as the internal and external factors that may affect individual stages of this process (Biliciler et al., 2022; Concari et al., 2020; Włodarczyk, 2013).

On account of an interdisciplinary approach to the research, contemporary definitions of consumer behaviour encompass various aspects of consumer activity on the market, be it: economic (e.g. the purchase process), social (e.g. individual's behaviour in a group) and psychological (e.g. achievement of satisfaction) (Engel, Miniard, & Blackwell, 2006; Enis, 1977; Kotler & Keller, 2011; Kumar, 2010; Schiffman, Kanuk, & Hansen, 2008). Special attention to the issues of consumer behaviour arose due to the pandemic restrictions and their impact on attitudes toward shopping (Holotová et al., 2020; Huszka et al., 2022) which caused appropriate business responses in form of the strengthening links with the consumers (Mishchuk et al., 2022). One such interdisciplinary definition was proposed by M.R. Solomon (1995, 2006), who recognized that consumer behaviour entailed the process of choice, purchase, use, acceptance or rejection of products, services and experiences in order to satisfy the needs and wants by an individual or a group. A similarly broad approach to the subject was demonstrated by G. Antonides and W.F. Raaij (2002). According to their opinion, consumer behaviour comprises mental and physical activities along with motivations and causes; it refers both to group and individual behaviour; it concerns the cycle of consumption, i.e.: orientation, buying, using, keeping and disposing of a product; it involves

goods and services purchased in the market sector and public sector, or the ones manufactured within the scope of a household operation; it enables an individual or a group to function in such a way so as to ensure satisfaction and to achieve prosperity through individual and social effects of such behaviour. One of the most exhaustive definitions was proposed by M. de Mooij'a (2021), according to which consumer behaviour is treated as a process of choice, purchase, use, management of goods, services and experiences in order to achieve satisfactory fulfilment of wants and needs. In this definition, the focus is on the elements of contemporary studies of consumer behaviour, with an emphasis on the attributes of an individual and of a decision-making process (the element of psychology and sociology), management and a possibility of choice (the element of management and economics) as well as values and culture (the element of cultural studies).

- Consumers' needs lie at the foundation of the decisions made by the consumers. Consumer needs play an important role in the analysis of consumer behaviour on the market. Typically, they are understood as a demand for specific goods and services. One of the definitions of a consumer need has been presented by J. O'Shaughnessy (1994, 2013). According to the author, a consumer's need is an inclination to use or possess a product, but also an inclination towards a certain form of behaviour. Simultaneously, the author has isolated two main types of needs when discussing consumer needs, namely, desire and a requirement. The former type (the desire) refers to the need that has not been satisfied; the latter type (the requirement) is understood as a demand or a universal requirement for a given product or service. The views on consumer needs were supplemented by J. O'Shaughnessy (1994, 2013) who added an assumption that consumer needs also included desire for values in use, arising from the achieved economic and cultural mankind's development

Every consumer tries to make rational choices, is guided by their own hierarchy of needs (Maslow, 1943; Maslow, 1954; Maslow, 1962; Maslow, 1970). The hierarchical structure of needs and values of an individual is the result of such individual's psyche and personality. However, such an individual hierarchical system of needs is not constant and it evolves throughout the person's lifetime (Wahba & Bridwell, 1976). It depends on biological, social, economic and psychological circumstances (Kenrick, Griskevicius, Neuberg, & Schaller, 2010). It is believed in the literature that each consumer, based on their own hierarchy of needs, makes rational choices and purchases, and in this way they shape their rational consumption structure (Tyszka & Zaleśkiewicz, 2001; Matysik-Pejas & Szafrańska, 2011; Zalega, 2012).

Economic psychology, which originated from the concept of psychological behaviour developed by G. Katona as early as in the 1950s (Katona, 1953), has a major impact on the contemporary analysis of consumers' rational behaviour. According to economic psychology, consumer behaviour had a rational character, i.e. it could be predicted and subject to influence, but it did not depend exclusively on prices and income. It was also dependent on the consumer's perception of economic reality, their expectations and attitudes (Markin, 1979; Krasiński, Piasny, & Szulce, 1984; Drakopoulos, 1989; Samson & Voyer, 2012).

The fundamental objective of a rational consumer seems to be maximization of usefulness (Green & Srivastava, 1986; Molina, 1996; Kahneman & Thaler, 2006; Li & Hsee, 2021). The first factor forcing consumers to think when taking the final and rational purchase

decision is a need, which consumers find to be the source of dissatisfaction and deficiency, and which at the same time arises from their biological, psychological and social characteristics (Bayton, 1958; Seeley, 1992; Griskevicius & Kenrick, 2013). Becoming aware of the reason for a given situation brings about the need to assess the market, obtain information and plan the purchase of a product or a service, the purpose of which is to change the state of dissatisfaction of the decision-making individual (Dima, Man, & Kot, 2010; Peluso, 2011). Rational consumer activities require making certain calculations (Boudon, 2003; D. P. Green & Fox, 2007; Runje et al., 2019; Nickerson, 2021). Additionally, all consumer decisions are dependent upon multiple factors, such as, for instance, economic factors, i.e.: income, prices, savings, credits, influence of marketing instruments, goods availability, as well as non-economic factors, i.e.: age, gender, shopping time, urgency of a need, emotions, habits, planning, and many more (Mowen, 1987; Engel et al., 1997; Lambkin et al., 2001; Włodarczyk, 2013; Schiffman & Wisenblit, 2015; Zhao et al., 2021).

Rationality is not a consistently defined concept (Kahneman, 1994; Chase, Hertwig, & Gigerenzer, 1998; Bazerman & Messick, 2001; Lindenberg, 2001; Zaleśkiewicz, 2015; Bassey, Okoi, Bassey, & Wirawan, 2022). A. Kacelnik (Kacelnik, 2006) believes that recognizing a certain form of behaviour as being rational depends on which definition we refer to. In "The Dictionary of Modern Thought" (Bullock, Stallybrass, Trombley, Eadie, & Adamiec, 1999), rationality is defined as a type of behaviour that satisfies two conditions: consistency and accomplishment of goals, but it is consistency that is meant to allow an individual to accomplish an intended goal. Another definition of rationality can be found in Blackburn's (Blackburn, 2004) "The Oxford Dictionary of Philosophy", in which rationality means sense, suitability, compliance with the goal of the truth and the good. An interesting definition of rationality is also presented by a psychologist, D. Over (Over, 2004), who equates rational activity with people fulfilling specific cognitive standards. At the same time, he deliberates and points out to two divisions of rationality. The first division concerns rationality of beliefs and the rationality of action, which do not always go hand in hand. The second division, a very similar one, points out to theoretical and practical rationality. In the case of the definitions originating from psychology and philosophy, rationality is treated as a process of thinking and decision-making (Zaleśkiewicz, 2015). From the standpoint of economic studies, Neuman and Morgenstern's model (Von Neumann & Morgenstern, 1947) concerning the theory of expected usability can be indicated as one of the fundamental models of rational activity. The model assumes that an individual acting under the conditions of specific risk behaves as if they had their own function of usability defined by available alternatives, and in the face of the risk, when they need to make a decision, they do so in such a way so as to maximise their expectations (Baumol, 1951; Rabin, 2000). With time, alternative models of rationality emerged in economic studies (Allais, 1953; Kahneman & Tversky, 1979). On the one hand, rationality is discussed by using the terms of maximisation/optimisation of benefits/usability/satisfaction that arise from the decision made. This approach to rational activity was presented , inter alia, by Wilkinson & Klaes, 2018; Dudziak, 2013; Zalega, 2014; Arrow, 1982, 1986, 1990; Becker, 1962, 1976; However, other scientists believe that rationality is not always tantamount to maximisation and they point out that a pre-condition for rationality is a satisfactory choice (which does not need to be maximum) – (Leibenstein, 1979a, 1979b, 1988), (Simon, 1976, 1978, 1995).

