ENHANCING USER EXPERIENCE IN RECREATIONAL HUNTING: A NEUROMARKETING APPROACH

Elisabetta Savelli
Carlo Bo University of Urbino, Italy

Vincenzo Gissi
Carlo Bo University of Urbino, Italy

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Abstract

This exploratory study investigates recreational hunting as an experiential practice by examining hunters' unconscious perceptions and emotional responses during interaction with a core piece of equipment: the rifle. While previous research has mainly examined the affective and social dimensions of hunting, little is known about how technical equipment influences user experience (UX) and long-term engagement and participation, making an exploratory approach especially appropriate. Adopting a neuroscientific approach, the research combines eye-tracking and electroencephalography to capture objective measures of attention, engagement, and cognitive load. Eighteen young hunters from the Italian central Apennines participated in two experimental steps. Firstly, eye-tracking and electroencephalography were used simultaneously to assess responses to the rifle's technical components (stock, bolt, trigger, forestock, grip, and barrel). Secondly, electroencephalography monitored cognitive and emotional reactions during four key-moments of hunter–rifle interaction: visual inspection, touch, embracing and preparing for shooting, and shooting and reloading. Tests were repeated with and without visible branding to evaluate the influence of brand exposure. Results indicate that hunters focus primarily on the stock, bolt, and forestock, components directly linked to safety and shooting accuracy. Tactile interaction proved particularly relevant, as handling the rifle elicited higher engagement despite increased cognitive effort. Branding also influenced responses generating stronger engagement and lower cognitive load, especially during the visual phase. Both theoretical and practical implications emerge from the study. Overall, the research provides initial evidence on how optimizing rifle-related UX may foster satisfaction, attract younger generations, and support the revival of recreational hunting, while also generating new hypotheses for future confirmatory research.

Keywords: Customer experience; Recreational hunting; Neuroscience; Electroencephalography (EEG); Eye-tracking (ET); Neuromarketing.

1. Introduction

Over the time, customer experience has become increasingly complex, encompassing hedonic, social, and pragmatic dimensions, and consequently requiring sophisticated strategies to ensure both safety and engagement in user interactions (Bascur and Rusu, 2020; Chi et al., 2024; Shamim et al., 2024). Research on this topic remains timely and calls for the growing adoption of neuroscientific methods to better capture implicit emotional processes beyond conscious awareness (Iorga and Sapatnekar, 2022; Lajante and Ladhari, 2019). Neuroscience, indeed, can help to identify and interpret the role of physiological responses in consumer research, offering valuable insights into emotional states.

While these methods have been increasingly applied in different contexts, including fashion (Jang, 2023), coffee stores (Rancati et al., 2024), and retail environments (Khatri et al., 2022), further exploration is needed (Iorga and Sapatnekar, 2022; Lajante and Ladhari, 2019), particularly in underexplored domains such as recreational hunting and firearms—a sector that is simultaneously promoted for its contributions to biodiversity conservation and rural livelihoods and increasingly scrutinized on ethical grounds (Di Minin et al., 2021). Research on hunting experience is relatively sparse, often focusing on specific aspects (e.g., leases: Lundhede et al., 2015), contexts (e.g., big game trophy: Angula et al., 2018), and industry settings (e.g., tourism: Komppula and Gartner, 2013). Yet, more knowledge is advisable since the sustainability of hunting is even more dependent on the quality of hunter experience (Van Der Merwe and Saayman, 2015). Moreover, past studies mainly emphasized the affective dimension of experience, linked to participation and connection with the natural environment, whereas tangible elements shaping the experience itself remain underexplored. Addressing this gap, through an exploratory research design, is therefore warranted in this context to help companies in designing products and services that provide hunters with memorable and rewarding experiences (Di Minin et al., 2021).

By adopting a neuroscientific approach, based on eye-tracking (ET) and electroencephalography (EEG), this study analyzes unconscious perceptions and emotional responses in the context of a hunting rifle purchase. The focus is on identifying rifle components generating stronger visual appeal and cognitive involvement, as well as the role of branding and physical contact in key-moments of interaction.

Specifically, the research objective is to explore how rifles, as essential hunting equipment (Dobson et al., 2019; Peterson, 2011; Uhl and Peterson, 2018), influence hunter experience and how companies in the arms sector can manage their product strategies to enhance satisfaction and attract recreational hunters. Two research questions operationalize the above objectives:

RQ1. *Which components and technical features of the rifle most affect hunters' attention, cognitive workload, and engagement, thus impacting their user experience?*

RQ2. *How do hunters currently behave when evaluating and interacting with the rifle?*

ET and EEG measure visual attention, cognitive load, and engagement (Guo et al., 2016), directly reflecting user experience (UX), defined as the "perceptions and responses that result from the use and/or anticipated use of a system, product or service" (ISO 9241-210, 2019). UX is a well-established predictor of behavioural outcomes, such as purchase intention (Moradi et al., 2017), and is increasingly regarded as a core component of the broader human experience (Lee et al., 2018). Investigating hunters' UX with rifles may thus reveal predictors of the overall hunting experience and potential shifts in attitudes and behaviours.

