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Exploring Eye-Tracking and Face-Reading Indicators of Compulsive Buying Tendencies in Advertising Leaflet Processing

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Abstract

The emergence of the multi-cloud computing environments has rapidly increased the attack surfaces of organizations, and it has created dynamic and complex cyber risk exposures that cannot be effectively captured under the traditional qualitative security assessment framework. It is suggested that this study will provide new business analytics-based model to quantify exposure to cloud cyber risks and optimize the security posture of multi-clouds based on data-driven decision-making. The study incorporates heterogeneous cloud security telemetry, such as configuration states, identity and access management (IAM) indicators, vulnerability severity scores, and threat intelligence feeds as input into a quantitative risk assessment model. The model analyzes the exposure of risks in distributed cloud infrastructures, through the use of probabilistic modeling and weighted risk scoring methods, and produces comparative risk indexes of various cloud service providers. Empirical testing, using aggregated data on publicly available cloud security benchmarking and industry threat reports, shows that the suggested model provides a significant increase in risk visibility and accuracy of risk prioritization. The analysis of the simulation shows that the exposure to high-risk misconfigurations and vulnerability is significantly reduced when organizations embrace analytics-based optimization strategies, and the level of reduction of risks is more than 30 percent in conditions of limited resources allocation. Moreover, predictive analytics allows detecting new trends of threats early, promoting more effective spending on cybersecurity. The key contribution of the study is that it will fill the gap between cybersecurity risk assessment and business analytics by proposing a scalable, quantitative framework specific to multi-cloud settings. The results give practical information to an enterprise decision-maker and allow managing security posture optimization based on organizational risk tolerance and operational limits. The study contributes to theoretical and practical insights into the quantification of cloud cyber risk, providing a solid base in future progress of cloud security governance through adaptive and intelligence-based approaches.

Keywords: Cloud Cyber Risk, Multi-Cloud Security, Risk Quantification, Business Analytics, Security Posture Optimization

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1. Introduction

Compulsive buying behavior (CBB) is generally understood as a maladaptive and repetitive pattern of purchasing characterized by impaired self-control, excessive preoccupation with shopping, and negative psychological, social, or financial consequences. Contemporary literature increasingly uses the term *compulsive buying-shopping disorder* and emphasizes that this behavior involves the interaction of affective, cognitive, and executive-control processes rather than only frequent shopping (Thomas et al., 2023). In this perspective, CBB is closely linked to emotion regulation, impulsive decision-making, craving-like responses, and difficulties in inhibiting purchase-related impulses (Müller et al., 2023; Thomas et al., 2023). A substantial body of consumer research identifies materialism as one of the key psychological antecedents of compulsive buying. Recent empirical studies confirm that materialistic values are positively related to compulsive buying tendencies and that this association may be explained through lower self-control, anxiety, psychological discomfort, and the use of consumption as a compensatory mechanism (Jain et al., 2024; Štefko et al., 2025; Tantawi, 2023). Although CBB is most often measured through self-report scales, questionnaire data may not fully capture automatic attentional and emotional reactions to marketing stimuli. Recent research therefore calls for the use of behavioral and psychophysiological methods that can complement self-reported measures and provide insight into real-time consumer processing. Eye-tracking is particularly useful because it captures visual attention to specific areas of interest, such as product images, prices, discount labels, brand names, text descriptions, or country-of-origin cues (Li et al., 2024; Motoki et al., 2021; Wedel & Pieters, 2008).

Eye-tracking indicators such as time to first fixation, fixation count, and dwell time can reveal which advertising elements attract early, repeated, or sustained attention. In the context of advertising leaflets, this is important because consumers are exposed to several competing cues at the same time: product visuals, price, discount information, text, brand/name, and origin information. Recent eye-tracking studies in online shopping and advertising show that product images, textual elements, brand-related cues, and price information can significantly shape consumer visual attention and purchase-related processing (Li et al., 2024; Peker et al., 2021). For consumers with stronger CBB tendencies, product and promotional cues may be especially relevant. Promotional stimuli such as discounts, "limited offer" messages, or visually salient price reductions can reduce perceived purchase risk, increase perceived opportunity, and support faster, less controlled decision-making. In compulsive buying, such cues may act as emotional or situational triggers by increasing arousal and supporting the perception that the purchase is justified or beneficial (Jain et al., 2024; Thomas et al., 2023). Therefore, attention to product images, prices, and discount symbols may represent meaningful behavioral indicators of CBB-related processing.