Undoubtedly, an important element of rationality in the consumer decision-making process is thoughtful product choices. A shopping list used by the consumer while at store and while making final shopping choices may contribute to the accuracy of the final decision being made. Previous studies analysing shopping lists used by the consumers and their impact on consumer behaviour comprised various aspects, such as list compilation, list contents, assistance in memorising shopping items, factors determining the compilation of the final version of the shopping list, the effectiveness of having a list vis-à-vis actually purchased items, developing an external memory, or doing planned and unplanned shopping (Spiggle, 1987; Thomas & Garland, 1993; Freyd & Gleaves, 1996; Block & Morwitz, 1999; Hand, Dall'Olmo Riley, Harris, Singh, & Rettie, 2009; Ghosh & Gilboa, 2014; Harsha Jayawilal & Premeratne, 2017; Martínez-Ruiz, Blázquez-Resino, & Pino, 2017; Ahmed & Ting, 2019; Morrissette & Lusk, 2022). In particular, with regard to the issues raised in this study, planned and unplanned purchases should be treated, because these consumer actions can be combined both with the issues of having a shopping list and the rationality of choices made (Abratt & Goodey, 1990; Hunt & Lambe, 2000; Sohn & Ko, 2021). During shopping in the market, one of the elements refers to the route the shopper follows. It speaks directly to how the shopper moved and can be related not only to the products he or she wanted to buy, but also to those he or she bought on impulse. One of the leading researchers studying this issue, S. Hui and J.Inman, made an attempt to answer this question (Hui, Bradlow, & Fader, 2009; Hui, Inman, Huang, & Suher, 2013). Their study was to compare consumer behaviour in a real shop (not created in VR). They tried to answer the question of how the route through the shop determined the products that would be in the customer's shopping basket. They point out that the route in the real shop depends on many factors - including the shopping list held. Furthermore, the analysis of behaviour through product routes alone is incomplete without the analysis of physiological signals or emotions. (Hui et al., 2009, 2013).

Compared to the study by S. Hui et al., it is possible to point out an important advantage of conducting research using the VR environment, which is its repeatability (Hui et al., 2009, 2013). This means that by using ready software, we obtain constant repeatability of each survey, where we eliminate any factors that may affect the course of the survey. Using, for example, appropriate modelling of customer behaviour in a shop, we can obtain full repeatability of their behaviour or introduce their variability if the research scenario so requires. The VR environment allows for an easy and simple way to change products in the virtual shop, add new prices or set promotions without the need for costly and time-consuming changes to physical products. Furthermore, it allows any configuration of the shop, including shelves and the position of products on them. In addition, we have removed all well-known brands from our shop in order to minimise the phenomenon of buying products from a well-known brand.

The implementation of VR environment increases the accuracy of all measurements, e.g. how long the subject views a given product, the exact location of objects as well as the subject in the shop. In addition, data recording on the computer helps recreate the entire history of the customer movement around the store as well as any actions related to, for example, picking up and putting given products into the basket. The most important advantage of the software solution, compared to the real shop described in Sam Hui's study, is that there is no use of complicated cameras, sensors and algorithms to determine the

customer location in a store and to record any actions taken by such person or by other customers in the store (Hui et al., 2013).

It should also be mentioned that a modern VR environment created, for example, in Unity software, allows research costs to be minimised. Conducting research in a real shop can often involve not only the potential cost of renting a shop, but also the inability to 'move' the shop to another location, which involves travel costs. Using a computer, VR hardware and a software environment enables the research to be carried out in any suitable location without the need for respondents to travel or to bear the cost of renting a shop. In our study, we used the VR laboratory located at the University of Szczecin.

One article examining consumer behaviour in a VR shop is a study by M. Siegrist et al. (Siegrist et al., 2019). They present two studies comparing customer behaviour in a real shop and in a virtual reality shop when selecting a particular product. It should be added that, as in our study, they also informed their subjects that they had a specific amount to spend - in their case it was 10 Swiss francs (Siegrist et al., 2019). However, their study significantly differed from ours. They were limited to only one type of product - breakfast cereal (all the brands they used were original brands from Swiss shops). It should also be added that the researchers stated that the first study was limited to a small slice of the prepared VR shop, in the second study customers were able to navigate through the entire virtual shop, but only breakfast cereal products were available. Furthermore, in the first study in the VR environment, subjects had to ask for product information to be displayed, which appears automatically in our experiment once the product is picked up. We also believe that being limited to one type of product cannot fully reflect in-store behaviour, as it must be assumed that a respondent may not buy a particular product, e.g. due to habits or health problems associated with such product. In the case of our shop, we did not use popular brands, in order to minimise the problem of choosing a product not based, for example, on a lower price, but on brand familiarity. The greatest advantage of our study is not only the complete freedom of the respondent in the shop, where he or she can move around the entire shop area, but also the very wide assortment - the respondent can choose, among other things, flowers, toys, books, but also chemical products, and even seafood. Therefore, we can research one or many specific products, during the normal shopping process, when the customer is shopping for a variety of goods.

Finally, a very important element of the study by Siegrist et al. should be added - they proved that customer behaviour in a VR shop did not significantly differ from behaviour in a real shop (Siegrist et al., 2019). Therefore, this conclusion provides additional support for our study.

We would also like to add that Siegrist et al. used VR goggles for research in the virtual reality environment (Siegrist et al., 2019). We mention this because of cases where researchers, instead of using goggles to simulate the environment, use, for example, computer monitors displaying simulator images on them (Huang, Backman, Backman, & Chang, 2016). Therefore, a distinction should be made between the use of a full set of virtual reality goggles and the use of computer screens.