This research contributes to bridging neuroscience and hunting studies, where neuroscientific methods have rarely been applied.

Specifically, it can be framed as an experiment in economic psychology that challenges the hypothesis of economic rationality by investigating the socio-psychological determinants of individual behaviour in a high-involvement consumption context (Bălău, 2018; Musso, 2024). By focusing on unconscious attention, engagement, and cognitive load, the analysis explicitly moves beyond purely deliberative models of choice. It also provides practical implications for arms companies by offering deeper insights into hunters' preferences, supporting product development that enhances satisfaction and renews interest in recreational hunting (Lundhede et al., 2015).

The rest of the paper is organized as follows. After analysing the theoretical background (Section 2), Section 3 depicts the methodology and Section 4 describes the research findings. Section 5 outlines theoretical and managerial implications, while Section 6 concludes with limitations and future research directions.

2. Theoretical Background

2.1 Recreational Hunting and the Value of Experience

During the 20th century, debates over the morality and legitimacy of hunting contributed to declining hunter numbers and weak recruitment (Fischer et al., 2013; Hearn et al., 2014; Lovelock et al., 2022; Loveridge et al., 2007). At the same time, recreational hunting expanded, especially in Western countries (Hearn et al., 2014), driven by demographic change and situational constraints (Campbell and Mackay, 2009; Cooper et al., 2015), and further motivated by social interaction, immersion in nature, and the challenge of the pursuit. While ethical concerns remain (Di Minin et al., 2021; Fisher et al., 2013), recreation-based arguments are generally more accepted, since they emphasize nature immersion, animal encounters, and the thrill of the pursuit, rather than meat acquisition (Marvin, 2006).

By focusing on recreational motives, scholars and practitioners acknowledged hunting as an experiential activity that offers sensory, emotional, and relational value (Van der Merwe and Saayman, 2015), resulting in increasing personal well-being, satisfaction, and engagement with the activity (Leader-Williams, 2009; Lundhede et al., 2015; Matejevic et al., 2022). Hence, experience becomes crucial for the hunting and firearms industry to attract new hunters and revitalize the whole sector (Lundhede et al., 2015).

Despite this relevance, research on hunting experience is fragmented and often context-specific. Lundhede et al. (2015) highlighted the multifaceted nature of hunting experience depending on multiple factors such as the size and location of the hunting area, the game harvested, landscape features, and social interactions - which also influence the price of a hunting lease. Other scholars examined hunting in specific contexts, such as big game trophy, where tourists pursue rare or exotic animals to obtain trophies like horns, tusks, or skins (Angula et al., 2018). A substantial body of literature has linked hunting to travel motivations, giving rise to the concept of hunting tourism, emphasizing the overlap between hunting practices and tourism experiences (Fisher et al., 2013; Komppula and Gartner, 2013).

However, the results of these studies are often inconclusive. Particularly, the research on potential antecedents of hunting experience still lacks decisive evidence, revealing the existence of several factors, including hunters' characteristics, wildlife attributes, encounters with species, natural settings, and hunting equipment (Hautaluoma and Brown, 1978; Komppula and Gartner, 2013; Van der Merwe and Saayman 2015; Woods and Kerr, 2010). The critical role of social and affective aspects of hunting has been often prioritized (Cohen, 2014; Lundhede et al., 2015; Van Der Merwe and Saayman, 2015), while less studies investigated the practice dimension of hunting experience, namely UX with technical equipment. In their pioneering study, Hautaluoma and Brown (1978) found that high-quality equipment enhances hunting experience, but later evidence is mixed, partly due to differences in hunter specialization. Some studies suggest novices pay little attention to equipment (Miller and Graefe, 2000), whereas others show that equipment choice affects experience regardless of specialization (Needham et al., 2007; Scott et al., 2005). This inconsistency highlights the need for further research (Lee et al., 2018; Moradi et al., 2017). Analysing UX may offer a comprehensive view of the overall hunter experience, beyond demographic, environmental, or situational factors. Moreover, despite measuring UX is not a straightforward process, it implies a comprehensive user-centric approach (Lee et al., 2018) that is critical for understanding users' perception of a product or service and to convince them along the path-to-purchase.

2.2 Measuring UX through Neuromarketing Tools

UX is a multi-dimensional concept embodying a set of user's emotions around the product. By considering the temporal dimension of UX, Zimmerman (2009) identified three distinct stages: a sensory phase during initial product exposure; an interaction phase involving active user engagement; and an evaluation phase occurring after the interaction or during pauses in the engagement process. The current definition of UX provided by ISO 9241-210:2019 (International Organization for Standardization, 2019) characterizes it as an individual's perceptions and responses arising from the actual or anticipated use of a product, system, or service. This definition encompasses a broad range of factors, including users' emotions, beliefs, preferences, perceptions, physical and psychological responses, thereby underscoring the inherently multifaceted nature of UX.