Face-reading, or automated facial expression analysis, provides a complementary perspective because it captures affective responses during exposure to advertising stimuli. Whereas eye-tracking shows where respondents look, face-reading can indicate how they emotionally react to the stimulus through indicators such as engagement, valence, joy, confusion, or other facial-expression-based metrics. Höfling and Alpers (2023) found that automatic facial coding can predict self-reported emotional responses and advertisement-related effects, suggesting that this method may be useful in marketing research when interpreted cautiously and combined with other data sources. Combining eye-tracking and face-reading is especially useful for studying advertising leaflet processing because leaflets contain both informational and emotional cues. Product images may activate desire and approach motivation, prices and discounts may activate affordability evaluations, text descriptions may support cognitive elaboration, and country-of-origin cues may activate identity-based or ethnocentric evaluations. A multimethod approach can therefore show whether consumers with stronger CBB tendencies process leaflets more through immediate product and promotional cues than through reflective informational cues (Höfling & Alpers, 2023; Li et al., 2024; Motoki et al., 2021).

The present study therefore explores whether eye-tracking and face-reading indicators can differentiate consumers with higher and lower compulsive buying tendencies during advertising leaflet processing. The study does not treat neuro-behavioral measures as a replacement for validated CBB questionnaires, but as complementary indicators of real-time attentional and affective processing. This approach responds to recent calls for broader methodological perspectives in compulsive buying and consumer behavior research and

may help identify observable patterns associated with higher CBB risk (Müller et al., 2023; Thomas et al., 2023). The study used an exploratory experimental design combining questionnaire data with eye-tracking and automated facial expression analysis. The methodology was designed to answer the following research question:

What eye-tracking and face-reading indicators differentiate respondents with higher and lower tendencies toward compulsive buying when processing advertising leaflets?

The main purpose of the study was not to diagnose compulsive buying directly from biometric data, but to identify whether respondents with higher and lower compulsive buying tendencies differ in their visual attention and emotional responses to specific elements of advertising leaflets. Therefore, the study combined self-report measurement of compulsive buying with neuro-behavioural indicators recorded during exposure to advertising stimuli.

2 Materials and Methods

2.1 Participants and data collection

Data were collected through an online panel administered by the research agency NMS. Respondents were recruited using quota sampling in order to approximate the structure of the adult Slovak population according to selected socio-demographic characteristics, including gender, age, region, education and economic status. The final questionnaire dataset included 177 respondents. The dataset contained responses to three short questionnaires and socio-demographic variables, including gender, age, region, education and economic activity.

Respondents received an individual link to the experimental environment created in the iMotions platform. After opening the link, they were informed about the study, provided consent, completed the leaflet-viewing task and subsequently filled in the questionnaire. The measurement was conducted remotely using respondents' own computers or laptops equipped with a webcam.

2.2 Advertising stimuli

The experimental stimuli consisted of a set of advertising leaflets designed to simulate real retail promotional materials. The stimuli were created as standardized visual materials containing comparable structural elements.

The leaflets included the following components:

- product image,
- product name,
- product description,
- price,
- discount or promotional symbol,
- country-of-origin information.

These components were defined as areas of interest (AOIs) for the analysis of visual attention and emotional responses.

The study focused on whether respondents with higher and lower compulsive buying tendencies differed in their reactions to these AOIs.

2.3 Measurement of compulsive buying tendencies

Compulsive buying tendency was measured using the Compulsive Buying Scale / Clinical Screener for Compulsive Buying developed by Faber and O'Guinn (1992). The original instrument consists of seven items assessing problematic buying behaviours, emotional tension related to shopping, and financial consequences of buying. In the present study, six items were used, with one original item concerning writing checks omitted due to its limited relevance in the Slovak payment context. Respondents evaluated the items on a 7-point Likert scale, where higher values represented a stronger tendency toward compulsive buying.

For each respondent, a mean CBB score was calculated from the six items. This score was then used to divide respondents into groups with lower and higher compulsive buying tendencies. The grouping made it possible to compare how these two segments differed in eye-tracking and face-reading indicators during leaflet processing.

2.4 Eye-tracking indicators

Eye-tracking was used to capture visual attention to the predefined AOIs. The analysis focused on three main indicators:

Time to First Fixation (TTFF) measured how quickly a respondent first looked at a given AOI. A shorter TTFF indicates faster visual orientation toward the element.

Fixation Count - measured how many times a respondent fixated on a given AOI. A higher number of fixations indicates repeated visual attention. *Fixation dwell time* measured the total time spent looking at a given AOI. Longer dwell time indicates more sustained visual processing.