We would also like to refer to a study by A. Schnack et al describing consumer behaviour in a VR shop. As it is in our case, they used a shopping list for the subjects containing specific food items, but they used the technique of presenting the printed shopping list to the subjects before entering the shop (Schnack, Wright, & Holdershaw, 2020). In our

study, we used the technique of displaying the shopping list any time the respondent was in the VR environment. This is based on the assumption that the list should be available to the respondent at any time, because a person who can remember what to buy does not need the list in order to make a purchase. The person using the shopping list may want to use it at any time to check if all the products are already in the basket.

Apart from objective aspects in analysing consumer behaviour, other issues are important as well, i.e. emotions accompanying shopping (Schwarz, Strack, Kommer, & Wagner, 1987; Schwarz, 1990; Escadas, Jalali, & Farhangmehr, 2019). Psychologists believe that the decision to buy is often based on feelings (Zimbardo & Gerring, 2017). It is on the grounds of feelings that a consumer compares, checks, purchases products (Lerner & Keltner, 2000; Isen, 2001; Cohen, Pham, & Andrade, 2018; Kahneman, 2012). Decisions based on emotions are often irrational (Pradeep, 2011; Mruk, 2017). Therefore, it is becoming increasingly more common for companies to gather multi-dimensional data on consumers in order to accurately appeal to their tastes and expectations (H. Hall, 2014; Gregor & Wdowiak, 2016; Chkoniya, 2020; Pluta-Olearnik & Szulga, 2022).

Therefore, summing up theoretical considerations, the authors notice and appreciate the huge theoretical and methodological achievements in the field of research on consumer behaviour, including in particular the issue of rationality, having the shopping list, or planned and unplanned purchases. However, they also assume that the research methods used so far in the issue presented are currently not sufficient, because thanks to new technological achievements they could be supplemented and improved. Therefore, an attempt was made to expand knowledge by using different configurations of methods in the study conducted than those used so far, in order to obtain a comprehensive picture of the modern consumer.

Currently, an important question is, irrespectively of the approach presented to the very understanding of rationality, how a rational individual makes choices? A confrontation of theories and models with every-day behaviour indicates that the decision-making process is highly complex. It arises from the fact that both the economic determinants, along with the increased importance of non-economic factors, particularly psychological ones, play an important role in shaping rational attitudes. Therefore, over the last 20 years the development of neuro-economics and neuro-marketing could be observed along with the research methods related to these sciences (Senior & Lee, 2008; Hubert & Kenning, 2008; Fugate, 2008; Foxall, 2008; Garcia & Saad, 2008; Ariely & Berns, 2010; Gang, Lin, Qi, & Yan, 2012; Hackett & Foxall, 2018). Consumer choices concerning the purchase of goods and services are described within the scope of neuro-marketing, including also the determination of how rational these choices are (Richard & Laroche, 2011; Page, 2012; Gutmann, 2015, 2017; Lawes, 2018). In the study presented, the focus was placed on the use of modern research methods and an attempt was made to indicate how far these methods can be employed in assessing rational consumer behaviour.

METHODOLOGY

Despite the fact that virtual reality technology has existed since the 1960s, it was only the development of the technology in the 21st century that enabled to precisely conduct research with the use of VR technology (Wohlgenannt, Simons, & Stieglitz, 2020). Development of

VR environment makes it possible to carry out research in any environment. Combining VR technology with EEG constitutes a relatively new research method. In his article, J. Tromp (Tromp, Peeters, Meyer, & Hagoort, 2018) indicates that researchers have been using the environment simulating vehicle driving since 2000 as one of the most popular research directions.

The popularization of research with the use of the above-mentioned techniques as well as the development of technologies caused that many branches of science started using them. They are employed very broadly in medicine. For instance, they have found an application in rehabilitation of the physically disabled (Cheron et al., 2012; Lazarou, Nikolopoulos, Petrantonakis, Kompatsiaris, & Tsolaki, 2018; Tan et al., 2020) as well as the mentally disabled (Cho et al., 2002; Roesmann et al., 2022). Furthermore, other areas include research on how individuals behave in a given space (e.g. in a labyrinth) (Kober, Kurzmann & Neuper, 2012), studies of drivers' behaviour while driving a vehicle (Zhao, Zhang & Cichocki, 2009; De Blasiis, D'Anna & Conforto, 2021), studying consumer preferences (Guo & Elgendi, 2013; Mann, Liu-Thompkins, Watson, & Papelis, 2015; Baceviciute, Lucas, Terkildsen, & Makransky, 2022), as well as studies on how people communicate (Tromp et al., 2018). The literature presented clearly demonstrates that the research technique composed of VR and EEG has become one of the most widely applied modern research methods. Such high-tech solutions enable researchers to obtain increasingly more accurate results and to study new spheres of life. The source literature indicates that rather sparse research has been conducted so far on consumer preferences and behaviour with the use of VR and EEG (Siegrist et al., 2019).

The present study was carried out from June 2021 to August 2021. The stages of the procedure within the scope of the adopted research formula were consistent with the methodology of in-depth interviews and the experiments described in literature and by the authors in a separate paper (Słupińska, Duda, & Biercewicz, 2021). Research based on the method of an interview was developed in the 1960s and the 1970s (Lewandowska, 2004). This method enables to obtain data and, through direct verbal contact with an individual, provide the information regarding the problems of interest to the researcher (Góralski, 1994). Thanks to such subjective approach and the possibility of a free conversation, the person being interviewed openly shares their observations and feelings as well as their own experiences.

Within the scope of the first stage, the study participants were invited to take part in an interview to be conducted at a focus workshop. The method of in-depth interviews (dyads and triads) was adopted. The choice of the method of carrying out interviews was dictated by the period in which the study was carried out, i.e. the time of increased restrictions resulting from the Covid-19 pandemic. A projection method was employed, which enabled to conduct an analysis of the aspects of conscious and unconscious spheres. The method required the use of long-term memory through which participants were expected to recreate their most often frequented store, then a moderator conducted an interview with them on their shopping habits, whether they prepared a shopping list, how they moved around the store, how they chose products. After the interview had been completed, participants were invited to take part in the 2nd stage that involved an experiment in a virtual store.

The participants were directed to a virtual reality laboratory, where they were introduced to a virtual world. Additionally, 35 people that had been involved in the previous stage

partook in this study. It was a conscious decision which enabled to observe differences occurring in the conscious and unconscious sphere. Due to the small number of participants, the study conducted was a pilot study At the beginning, the research subjects were asked to fill in a survey questionnaire indicating their preferences regarding the manner of making a purchase, defining themselves as a customer type and declaring whether or not they tend to use a shopping list on an every-day basis. The study participants were divided into 2 groups: those who did shopping in accordance with the shopping list drawn up by the researchers and who had PLN 50 at their disposal (20 individuals), and those who were not given any shopping list and who had PLN 50 at their disposal (15 individuals). Additionally, the groups were further divided based on the declarative statements made during individual interviews into those who regularly did shopping with a shopping list and those who did not use such support.