Despite extensive theoretical work, UX measurement remains underexplored (Aslam, 2023) highlighting the need for multidisciplinary approaches (Benoit et al., 2017) and applications across diverse contexts (Lemon and Verhoef, 2016). Neuroscientific methods offer a promising avenue, capturing unconscious, emotional, and dynamic dimensions that complement traditional approaches (Lajante and Ladhari, 2019; Rancati et al., 2024). These methods capture neural activity both within the brain (e.g., electroencephalogram: EEG, and functional magnetic resonance imaging: fMRI), and outside the brain (e.g., galvanic skin response: GSR, eye-tracking: ET, electromyography: EMG, and electrocardiogram: ECG) (Lim, 2018). Among them, ET and EEG have been increasingly validated in UX research for identifying crucial moments of user–product interaction (Bojko, 2013; Guo et al., 2016; Rui and Gu, 2021; Zaki and Islam, 2021).

ET tracks eye movements, providing an objective measure of visual attention and revealing how product appearance guides perception and comparison (Esteban-Bravo and Vidal-Sanz, 2021). Based on the assumption that gaze direction reflects attention and emotional intensity (Bojko, 2013; Guo et al., 2016), ET is particularly relevant as vision is often the dominant sense in product experiences. However, while ET captures observable behaviour and engagement, defined as "a state of being fully absorbed, involved, occupied, or engrossed in something" (Johnston, 2016, p. 272), it does not account for underlying cognitive processes. Engagement also depends on the allocation of mental resources, with deeper cognitive processing reflecting stronger engagement (Goldberg et al., 2021).

EEG complements ET by measuring brain electrical activity, thus capturing both engagement (attention devoted to stimuli) and cognitive load (the ability to process information) (Esteban-Bravo and Vidal-Sanz, 2021). Specifically, high theta activity indicates high cognitive load and low engagement, whereas high alpha activity reflects lower cognitive load and greater engagement. Optimal UX typically emerges when engagement is high and cognitive load is low, corresponding to reduced theta and elevated alpha power (Rui and Gu, 2021).

By combining ET and EEG, researchers can link visual attention with neural activity, offering a comprehensive view of cognitive and emotional processes underlying UX. This integrated approach provides valuable insights for optimizing product design, enhancing satisfaction, and fostering user involvement.

3. Methods and Materials

3.1. Design and Measures

This study explores hunters' interaction with the rifle in order to identify the design features and technical components that most strongly influence engagement and UX. Its overarching aim is to generate insights that can enhance recreational hunting and support firms operating in the hunting equipment industry.

The rifle was selected as the focal object of analysis because it is central to hunting success, more so than other types of equipment (e.g., boots or optics). Appropriate rifle and ammunition use directly improves shooting accuracy and, consequently, hunter satisfaction (Dobson et al., 2019; Peterson, 2011).

The research design comprised two steps, addressing RQ1 and RQ2 respectively.

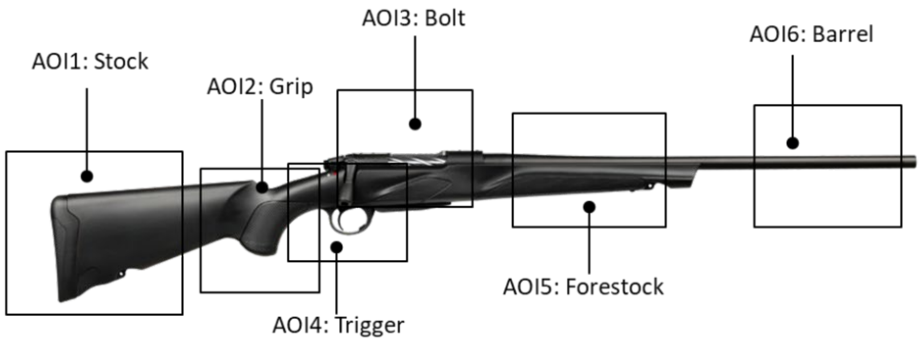
In the first step, ET and EEG were simultaneously employed to assess the UX in relation to the rifle's technical components (e.g., stock, grip, bolt, trigger, forestock, and barrel) (RQ1).

For ET, three metrics were used, namely Fixation Rate (FR), Average Fixation Duration (AFD), and Average First Fixation Duration (AFFD) (Borys and Plechawska-Wójcik, 2017). FR measures the proportion of fixations on a specific Area of Interest (AOI) of the stimulus, with higher values indicating greater interest. AFD reflects the average time spent per fixation on an AOI, with longer durations denoting higher attractiveness.

AFFD measures the time from stimulus onset to the first fixation on an AOI, capturing its saliency and attraction power; higher values suggest greater cognitive effort in processing the AOI.