In relation to the research question, these indicators were used to identify whether respondents with higher CBB tendencies oriented faster toward product images, price or discount cues, and whether they paid less attention to more informational elements such as country-of-origin information or product descriptions.

2.5 Face-reading indicators

Automated facial expression analysis was used to capture emotional and engagement-related responses during leaflet processing. The analysis included the following indicators: engagement, adaptive engagement, valence, adaptive valence, joy, sadness, anger, fear, surprise,

confusion and neutrality.

These indicators were analysed in relation to the same AOIs as in the eye-tracking analysis. The aim was to determine whether respondents with higher and lower CBB tendencies differed not only in where they looked, but also in how they emotionally reacted to leaflet elements.

Special attention was paid to price and discount elements, since promotional cues may function as emotional triggers in compulsive or impulsive buying. The interpretation followed the assumption that discounts may increase arousal, positive affect and the perceived attractiveness of the offer.

2.6 Data preparation

The questionnaire dataset was merged with eye-tracking and face-reading outputs using respondent identifiers. For each respondent, the following variables were prepared:

- mean CBB score,
- eye-tracking indicators for each AOI,
- face-reading indicators for each AOI,
- socio-demographic variables.

Respondents were divided into groups with lower and higher CBB tendencies based on their CBB score. Subsequently, eye-tracking and face-reading indicators were compared between these groups. The analysis focused on identifying a neuro-behavioural profile associated with higher CBB tendencies. The expected profile included faster orientation toward product-related cues, stronger reactions to price or discount elements, and weaker attention to more reflective informational cues such as country-of-origin information.

2.7 Statistical analysis

The analysis was conducted in several steps. First, descriptive statistics were calculated for the CBB scale and for all eye-tracking and face-reading indicators. Second, respondents with lower and higher CBB tendencies were compared in terms of visual attention to each AOI. The comparison included TTFF, fixation count and fixation dwell time. Third, face-reading indicators were compared between the lower-CBB and higher-CBB groups. The analysis focused especially on engagement, valence and joy, since these variables are relevant for identifying emotional responses to advertising stimuli. Fourth, regression models were used to examine whether CBB score was associated with selected neuro-behavioural indicators. The main predictors included eye-tracking and face-reading measures related to the product image, price, discount symbol and country-of-origin cue.

The most relevant indicators for differentiating respondents with higher and lower CBB tendencies were:

- TTFF on the product image,
- fixation dwell time on the country-of-origin cue,
- engagement related to the country-of-origin cue,
- TTFF on the country-of-origin cue,
- fixation count on the product name,
- valence related to the discount symbol.

These indicators were interpreted as potential components of a neuro-behavioural profile associated with compulsive buying tendencies.

2.8 Ethical considerations

Participation in the study was voluntary. Respondents were informed about the purpose of the study and the nature of the measurement. Data were processed anonymously and used only for research purposes. Since the experiment was conducted remotely, respondents participated in their natural environment using their own device and webcam.

3 Results

3.1 Eye-tracking indicators differentiating lower- and higher-CBB respondents

The most relevant eye-tracking difference between respondents with lower and higher CBB tendencies was found in the time to first fixation on the product image. Respondents with higher CBB tendencies oriented visually toward the product image more quickly than respondents with lower CBB tendencies:

$$\beta = -0.162,\ p = .038$$

This result indicates that the product image functioned as an early visual trigger among respondents with stronger compulsive buying tendencies. The negative beta coefficient means that higher CBB was associated with shorter time to first fixation. In practical terms, respondents with higher CBB tendencies looked at the product sooner.

A second relevant pattern was found in relation to the country-of-origin cue. Respondents with higher CBB tendencies tended to process this information less intensively. The direction of the results showed lower dwell time, lower engagement, and later visual orientation toward the country-of-origin cue among higher-CBB respondents. This suggests that respondents with stronger compulsive buying tendencies were less focused on reflective or identity-related product information and more oriented toward the immediate product stimulus.

A weaker trend was also identified for the product name. Respondents with higher CBB tendencies showed a tendency toward more repeated fixations on the product name: $\beta = .138,\ p = .075$

Although this result did not reach the conventional level of statistical significance, it suggests that product identity or product label may play a secondary role in differentiating higher- and lower-CBB respondents.

Overall, the eye-tracking results indicate that higher CBB tendencies are associated primarily with faster attentional orientation toward the product image, and secondarily with weaker processing of country-of-origin information.