The groups were divided as follows:

1st group - individuals shopping without a list, who did not use the list in the VR environment (10 people);

2nd group – individuals shopping with a list, who used the list in the VR environment (12 people);

3rd group - individuals shopping with a list, who did not use the list in the VR environment (8 people).

4th group - individuals shopping without a list, who used the list in the VR environment (5 people);

All four groups of the subjects observed were expected to do daily shopping. The division into groups and sub-groups is part of a regular procedure of an experimental VR study (Słupińska, Duda, Biercewicz 2021). As group 4 was underrepresented, it was not taken into account in the analyses. The study was conducted in Virtual Reality (VR) environment, which enabled the analysis of the unconscious sphere of behaviour. The environment was planned in such a way so as to reliably recreate a traditional FMCG store. The main objective was to create situations that would reflect the ones encountered by the study subjects in the real world. The precondition for joining in the study was granting an informed consent to participate in the VR study. The respondents were advised on the manner of conducting the experiment.

This division gives additional information about human behaviour based on past experiences and habits, which are a form of unconscious behaviour. This allows one to check to what extent it can introduce this disturbance in the decision-making process. Conscious behaviour is considered to be people's declarations about their shopping behaviour while unconscious aspects are their actual behaviour.

In addition, the afore-mentioned experiences influence unconscious behaviour. People, by definition, act in accordance with the method they adopt on a daily basis.

The time spent in the store was used as the controlled parameter in the experiment. Audio announcements were used to inform about the closing of the checkout, which occurred after 15 minutes of the respondent's stay in the store. Announcements heralding the closing of checkouts occurred 3 minutes before the end of the time limit allotted and communicated that participants had 10 minutes until the closing of checkouts.

The restriction in the form of message transmission was intended to assess consumer behaviour under time pressure, i.e. to what extent the consumer will complete the purchase,

and to what extent he will abandon it and head to the checkout. The message setting was arranged so as not to interfere with the additional study of spending time in the store, as the pilot study estimated the time average for the final moment of shopping, rather than interrupting the entire shopping process.

This variable was chosen as a factor that could influence the behaviour of participants, especially the ones without the shopping list.

Virtual Reality Environment

The pilot study was carried out in a virtual store developed in Unity 2019.4.6f1 game engine. When developing the store, a demonstration scene was used along with models from the asset of Supermarket interior with LOD. The models of independent characters playing the role of customers were made with the use of MakeHuman software, based on sets of clothing on an OpenSource licence. Some models of the facilities were made or modified in Blender programme.

The virtual store represents a supermarket comprising three aisles with four rows of shelves in each of them. One of the island displays offered products on promotion.

The first aisle featured the following departments: fruit, vegetables, cheeses, cured meats, meat, frozen products, spices, kitchenware and a promotion island display. The next aisle featured the following departments: toiletries, toys, cleaning products, books, tins, pasta, sweets, seafood. The third aisle offered soft drinks, alcohols, dairy products, bakery products.

The study subjects were placed at a starting point (Figure 1). After completing their shopping, the participants had to reach (or be transferred to, if they ran out of time) to checkout number one (marked as “the end”). Goods in the store were placed in accordance with retail merchandising principles.

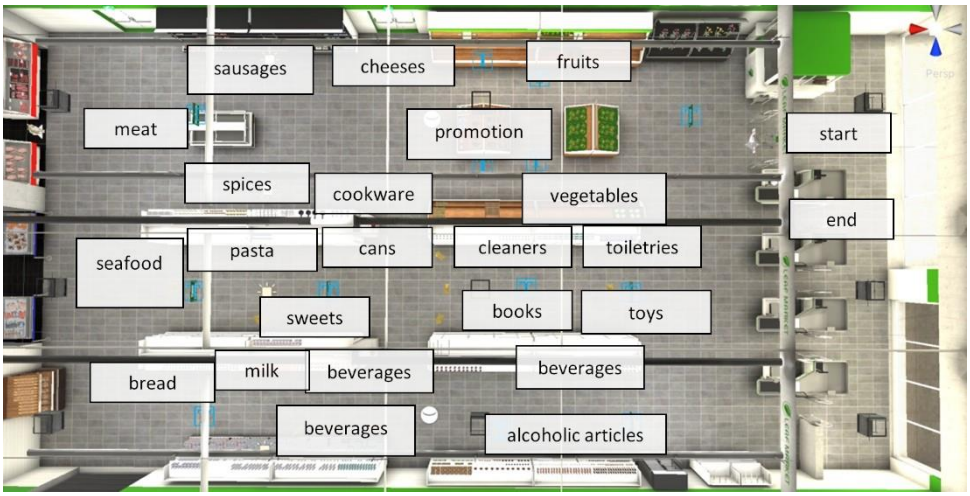

Figure 1. Goods placement.
[Source: Own elaboration]

The store had 34 zones designated in which study participants could move (Figure 2). The dimension of each zone was not bigger than 4.5x3.5m.

Figure 2. The areas in which the player could move around.
[Source: Own elaboration]

The study subject was accompanied by a model of a shopping trolley. Similarly as in a real store, goods could be put in and taken out of the trolley. Each product that could be held, was subject to the laws of physics: it could be dropped, thrown, etc. When an item was picked up, its price was displayed (Figure 3).

Figure 3. Displaying product price.
[Source: Own elaboration]

The study subject who finished shopping had to go to the area next to checkout number one. Entering the checkout area resulted in adding up the total amount to be paid for shopping. Finally, the study participant had to choose the payment method (Figure 4).

Figure 4. Selecting the payment method.
[Source: Own elaboration]

In order to make the experience as realistic as possible, independent characters, acting as store customers, were introduced into the virtual reality environment. There were five such characters in the store: two men and three women. They moved around at random among designated areas in front of the shelves.

Every event in the virtual reality environment was recorded and saved as an *.xls (xml version) file. Events included, inter alia: picking a product up from the shelf, putting it away in the trolley, entering the area designated by the researchers, coming close to an independent character, etc.

Experimental Design

At the beginning of the study, research participants were shown an instruction film footage on how to move around the store, how to use VR controllers. After viewing the instruction film footage, VR goggles were put on the study participants to allow them to practice moving around the store. To that end, a demo version of the store was run, in which the store content was limited to only a few shelves. Following that, the participants were fitted with the entire equipment used during the study (an EEG cap and VR goggles). Then, recording of the images seen by the participant was initiated, along with the EEG signal and the VR environment.