EEG was applied in parallel to ET to examine how rifle features influence cognitive load and engagement. The rifle's main components (i.e., stock, grip, bolt, trigger, forestock, and barrel) were designated as AOIs (Figure 1), represented by geometric shapes. From these areas, the study extracted metrics related to visual attention, engagement, and cognitive load.

Figure 1 – Areas of Interest (AOI) for ET and EEG measurements



EEG has been also applied in the second step of the study, addressing RQ2, to examine UX during key-moments of interaction with the rifle (i.e., visual, touch, embracing and preparing for shooting, and shooting and reloading). These activities engage multiple senses and elicit different emotional responses, thereby providing a more detailed understanding of UX than treating it as a single, unified process. Brainwave frequencies were recorded in Hertz (Hz) and automatically converted to a 0–100 scale (with values around 40–60 commonly interpreted as 'neutral/baseline') using the internal algorithm of Cooltool software, which was also applied to process ET data. The exact procedure used to determine the baseline and map raw signals onto the 1–100 scale is proprietary, as specified by the software provider; therefore, in this study we report and analyse these indices as provided by the technical system.

3.2. Participants

Eighteen participants voluntarily took part in the study. Consistent with the exploratory nature of the research, the aim of this sample was not statistical representativeness but the in-depth observation of cognitive and emotional patterns in a controlled setting. However, the sample size was consistent with most neuroscience-based research, typically involving 20–30 individuals due to the costs and complexity of experiments (Plassman et al., 2015; Solnais et al., 2013).

The study focused on young adults aged 20–35 for multiple reasons. First, young people are prominent in many domains and their behaviour requires continuous exploration (Muniady et al., 2014; Valentine and Powers, 2013). Second, their relationship with hunting equipment is contradictory: while they often have low specialization and limited financial means, they also demonstrate strong attention to equipment (Needham et al., 2007). Moreover, younger groups generally express less positive attitudes toward hunting than older ones (Gamborg and Jensen, 2017), making their involvement essential for reviving participation. Lastly, young people tend to value the emotional and sensory benefits of consumption more strongly than older cohorts (Barrena and Sanchez, 2009; Kocak and Ruzgar, 2017), suggesting that enhancing UX could significantly improve their engagement with recreational hunting.

Participants were recruited from the Italian central Apennines, an area where wild boar hunting is widely practiced (Maiorano et al., 2015; Scillitani et al., 2010). To ensure baseline familiarity with hunting, only individuals with at least one prior hunting experience were included. At the selection stage, they reported their annual hunting frequency using a seven-point Likert scale (1 = never; 7 = every time). Since the frequency of hunting practice may not be necessarily indicative of expertise/specialization, participants were also asked to assess their perceived hunting competence on a scale adapted from Tafarodi and Swann Jr (1995).

Although the participants were not completely new to the hunting practice, results showed low levels of practice and modest perceived expertise: most participants hunted rarely or occasionally, with 11 respondents disagreeing or somewhat disagreeing with the competence statement, 5 neutral, and only 2 agreeing. This reflects broader patterns of weak recruitment and retention among young hunters (Adams et al., 2004; Lovelock et al., 2022), while underscoring the importance of exploring their motivations.

After the tests, the participants received a gift-pack containing local foods and wines, as a reward for their contribution.

3.3. Instruments and Data Collection

For the first experimental step, three versions of a top-brand bolt-action rifle (black-barrel, white-barrel, and bi-colour) were used. Bolt-action rifles, commonly employed in ungulate hunting such as wild boar, are valued for their lightness and shooting accuracy. Participants compared the rifles to detect perceptual differences in design and to assess which technical features most influenced unconscious evaluations. Stimuli were displayed on a 23” HD monitor (1920×1080 resolution) connected to an Eye Tribe eye-tracker, with participants seated 60–70 cm away. Each rifle image was presented for 15 seconds, followed by a 5-second neutral background, with the order randomized. The eye-tracker was re-calibrated before each trial to ensure accuracy.

During ET, participants simultaneously underwent EEG recording via a one-channel wireless headset (MindWave Mobile 2, NeuroSky), equipped with three dry electrodes: two on an ear clip (reference and ground) and one on the forehead above the eye. The device digitized and amplified brain signals, transmitting data via Bluetooth for processing. EEG outputs indicated engagement and cognitive load values on a 0–100 scale. The combined ET–EEG setup enabled evaluation of UX during exposure to rifle features and appearance.