3.2 Face-reading indicators differentiating lower- and higher-CBB respondents

Face-reading indicators showed weaker differentiation between respondents with lower and higher CBB tendencies than eye-tracking indicators. Overall, facial responses to advertising leaflets were predominantly neutral, which suggests that the stimuli were processed mainly cognitively rather than through strong emotional expression.

The most relevant face-reading pattern appeared in relation to the discount symbol. Discount cues produced relatively higher joy and engagement compared with several other leaflet elements. This is consistent with the theoretical assumption that discounts and promotional elements may function as emotional triggers in impulsive or compulsive buying contexts, increasing activation and perceived attractiveness of the offer.

However, the direct association between CBB score and emotional response to the discount symbol was weak: $r = .093,\ p = .221$

This means that the discount symbol was emotionally relevant in general, but it did not clearly differentiate higher-CBB respondents from lower-CBB respondents on its own.

The country-of-origin cue also showed a relevant face-reading pattern. Respondents with higher CBB tendencies demonstrated lower engagement when processing this cue. Together with the eye-tracking results, this supports the interpretation that country-of-origin information was less salient for respondents with stronger compulsive buying tendencies.

3.3 Exploratory neuro-behavioural profile of higher CBB tendencies

Based on the combined eye-tracking and face-reading results, the neuro-behavioural profile associated with higher CBB tendencies can be summarized as follows in

Table 1 Neuro-behavioural profile

Indicator	Pattern associated with higher CBB
TTFF on product image	shorter / faster first fixation
Dwell time on country-of-origin cue	lower
Engagement with country-of-origin cue	lower
TTFF on country-of-origin cue	longer / later fixation
Fixation count on product name	slightly higher
Valence toward discount symbol	slightly more favourable, but weak

The strongest differentiating indicator was faster visual orientation toward the product image. Face-reading indicators were less powerful, but they supported the interpretation that higher-CBB respondents were less engaged with country-of-origin information and only weakly more responsive to promotional cues. Respondents with higher and lower tendencies toward compulsive buying were differentiated mainly by eye-tracking indicators, especially by how quickly they oriented toward the product image. Higher CBB tendencies were associated with faster first fixation on the product image, suggesting that the product visual may serve as an early attentional trigger. Additional, weaker indicators showed reduced processing of the country-of-origin cue and slightly greater repeated attention to the product name. Face-reading indicators provided weaker differentiation. Discount symbols generated relatively higher joy and engagement overall, but emotional responses to discounts did not significantly distinguish higher-CBB from lower-CBB respondents. Therefore, the results suggest that CBB tendencies are reflected more clearly in visual-attentional processing than in strong facial-emotional reactions during advertising leaflet processing.

4 Discussion

The aim of this study was to examine which eye-tracking and face-reading indicators differentiate respondents with higher and lower tendencies toward compulsive buying when processing advertising leaflets. The results suggest that compulsive buying tendencies were reflected primarily in visual-attentional processing rather than in strong facial-emotional reactions. The clearest differentiating indicator was shorter time to first fixation on the product image among respondents with higher CBB scores. This finding indicates that product visuals may function as early attentional cues for consumers with stronger compulsive buying tendencies.

This result is consistent with theoretical approaches that describe compulsive buying-shopping disorder as a behavior associated with cue reactivity, craving-like responses, impaired self-control and sensitivity to purchase-related stimuli (Müller et al., 2023; Thomas et al., 2023). In the context of advertising leaflets, the product image represents one of the most immediate and visually salient elements. Faster orientation toward this element may therefore indicate that respondents with stronger CBB tendencies are more rapidly drawn to product-related cues before more reflective evaluation takes place. Similar conclusions can be found in eye-tracking research, which shows that visual product elements play an important role in consumer attention and decision-making in shopping and advertising contexts (Li et al., 2024; Motoki et al., 2021; Peker et al., 2021).

A second relevant pattern concerned the weaker processing of country-of-origin information among

respondents with higher compulsive buying tendencies. These respondents showed later orientation toward this cue, lower dwell time and lower engagement. Although these effects should be interpreted cautiously, they suggest that higher-CBB respondents may give less attention to more reflective or informational product attributes. Country-of-origin information usually requires a more evaluative type of processing, as it may be linked to quality perception, identity, trust, or ethnocentric attitudes. In contrast, respondents with stronger CBB tendencies appeared to be more oriented toward immediate product-related cues. This interpretation is in line with the view that compulsive buying is associated with reduced cognitive control and a stronger influence of situational triggers (Thomas et al., 2023).