At the beginning, study participants were presented with a black screen for 60 seconds, during which time they were asked to calm their senses, and thus their brainwaves. Next a store simulation was launched, in which participants were placed at the starting point (fig.1). During the study, each participant did shopping by putting selected products into the trolley. Products could be taken out of the trolley and put back on the shelf at any time. While a product was held in hand, its price was displayed. The individuals doing shopping with the shopping list could choose to display their shopping list by pressing the right button on the

controller. The list comprised: bananas – 2 pieces, yoghurt – 3 tubs, pizza – 1 piece, bread – 1 piece, water – 1 piece, fish – 2 pieces and cheese – 1 piece. It was assumed in the study that individuals shopping with the list had a specific list of products to buy and despite a limited shopping budget, they treated it as a task that needs to be accomplished. Such a claim was tied to the results of the qualitative research. The individuals who indicated they did shopping efficiently, not requiring a lot of time at the store, were quite strongly co-related to the individuals who previously declared that they prepared a shopping list or that they did standard shopping that did not need to be put down, but which they treated as if products were put on the list. Additionally, the individuals who specified that they tend to shop with the shopping list, paid less attention to the environment – signboards, price promotions. In the replies given by the individuals referring to a constant arrangement, task orientation and constant shopping route were stressed: "I do not pay attention to signboards, I am task-oriented when I shop", "I enter a store, go to a specific shelf and then head towards the checkout", "I am task-oriented when I shop. I walk along my regular route. (…) In this way I do not waste time."

DATA ANALYSIS

VR goggles (HTC Vive Pro Eye) were chosen for the study. Moreover, a wireless Enobio® EEG systems – Neuroelectrics EEG cap was used. It is fitted with 20 electrodes placed in accordance with 10-20 system at the following points P7, P4, Cz, Pz, P3, P8, O1, O2, T8, F8, C4, F4, Fp2, Fz, C3, Fp1, T7, F7, Fpz. The data were registered with a sampling frequency of 500Hz.

All the analyses, with the exception of the presentation of the study participants' routes, were conducted with Matlab computing platform. The presentation of the study participants' routes in the VR environment was prepared with the use of C# language. EEGLAB and FieldTrip toolboxes, dedicated to the MatLab environment, were used for EEG analyses.

Registered EEG signals were subject to preliminary processing. Using EEGLab and FieldTrip, any interference from the power grid was filtered out, along with any artefacts related to, inter alia, eyeball movement, muscle movement, etc. The quality of the EEG signal was further verified and all of its low quality fragments were removed. In the next stage, a band filtration was employed, thanks to which the data in a subsequently used frequency range were isolated. It decreased the impact of any interference caused by the operation of VR goggles on the results of analyses.

Data analysis was based on the processing of data recorded by the VR environment and by recording devices. The analysis of the length of the routes covered was based on the records of VR goggles location. The total route covered by the study participant was calculated on the basis of the following formula:

$$d = \sum_{i=1}^{N_p-1} \sqrt{(x_i - x_{i-1})^2 + (z_i - z_{i-1})^2}, \quad (1)$$

where:

x_i, z_i – i-th goggles coordinates (y_i height is omitted),

N_p – number of registered positions;
d – route covered by a study participant.

In order to calculate the route with the exclusion of transfers between areas, the following formula was used:

$$d' = \sum_{i=1}^{N_p-1} \begin{cases} \sqrt{(x_i - x_{i-1})^2 + (z_i - z_{i-1})^2} & \text{when} \quad \sqrt{(x_i - x_{i-1})^2 + (z_i - z_{i-1})^2} \leq p \\ 0 & \text{when} \quad \sqrt{(x_i - x_{i-1})^2 + (z_i - z_{i-1})^2} > p \end{cases}, \tag{2}$$

where:
p – threshold defining a minimum distance of transfer between areas,
d' – route covered by the study participant, not taking into account any transfers between areas.

Before the indices were calculated, a preliminary signal processing was carried out. First, all interference was filtered out (for instance, the one coming from electric current sources). Then, all interference resulting from the working of the eye muscles and eyeball movement (Al-Fahoum & Al-Fraihat, 2014) was removed (the so-called artefacts (Fitzgibbon, Powers, Pope, & Clark, 2007; Romero, Mañanas, & Barbanoj, 2008)) using an independent component analysis (ICA (Jung et al., 2000)).

After such preliminary EEG signal processing, EEG data was synchronised with the registered events. Following that, a gamma band (25-40Hz) was isolated from the EEG signal with the use of a continuous wavelet transform, for which a global field power (GFP) was determined. On the basis of the GFP, *F* values were calculated for the Arousal-Valence indices (McMahan, Parberry, & Parsons, 2015) and they were substituted to the following formulas:

$$Arousal = \frac{F3_{beta} + F4_{beta}}{F3_{alpha} + F4_{alpha}}, \tag{3}$$

$$Valence = \left(\frac{F4_{alpha}}{F4_{beta}}\right) - \left(\frac{F3_{alpha}}{F3_{beta}}\right), \tag{4}$$

where:
F3 alpha – the signal obtained from F3 electrode with alpha wave record
F3 beta - the signal obtained from F3 electrode with beta wave record
F4 alpha – the signal obtained from F4 electrode with alpha wave record
F4 beta - the signal obtained from F4 electrode with beta wave record

The results obtained with the use of the above-mentioned formulas were calculated with the GFP and electromagnetic alpha and beta brainwave signals recorded during the study.

In their papers, the authors (A. McMahan, 2003; T. McMahan et al., 2015) point out that the above-mentioned Arousal-Valance model may also be used for analysing players'

involvement, but also their preferences. The value obtained of the Arousal index enables to determine whether the study participant is under stress (too high level) or whether they are bored (too low level) – it is an intensity index (Russell & Barrett, 1999; T. McMahan et al., 2015). In the same paper, McMahan (T. McMahan et al., 2015) emphasises that the Valance index is applied in order to determine negative and positive emotions. Defining the value of that variable enables to determine what emotions accompanied the study participant, e.g. whether it was sadness or happiness (T. McMahan et al., 2015).

RESEARCH RESULTS

It was assumed in the study that the individuals using the shopping list had a specific list of products to buy and despite limited budget allocated to shopping, they behaved in a task-oriented manner. The claim was linked with the results of the qualitative research. The individuals who indicated they did shopping efficiently, not requiring a lot of time at the store, were quite strongly co-related with the individuals who previously declared that they prepared the shopping list or that they did standard shopping that did not need to be put down, but which they treated as if products were put on the list. Additionally, the individuals who specified that they tend to shop with a shopping list, paid less attention to the environment, i.e. signboards, price promotions. In the replies given by the individuals referring to a fixed arrangement, task orientation and fixed shopping route were stressed: "I do not pay attention to signboards, I am task-oriented when I shop", "I enter a store, go to a specific shelf and then head towards the checkout", "I am task-oriented when I shop. I walk along my regular path. (…) In this way I do not waste time."