EEG alone was also used to analyze UX across four key interaction moments: visual inspection, touch, embracing and preparing for shooting, and shooting and reloading. The ‘shooting and reloading’ phase was conducted as a standardized laboratory simulation (dry-run), with no live ammunition and no discharge, aimed at reproducing the motor and procedural sequence of aiming, dry-trigger action, and reloading gestures under controlled conditions. A neutral black-barrel bolt-action rifle, similar to the stimuli in step one, was selected to minimize design bias. Participants interacted with the rifle for 130 seconds, divided into four ~32-second phases corresponding to the above moments. EEG was conducted twice (once with the brand name visible and once masked) to capture the influence of branding, as hedonic aspects such as brand experience are integral to UX (Pencarelli et al., 2013; Van de Sand et al., 2020). Therefore, EEG helped to capture additional differences in brainwave activity associated with individual exposure to the brand.

Each participant's full testing session, including preparation, lasted no more than 20 minutes to limit fatigue (Plassman et al., 2015). All tests were conducted in the controlled environment of the Sensory and Neuroscience Lab, Intertek Group, ensuring standardized conditions.

4. Results and Discussion

4.1 First Step: Focus on Rifles' Technical Features

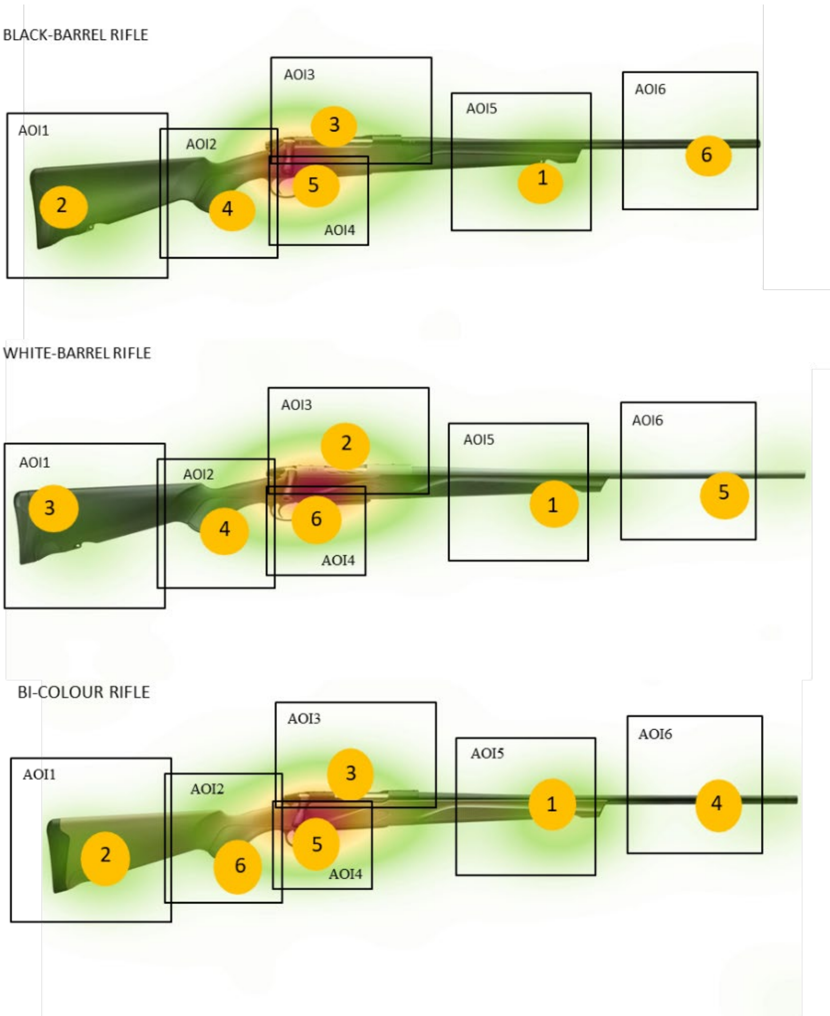
The results from the first research step, addressing RQ1, are presented in Table 1, showing ET and EEG metrics, and Figure 2 depicting the heat maps.

Table 1 – ET and EEG parameters' estimation (Step 1: focus on technical features)

		Stock (AOI2)	Grip (AOI5)	Bolt (AOI3)	Trigger (AOI4)	Forestock (AOI1)	Barrel (AOI6)
		Black-barrel rifle					
ET	FR	24**	6***	19**	7***	41**	3**
	AFD	3.22**	1.62**	3.35**	1.91**	5.33***	1.33***
	AFFD	3.46***	6.17**	3.60*	6.38***	0.92***	6.40***
EEG	ENG	48.41***	44.13***	47.32**	41.89*	51.23**	39.44***
	CL	44.56**	43.81***	32.12**	42.18*	47.32*	41.24**
		White-barrel rifle					
ET	FR	16**	7***	17*	8***	43**	8**
	AFD	1.00***	0.67**	2.25**	0.86**	3.97*	0.80***
	AFFD	3.61**	5.54***	2.56*	7.19**	0.85***	5.71**
EEG	ENG	45.69*	43.89***	44.30*	41.12**	49.47**	39.87**
	CL	38.52**	42.14***	39.16*	40.12*	41.46**	40.78***
		Bi-colour rifle					
ET	FR	25***	12***	14***	6**	36***	8**
	AFD	5.11***	3.50*	5.00**	3.50***	7.28***	2.80***
	AFFD	1.98*	5.88*	3.28***	5.13**	1.72**	3.78**
EEG	ENG	51.18**	44.56***	48.89***	42.23**	55.26**	41.98**
	CL	38.59***	44.12**	39.67**	41.46**	36.14**	40.49**