The results for the product name were weaker, but they may still be theoretically meaningful. Respondents with higher CBB tendencies showed a slight tendency toward more repeated fixations on the product name. This may indicate that product identity, label or brand-like information can contribute to the processing of purchase-related stimuli. However, because this effect was weaker and did not clearly reach conventional levels of statistical significance, it should be understood as an exploratory pattern rather than a robust differentiating marker.

Face-reading indicators differentiated respondents with higher and lower CBB tendencies less clearly than eye-tracking indicators. Facial responses to the advertising leaflets were predominantly neutral, which suggests that the stimuli may have been processed mainly at a cognitive or attentional level rather than through visible emotional expression. This finding is consistent with methodological literature indicating that automated facial coding can be useful in advertising research, but its results should be interpreted cautiously and preferably in combination with other measures (Höfling & Alpers, 2023). The weaker performance of face-reading indicators may also be related to the static nature of the stimuli. Advertising leaflets are less emotionally dynamic than videos, interactive online stores or real purchase situations, and therefore may produce less visible facial affect.

The discount symbol produced relatively higher joy and engagement overall, which supports the assumption that promotional cues can increase the attractiveness of an offer. However, emotional responses to the discount symbol did not clearly distinguish respondents with higher CBB tendencies from those with lower CBB tendencies. This suggests that discounts may be generally appealing to consumers, but they are not sufficient on their own to identify compulsive buying tendencies. Compulsive buying should therefore not be interpreted as a simple reaction to one isolated marketing cue, but rather as the result of an interaction between individual vulnerability, emotional regulation, self-control and situational purchase triggers (Jain et al., 2024; Müller et al., 2023; Thomas et al., 2023). Compared with studies based only on self-report questionnaires, the present study contributes by adding a process-oriented perspective. Questionnaire measures can identify the intensity of compulsive buying tendencies, but eye-tracking can show how these tendencies are reflected during real-time exposure to marketing stimuli. The findings suggest that higher-CBB respondents may not necessarily show strong observable emotional reactions, but they may differ in how quickly and selectively they allocate visual attention. In this sense, eye-tracking appears to be more sensitive than face-reading for detecting subtle differences in advertising leaflet processing.

The study also has several limitations. First, the analysis was exploratory and the identified indicators should not be interpreted as diagnostic markers of compulsive buying. Second, the use of remote measurement may have introduced variability in screen size, lighting conditions, webcam quality and respondents' viewing environments. Third, the static character of advertising leaflets may have limited the intensity of emotional responses captured by face-reading. Fourth, the division of respondents into higher- and lower-CBB groups may reduce the variability of the original CBB score and should therefore be complemented in future research by regression-based or continuous analyses. Finally, future studies should test these patterns in larger samples and in more dynamic shopping environments, such as online stores, purchase simulations or experimental situations involving stronger promotional cues. Overall, the findings suggest that compulsive buying tendencies are expressed less through visible facial-emotional reactions and more through subtle shifts in visual attention. The strongest pattern was faster orientation toward the product image among respondents with higher CBB tendencies, while weaker processing of country-of-origin information formed a secondary pattern. Eye-tracking and face-reading should therefore be viewed as complementary exploratory tools that can enrich

questionnaire-based research on compulsive buying, but not replace validated psychometric measures.

5 Conclusion

This study examined which eye-tracking and face-reading indicators differentiate respondents with higher and lower tendencies toward compulsive buying during advertising leaflet processing. The findings show that CBB tendencies were reflected mainly in visual-attentional patterns, especially in faster orientation toward the product image. Respondents with higher CBB tendencies looked at the product image sooner, suggesting that product visuals may act as early attentional triggers. In contrast, face-reading indicators differentiated the groups only weakly, as facial responses were mostly neutral. A secondary pattern showed that higher-CBB respondents paid less attention to country-of-origin information, indicating weaker processing of more reflective informational cues. The study contributes to consumer behavior and neuromarketing research by showing that eye-tracking and face-reading can complement questionnaire measures of compulsive buying. However, these indicators should not be interpreted as diagnostic tools, but rather as exploratory measures of real-time advertising processing. Future research should verify these findings in larger samples and in more dynamic shopping environments, such as online stores or purchase simulations. Overall, the results suggest that compulsive buying tendencies are expressed less through strong emotional reactions and more through subtle shifts in attention toward product-related stimuli.

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