Data registered during the test conducted in VR made it possible to specify what route was covered by each study participant. The figure presents overlaid routes of the individuals shopping with and without the list. The figure shows that the movements of the individuals using the shopping list were more purposeful. They did not enter certain areas at all, while some areas were visited only by certain people. It was closely linked with the products found on the shopping list. In the case of people moving around without the list, their movement routes demonstrated which products they were willing to purchase more or less readily. Toys and toiletries can serve as a good example of that finding.

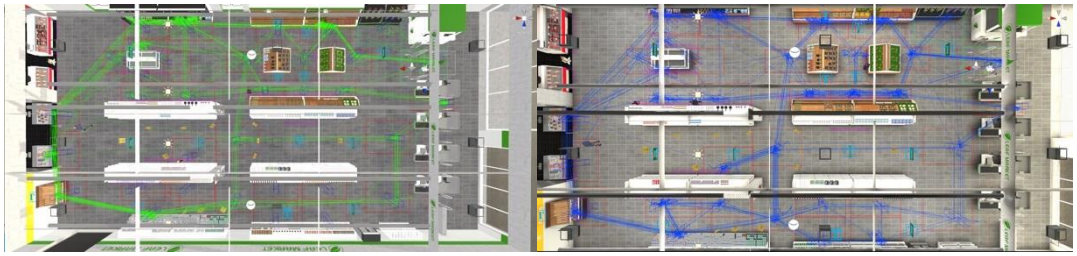

Figure 5. Routes covered by the study participants: a) moving around with the list (green lines); moving around without the list (blue lines).
[Source: Own elaboration]

All the following results and conclusions apply to the pilot group. They should be verified on a larger group of people. Due to the small number of respondents, statistical tests were not carried out and statistical significance was not determined. Information about the pilot group is presented in the methodology section.

A comparison of the distances covered by the individuals moving around with the list (average route was 250 m) and the individuals walking around without the list (average route was 243 m) indicates that the individuals from the former group covered a longer distance. However, if the distances related to moving between areas are ignored (it gives 75 m with the list and 82 m without the list, respectively), the conclusion is that the individuals using the list covered a smaller distance. Comparing these data, the conclusion can be drawn that individuals shopping with the list moved between areas a lot. Furthermore, it does not refer to all the individuals to the same degree, which was demonstrated by significant values of standard deviation: 82 (with 64 for the individuals shopping without the list). The route taken by a certain group of people was highly non-optimal, they covered very long distances between the instances of putting subsequent products into the trolley. There were far more such individuals among men (average route length was 273, with standard deviation of 77) than among women (210, 61, respectively).

The fact that the individuals moving around without the list covered a greater distance, if the distance related to moving between areas is ignored, indicates that they covered a greater route within the areas themselves. It means that they walked alongside the shelves much more. It was linked most likely to them looking through and comparing similar products. Those people were more focused on making a better choice of a product than the individuals shopping with the list. The virtual reality environment provided the participants with only two types of information: visual information (appearance) and price. It means that they may have been looking for products more attractive in terms of appearance and/(or) price. Women were more concentrated on making a better choice (average route length for women was 90) in relation to men (whose average route length was 69). Therefore, one may conclude that women are more sensitive to product appearance and/(or) price.

Following that, specific groups of people were analysed who at the stage of the qualitative research defined themselves as individuals shopping with the list and without the list, as well as the ones who in VR were tasked with doing shopping with the list and doing shopping according to their free choice. Therefore, 4 analysed groups can be specified:

1. individuals shopping without the list, who did not use the list in the VR environment (10 people);
2. individuals shopping with the list, who used the list in the VR environment (12 people);
3. individuals shopping with the list, who did not use the list in the VR environment (8 people).

The fourth group was removed from the analysis of the results, due to an insufficient number of respondents.

Figure 6 shows the arrangement of products in the shop with their order number in the list. The majority of people using the list concentrated on selecting the next products on the list, generally ignoring the possibility to change this order. Among the respondents, 5 people shopped exactly in the order indicated on the list and 7 people made only one deviation from

this order. In the shop, there were 3 products next to each other: yoghurt, pizza and cheese, but only yoghurt and pizza were next to each other on the list. Only 2 people took the 3 products at once, 2 people took the yogurt and cheese at once, but came back later for the pizza. On the other hand, as many as 8 people took the yoghurt and pizza and came back later for the cheese. This indicates a strong influence of the list on the order of shopping.

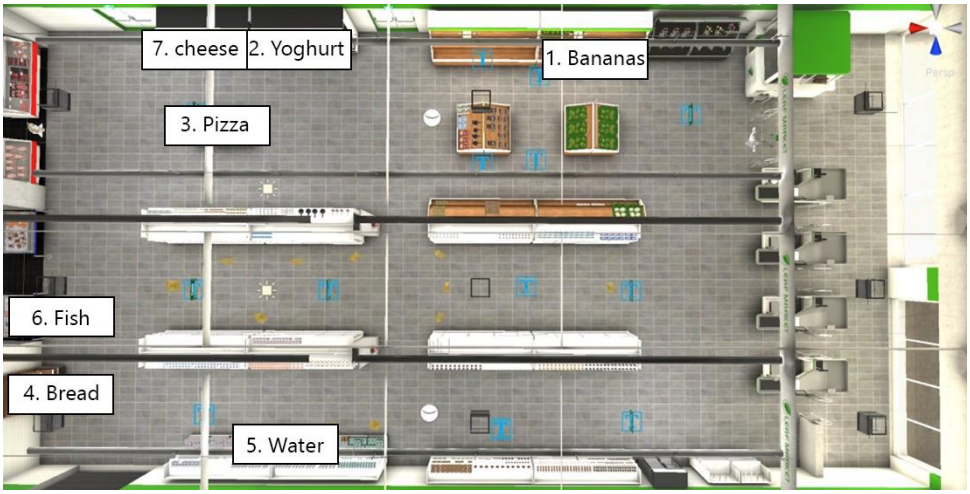

Figure 6. Arrangement of individual items present on the shopping list. The items were presented as they were on the shopping list.
[Source: Own elaboration]

The third group was introduced in order to check how the shopping process would be affected by upsetting a person's shopping habits. The average spending in the first two groups (first and second) was more or less similar (PLN 79.09 and PLN 72.18, respectively). However, the standard deviation for the first group was slightly greater (PLN 45.75 and PLN 31.74, respectively). It probably resulted from the fact that the group shopping without the list enjoyed greater freedom in selecting products, which translated into a greater spread of spending. The greatest average expenditure (PLN 100.36) and the greatest standard deviation (PLN 63.91) was observed in the case of the third group. The results obtained indicate that the lack of the shopping list, which participants were used to, probably led some of them to pick the products they liked, rather than the ones they actually needed. That is why they easily exceeded the budget allocated to them. The group also included individuals who maintained shopping "discipline", which translated into low spending on the products purchased.