Notes:
FR=Fixation Rate (percentage values); AFD=Average Fixation Duration (mean values); AFFD= Average First Fixation Duration (mean value). Eye-tracking metrics are measured in seconds (sec.).
ENG=Engagement (mean values); CL=Cognitive Loading (mean values). Electroencephalography metrics are measured on a score ranging from 0 to 100.
***, **, * indicate statistical significance at p=0.001, p=0.01 and p=0.05 respectively.

Figure 2 – Heat maps



Note: Red and yellow colours on the maps correspond to the points of highest visual attention (i.e. maximum number or Fixation Rate and Duration), while green colour represents regions of minimum attention from participants. Numbers in the circles indicate the sequence of eye-gazes on AOIs.

The stock, bolt, and forestock emerged as the most engaging and visually salient components. These parts showed the highest FR and AFD values, indicating strong interest and attraction, while AFFD values were lower than for grip, trigger, and barrel, suggesting less cognitive effort was needed to process them. EEG confirmed these findings: stock, bolt, and forestock were associated with high engagement and low cognitive load, meaning they captured attention with minimal mental effort.

These results highlight young hunters' interest in features linked to safety and shooting accuracy. Notably, the bolt is the device that closes the breech of the barrel, thus representing a safety mechanism designed to protect against accidental or unintentional discharge during the hunting. The rifle's stock is further important for the hunter's safety as it avoids the rifle to shift under recoil. Moreover, a properly fitting stock assures both ergonomic benefits and the accuracy of the shoot as it increases the firmness of the shooter's hold. Similary, a well-designed and well-built forestock provides the secure, stable base needed for an accurate rifle.

4.2 Second Step: Focus on Crucial Moments of Hunter-Rifle Interaction

Table 2 provides a synthetic description of the results emerging from the second step of the study, investigating the emotional responses associated to crucial moments of hunter-rifle interaction. As previously explained all values reported for the 'shooting and reloading' phase refer to a controlled dry-run simulation of shooting actions, rather than to live firing.

Table 2 – EEG parameters' estimation (Step 2: focus on crucial moments of user/rifle interaction)

		Phases				
		Visual	Touch	Embracing and preparing for shooting	Shooting and reloading	Mean value
		Top-brand rifle				
EEG	ENG	54.54	56.19	53.65	54.56	54.71
	CL	38.58	44.81	38.38	40.56	40.58
		No-brand rifle				
EEG	ENG	48.88	55.08	52.23	53.63	52.45
	CL	38.04	48.58	39.42	41.89	41.98

Notes: ENG=Engagement (mean values); CL=Cognitive Loading (mean values). Electroencephalography metrics are measured on a score ranging from 0 to 100.

Both engagement and cognitive workload increase in the tactile phase of the hunter-rifle interaction. In fact, when participants take the rifle in hand, their user experience is improved by the greater attention and engagement provided, despite an increasing effort of analysis and understanding is required. Thus, EEG suggests that the touching phase plays an important role in influencing the overall UX. By contrast, when participants embrace and prepare the rifle for the shooting, they are less engaged, and even the mental effort associated with information processing is less relevant than that associated with other key-moments of interactions.

Branding also played a significant role. The branded rifle obtained better performance in terms of engagement in all steps in which the test was divided. Similarly, the values of cognitive load were lower for the brand sample compared to the anonymous one, except in the visual phase. Given that a great value of the cognitive load is usually associated with a worse UX, while high levels of engagement suggest more involvement and attention in analyzing the stimulus, EEG results suggest that the overall UX perceived during the observation and technical evaluations of the rifle is higher for the brand sample than for the anonymous one, thus enlightening the important role of brand in affecting subjects' evaluations and preferences. Notably, the influencing role of brand mainly arose in the visual phase of EEG test. By contrast, during the evaluation phase of rifles' materials and ergonomics, as well as during the embracing, preparation and shooting steps, the differences flatten, despite the brand sample always displayed the best performance rates.

5. Discussion and Implications

As an exploratory investigation, this study does not aim to provide statistically generalizable estimates, but rather to uncover latent patterns of perception, engagement, and cognitive processing that characterize hunters' interaction with rifles.

From the perspective of economic psychology, the results offer direct empirical evidence that hunters' evaluations are not driven by fully rational and purely utilitarian calculations, but by socio-psychological processes related to attention, emotion, and embodied interaction with the product.