When comparing our results obtained with those of Sam Hui and Jeff Inman's study, similarities can be found. For our first two groups and their study, significant overlap can be seen for shopping with and without the list. Their results indicated that shopping with the list could reduce additional spending on unplanned items by around 21% (they did not report the difference in price) (Huang, Hui, Inman, & Suher, 2012). In the case of our study, the difference in expenditure between group 1 and group 2 is around 10% (PLN 72.18 and PLN 79.09). It can therefore be concluded that, in both cases, the shopping list drawn up in advance helped to reduce unplanned expenditure.

The average duration of the shopping done by members of the first group (9 minutes 46 seconds) was distinctly longer than the time the members of the second group needed on their shopping (7 minutes 59 seconds) with a comparable standard deviation (2 minutes 41 seconds and 2 minutes 11 seconds, respectively). The result demonstrates that the individuals using the shopping list were more organized, since they did not need to ponder over what products they had to buy, but only the product of which manufacturer to choose. Forcing the people to use the shopping list, who normally did not use it, did not result in reducing their shopping, quite the reverse, their shopping time was extended. The average time of shopping for the third group was 9 minutes 30 seconds with a standard deviation of 3 minutes 17 seconds, which constitutes a significant increase in relation to the second group. This indicates that a certain proportion of the study participants required more time to search for products.

According to the study by S.Hui and J. Inman, the time spent in a shop influences purchasing decisions. According to their calculations, a clear conclusion emerged from the results of the study - if a respondent thinks about buying a product for 10 seconds, according to the study, the chance to buy it increases by 2%. If we assume that every 10 seconds spent in a shop, according to S.Hui and J.Inman's study, results in a 2% increase in the chance of buying an unplanned product, we can try to compare this with our study (Huang et al., 2012).

For the first study group without the list, the time spent in the shop is 9 minutes and 46 seconds, and for the group with the list it is 7 minutes and 59 seconds. The difference between the groups is therefore 107 seconds. After calculating the percentage, based on the study by S. Hui and J. Inman - we obtain a value of 21.4% (Huang et al., 2012). Comparing the values with the amounts for the two groups respectively (group 1 - PLN 72.18, group 2 - PLN 79.09) yields a difference of 21%. Therefore. we obtain overlapping results - 21.4% (time) and 21% (expenditure). Therefore, we can conclude that every 10 seconds more spent in the shop by people without the list increased their spending by 2%, according to which the difference in spending actually coincides with the value calculated on the basis of the survey results. The distance covered by study participants, without taking into account teleportation (i.e. moving around in the vicinity of store shelves) was the shortest in the second group and it equalled 64.28 metres with a standard deviation of 26.6 metres. It proves that there is strong orientation towards task accomplishment: the purchase of all the products on the list with little need to look for products not included on the list. The average distance covered, including teleportation, was 235.46 meters with the highest standard deviation of 85.07 meters, which demonstrates that some individuals did their shopping in a non-optimal fashion. Most likely, they were searching for products in the order in which they were enumerated on the list. Members of the first group shopping without the list covered a greater distance without taking teleportation into consideration – 80.62 metres (with a standard deviation of 30.93 metres) and taking teleportation into account – 261.32 metres (with a standard deviation of 63.7 metres). Forcing the people who typically do not shop with the list to use it, had virtually no impact on changing the distance they covered in the vicinity of store shelves (average distance covered without taking teleportation into account: 80.19 metres with a standard deviation of 9.41 metres). In turn, the distance covered including teleportation decreased to 251.71 metres and the standard deviation to 40.42. It demonstrates that those individuals moved less across greater distances. The members of the third group covered a greater distance in comparison to the members of the second group without taking teleportation into consideration (83.21 metres with a standard deviation of 23.85 metres), but

they covered a smaller distance if teleportation was to be accounted for (219.23 metres with a standard deviation of 65.11 metres). It demonstrates that they moved around more in the vicinity of the store shelves, which may constitute proof that they took more time to consider what they had to buy. They moved less across greater distances, thereby likely eliminating wandering around in search of the places where the goods on the list may be located.

Again, our results can be compared with the study by S. Hui and J. Inman. They showed in the study of the walking route in shops that if the route was increased by 10% (in their case it was about 50m) the increase in unplanned expenditure could be 7% (Huang et al., 2012). In our study, the subjects with the list (group 2) walked, without teleportation between areas, 64.28m, and the subjects without the list (group 1) walked 80.62m - a difference of 21%. On the other hand, comparing the result including teleportation, i.e. 235.46 m (group 2) and 261.32 m (group 1), we obtain even 10% difference. This means in this case that the distance covered by the listless is greater and, as in the study by S.Hui and J. Inman, the expenditure also increased, in our study by the previously mentioned 10% (7% in their study) (Huang et al., 2012). This confirms to us that a greater distance travelled in-store increases shopping expenditure.

For the purpose of assessing emotions accompanying the study participants, average values of the Arousal-Valance indices where calculated for the moments during which study subjects held products in their hands. The averages were computed for the previously specified three groups. The results are presented in Table 1 and in Figure 2. On the basis of the results obtained, it can be concluded that the individuals shopping with the list and moving around in VR with the list experienced excitement when looking at products. Similar results were observed in case of the individuals shopping without the list and moving around in VR without the list, however the level of excitement they experienced was far lower. Whereas the remaining group of people who were forced to alter their shopping habits experienced frustration. The frustration was greater among those people who typically did shopping with the list, but who were instructed to shop without it in VR.

Table 1. Average values of the Arousal-Valence model calculated for the moment of holding products.