More in detail, regarding the technical features, the results show that participants mainly focus on those components (stock, bolt, and forestock) that are directly linked to safety and shooting accuracy (RQ1). Concerning the interaction phase, touching the rifle emerge as particularly important, enhancing attention and engagement despite requiring greater cognitive effort (RQ2). Finally, brand cues significantly influence UX, especially during the visual evaluation. Hence, brand and tactile experience systematically affect cognitive effort and engagement, influencing individual economic behavior in ways that are largely unconscious.

From these findings, both theoretical and practical implications emerge.

Theoretically, the study improves knowledge on the field of recreational hunting experience, at least on a threefold level.

First, it confirms the centrality of the rifle in hunting experience, with user interaction eliciting strong visual and cognitive responses. Consistent with Hautaluoma et al. (1978), this suggests adopting a user-centric approach to improve the overall hunting experience, potentially boosting satisfaction, purchasing intention, and store patronage (Lee et al., 2018; Moradi et al., 2017). Given that even young, inexperienced participants demonstrated high levels of engagement, our findings also highlight that rifle-related UX is significant regardless of the hunter's level of specialization, contrasting earlier studies of Miller and Graefe (2000) and supporting the strategic importance of focusing on young hunters to enhance attraction, retention, and a general revival of recreational hunting (Lee and Scott, 2004; Needham et al., 2007).

Second, the study contributes to knowledge by identifying specific rifle components and interaction moments that generate the greatest attractiveness and engagement. While prior research has primarily focused on specific aspects of technical features, such as the economic relevance (e.g., Poudel et al., 2016) and cultural significance (e.g., Wadley et al., 2015), its influence on the hunting UX has been largely overlooked. Yet, this is crucial for manufacturers and retailers to refine their value propositions, attract hunters, enhance satisfaction, and retain interest. More specifically, the findings highlight users' attention on rifle attributes related to safety and precision. This is consistent with trends observed across various research domains, such as food (Liu et al., 2020; Savelli et al., 2022), automotive (Pisitsankkhakarn and Vassanadumrongdee, 2020), and apparel (Rahman et al., 2021), highlighting young consumers' growing prioritization of ethical considerations, including individual safety, over purely economic factors. Moreover, the findings emphasize the significant role of tactile perception in shaping user-product interaction, shifting focus from the visual-centric analyses that traditionally dominate UX and product design (Guo et al., 2016; Karim et al., 2022). This change of perspective has been recently claimed in the literature (Karim et al., 2022), emphasizing the need to reconsider the dominance of visually driven interfaces, which may not always offer the most effective or intuitive solutions (Karim et al., 2022). In this respect, our study provides novel evidence within the hunting equipment context, demonstrating that tactile sensation can surpass visual perception in enhancing UX. Finally, the study underscores the influential role of the brand name, reinforcing prior findings on the strong connection between brand and UX (Lee et al., 2018; Van de Sand et al., 2020). Notably, this result highlights the importance of integrating both pragmatic and hedonic elements into product design to create more enjoyable and engaging experiences.

A third theoretical contribution concerns the research method. By focusing on hunting as a recreational activity, which is mainly appreciated for its experiential benefits, physiological observations, based on EEG and ET techniques, have been properly employed while prior research usually based on self-reported data (e.g. Cohen, 2014; Van der Merwe and Saayman, 2015). The comprehension of hunters' sensations and emotions, indeed, can be hardly detected through the administration of questionnaires (Venkatraman et al., 2012), hence new findings from neuroscience techniques are harbinger of novelty in the field of hunting experience, providing objective measurements of subjective emotions and unconscious sensations of hunters.

In this respect, the findings of this study complement and extend earlier research (e.g., Pencarelli et al., 2013), which emphasizes functional and psychosocial determinants of hunters' firearm purchase decisions, by showing that unconscious engagement and cognitive responses significantly contribute to UX and behavioural outcomes in equipment interaction.

5.1 Practical Implications

From a practical standpoint, this study provides information about the rifle's components that attract the hunter's interest and obtain the best performances in terms of visual and cognitive attention. Moreover, it investigates the emotional engagement and cognitive load associated with rifle handling and use. These results, while influencing the UX deriving from the hunter's interaction with the rifle, inform marketing policies of both manufacturers and retailers operating in the hunting equipment setting, assisting their efforts in creating a valuable user (and customer) experience.

Three main implications are worthy of notice linked to (i) the importance of rifle's technical features associated with safety and shooting accuracy, (ii) the critical role of brand in influencing the UX, and (iii) the highest engagement associated to the tactile sensation arising from the user/product physical interaction.