Daily shopping	**List**	**List**	**No list**
Shopping in VR	**List**	**No list**	**No list**
Average value of the Arousal index	0.199808	0.025175	0.038775
Average value of the Valence index	0.088057	-0.06967	0.017565

[Source: Own elaboration]

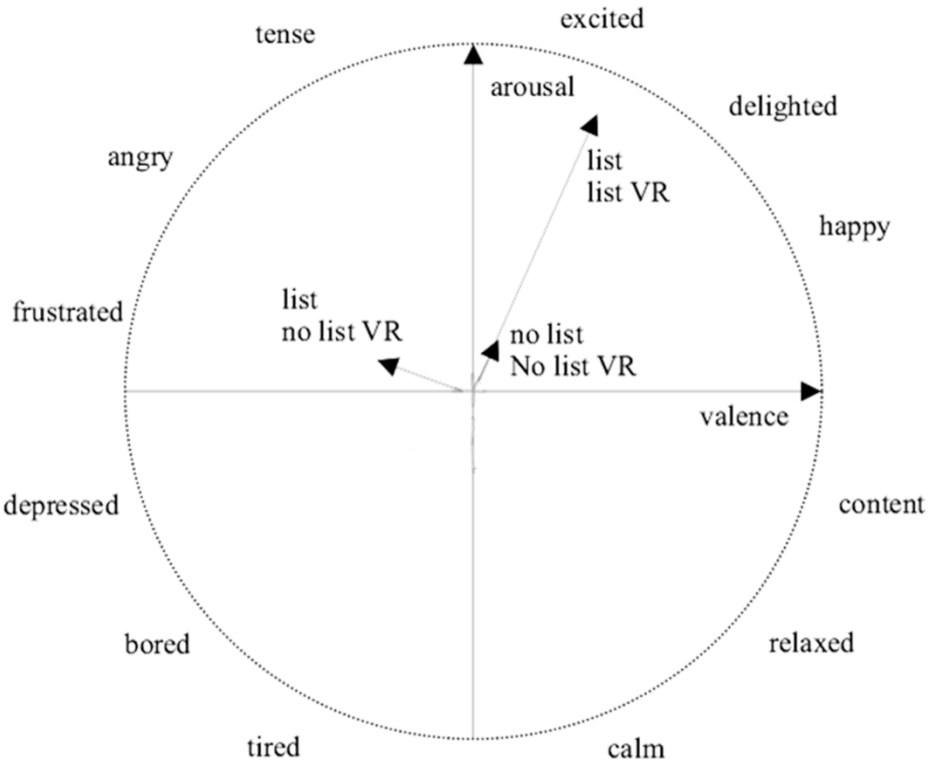

Figure 7. Emotional states for the four examined groups of people (emotion distribution according to Building Chinese Affective Resources in Valence-Arousal Di.
[Source: Yu, et al., 2016]

This result demonstrates that the emotions are indirectly dependent on the fulfilment of the shopping list, and that they directly arise from consumers' habits. A person acting rationally does not associate the performance of a regular activity with negative emotions.

DISCUSSION

The research results presented were meant to examine and demonstrate to what degree rational behaviour can determine consumers' behaviour in a shop from the perspective of drawing up the shopping list. Referring to the main and the supporting hypotheses adopted in the study, it can be concluded that the shopping list has a significant impact on consumers' behaviour. As demonstrated by the analyses, the shopping route taken by individuals with the shopping list is substantially shorter than that of the individuals shopping without the list, as it was assumed in hypothesis 1. Such individuals concentrate on the task when moving from point a to b, without paying much attention to the environment. Their focus was solely on comparing products of the same category.

However, it could be noted that the individuals who draw up a shopping list on a regular basis tended to be organized more quickly. In a situation in which they were not required to prepare a list, they still drew it up and got oriented more swiftly while making choices. They

confirmed their model of operation also in post-study interviews. When asked how they chose products, they referred to an objective set in advance: “I imagine that I shop for breakfast, dinner and supper”; “I thought what I wanted to eat for dinner and what products I required to prepare it”; “I was choosing the products that I buy on a daily basis”.

With regard to hypothesis 2, even though each of the participants was in the given store space for the first time, the individuals who were offered the shopping list and who prepared one for their regular shopping crossed the store much faster than the remaining participants. Those groups where highly task-oriented when moving around the store and they were focused on accomplishing the goal set to them, and not on becoming familiar with the space or the offer.

The greatest surprise involved the results of the study concerning hypothesis 3, which demonstrated that there is no explicit relationship between expressing positive and negative emotions by the individuals equipped with the shopping list or those shopping without it. Those people who were moving around the shop without the list were less excited than those with the list. Such behaviour may demonstrate the attitude they have to making a purchase. A goal and a need to accomplish the task provides more positive emotions and excitement than walking aimlessly around the store. It shows that habits strongly determine our emotions.

The results demonstrated substantially that the shopping list may constitute a factor that determines rational consumer behaviour. Since it possesses all the characteristics that affect task-oriented behaviour, bringing a consumer closer to the assumed final result in a quick and efficient manner without unnecessary additional emotions.

The research results presented cover the first group of the experiment conducted, which was selected according to the adopted criteria. Its results provided the basis for the continuation of the research, which is currently being carried out. Expanded conclusions will be presented in further work of the team. The number of studied individuals needs to be expanded in particular, since after dividing the group into four sub-groups, the number of research subjects in the examined sub-groups occurred to be insufficient. For that reason, the conducted research may only be recognized as a pilot study.

For this reason, conducting significance tests was deemed inappropriate by the authors, as with a non-representative group in the subgroups in question, the results would not be fully objective and appropriate.

The study is of great cognitive value from the point of view of the direction of further in-depth research assumed by the team.

CONCLUSIONS

Everyday rush, the need to make quick choices have a big impact on consumer behaviour. Doing shopping could be treated as a way of departing from regular task-oriented approach to that activity. It additionally becomes a category in which decisions are made rationally, and thereby swiftly, schematically, or they are focused on achieving a clearly-defined goal. Such an approach chiefly concerns those people who treat shopping as a regular activity, in which a shopping list enables them to organize and perform the task quickly.

On the other hand, thanks to the application of a formula assuming the shape of a shopping list, those people are less prone to the stimuli addressed to them as part of price

promotions and merchandising activity. Consumers make decisions in a manner that is better thought out, and thus rational. Yet, it needs to be pointed out that there are individuals who use the shopping list in an irrational fashion, which manifests itself in substantial distances they cover in a store. Although their shopping decisions may be rational, the order in which they look for products is most likely irrational. Their behaviour ought to become the subject of a separate study.

Decision-making is directly related to goal accomplishment. Rationality requires a consumer to possess the skill of seeking alternative solutions without experiencing negative emotions that may accompany it. Therefore, as the study showed, frustration is the effect of the inability to follow a known or adopted method of operation. Having a shopping list enables task-oriented shopping, which may involve substitution scenarios. Furthermore, it is worth noting the emotions, shopping duration, and rationality from the standpoint of visual merchandising. Thanks to the distinct marking of given products and their unchanging arrangement, a customer who would seem to be less valuable from an economic standpoint, may become more loyal. Thanks to the familiarity with the arrangement of products on the shelves, such customer is more willing to return and speak positively about their store. This sphere constitutes one of the topics analysed by the authors in further research. The presented reflections and directions for further activities are based on the current observations expressed by the study participants during their in-depth interviews. That material will be the subject matter of subsequent papers.

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