As concern the hunters' attention towards safety attributes and rifle accuracy, manufactures should focus on such features of the rifle (i.e., stock, bolt and forestock), by designing products that are easy to use, safe for the hunter, and effective in terms of shooting precision. The critical attitude of the hunters towards hunting equipment – the rifle, in this case – also highlights the need for both manufacturer and retailers to invest strategically in communication efforts emphasizing the technical safety and accuracy of the product. For younger, less experienced hunters, such as the participants in this study, it may be particularly important to use straightforward language and clear communication ensuring that messages are accessible to individuals with limited hunting expertise. Retailers, in particular, should tailor their marketing strategies to address this demographic, incorporating interactive demonstrations and practical guidance that underscore the safety and accuracy of the products while fostering trust and engagement among novice hunters.

Regarding brand strategies, in the ET and EEG tests, a top-brand rifle elicited higher engagement and lower cognitive load compared to its unbranded counterpart. However, the significance of the brand was observed primarily during the visualization stage of the rifle. This suggests companies the opportunity to improve their efforts on brand strategy (and brand communication) in order to attract hunters and to develop long-term relationships and hunters' loyalty, despite their priority should remain on the intrinsic and technical features of the product, which make one rifle different from another. For retailers, these findings underscore the importance of strategically managing their product assortments by including top-brand equipment and materials. Offering well-regarded, high-quality brands cannot only attract hunters but also strengthen their attachment to the store, fostering long-term customer loyalty and competitive advantage in the marketplace.

Further implications arise from the EEG findings, underscoring the critical role of tactile sensation during the rifle evaluation. Engagement and cognitive load increased significantly when participants handled the rifle, having the opportunity to try it, by shooting and reloading. This emphasizes the importance of allowing hunters to test the product. Manufacturers could organize events where individuals cannot only view but also try out rifles, fostering a deeper connection with the product. For retailers, this presents a valuable opportunity to enhance the in-store experience. Providing customers with the chance to physically handle rifles and test them, whether through simulated environments or designated trial areas, can greatly improve product evaluation and engagement. This approach not only strengthens customer satisfaction and trust but also encourages store visits, promotes longer in-store dwell times, and fosters loyalty among a younger demographic of hunters.

Overall, these implications are essential for enhancing hunters' engagement while reducing the cognitive effort associated with their UX. By implementing these strategies, companies and retailers may effectively attract hunters, address their needs, recruit new enthusiasts, and foster deeper involvement and passion for recreational hunting as a whole.

6. Conclusions

This exploratory study is part of the emerging field of neuroscience applied to consumer behaviour, with a specific focus on UX in the context of hunting equipment. By adopting neuromarketing tools (ET and EEG), the analysis allowed us to detect the unconscious perceptions and emotional responses of hunters during crucial moments of interaction with the rifle. This was particularly relevant to overcome the limitations of traditional methodologies based on self-declarations, providing objective and detailed measurements of cognitive and emotional dynamics.

The work contributes to the literature on retail and neuroscience, highlighting the value of neuroscientific techniques for understanding consumer experience. On a practical level, the results offer useful indications for companies and retailers, suggesting to focus on technical features that improve safety and performance, to invest in branding strategies to increase loyalty and to promote tactile and interactive experiences to attract new generations of hunters. Besides increasing customer satisfaction, such actions may also relaunch interest in recreational hunting, enhancing the consolidation of a significant yet challenging sector.

Notwithstanding its theoretical and practical contribution, the study suffers some limitations related to the same use of neuroscientific methods, which provides suggestions for future research. First, as noted by Plassman et al. (2015), neuroscience research informs about brain behaviour but not the consumer behavior. Thus, future behavioral experiments would be useful for testing the results obtained so far. Moreover, the small and relatively homogeneous sample, while being consistent with the exploratory nature of the research design, limits the statistical generalizability of the findings; it is well suited for detecting meaningful cognitive and emotional patterns that can guide theory development and future hypothesis testing. Finally, brain waves and eye movements can be influenced by situational factors and sometimes they are unintentional and unconscious, thus findings from laboratory tests can fail in reliability.

Future research should therefore improve the results' generalizability and consistency of the current results, in order to assess whether the emotional and cognitive reactions captured by this study form reliable bases for stable and comprehensive hunters' experience. The repetition of similar EEG and ET experiments should be made as follow-up studies (Plassman et al., 2015). Moreover, a questionnaire survey might be conducted on a larger population to test the neuroscience results and provide a deeper investigation of how cultural and socio-demographic variables can influence the hunter's behaviour and experience. Additionally, since this study has been conducted in Italy, a broader sample including people from different Countries could be analysed in order to investigate both analogies and differences, and potential opportunities related to socio-cultural dynamics. Lastly, this study focused on a specific component of the equipment that is the rifle, especially relating to bolt-action models usually employed for wild boar hunting. Despite the core equipment is important for any leisure activity, future investigations might consider a wider setting of analysis, both in terms of equipment (including, for example, protective cases, scales, arrows, etc.) and hunting typologies in order to achieve greater knowledge and results generalization.

In this respect, the present study should be seen as a theory-building and hypothesis-generating contribution, providing a foundation for future large-scale and cross-cultural investigations into hunting-related UX.

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