The Impact of Age and Gender on Sensory Imagery: Insights from the IMAVIC Dataset

Simona Corciulo[⋆], **Mario Alessandro Bochicchio**[◇] **Rossana Damiano**[⋆], **Viviana Patti**[⋆]
[⋆] Computer Science Department, University of Turin, Turin, Italy
[◇] Computer Science Department, University of Bari "Aldo Moro", Bari, Italy
{simona.corciulo|rossana.damiano|viviana.patti}@unito.it
mario.bochicchio@uniba.it

Abstract

With the advent of Large Language Models, conversational skills are no longer exclusive to humans, but human features such as senses and imagination remain a topic of debate in conversational systems. In this paper we describe the IMAVIC (IMAgery and Vividness In Context) dataset, annotated to investigate how linguistic context modulates sensory imagery, defined as the cognitive capacity to generate mental representations of sensory experiences across modalities (vision, hearing, touch, smell, and taste) in the absence of direct external stimuli. This study focuses on how linguistic stimuli, both in isolation and in context, elicit and modulate such imagery, and how these processes vary based on demographic factors. IMAVIC includes ratings from 909 native English speakers on the vividness of mental images and the intensity of sensory experiences evoked by adjectives, nouns, and adjective-noun pairs across five sensory modalities. The analysis of data reveals significant differences in sensory imagery across genders and age groups, suggesting that biological and sociocultural factors shape our imaginative abilities and providing a foundation for the development of models targeting sensory grounding.

1 Introduction

Sensory imagery, the ability to mentally recreate perceptual experiences without direct sensory input, plays an important role in cognition, influencing processes such as memory recall and language comprehension. Collecting data on sensory imagery, particularly in relation to linguistic context, can offer a more detailed understanding of how demographic factors, such as age and gender, influence this cognitive function. Insights from such studies are not only important for advancing theoretical knowledge but also have potential practical applications in domains where sensory experiences are central. For example, in conversational interfaces and healthcare or assistive technologies, a more precise understanding of sensory imagery could enhance communication by allowing greater personalization of interactions. Furthermore, these findings may inform the development of machine learning models aimed at simulating human sensory and cognitive processes with greater accuracy, thereby improving their applicability in real-world contexts.

This study focuses on how demographic factors, specifically age and gender, influence sensory imagery, which in this context refers to the cognitive ability to generate mental representations of perceptual experiences in response to linguistic stimuli. Building on the theory of embodied cognition, which suggests that language processing is closely tied to sensory and motor systems (Barsalou, 1999, 2008), previous research has shown how isolated words can evoke sensory representations (Lakoff, 2012). However, the effects of sentence context on sensory imagery remain less explored, particularly in relation to demographic differences. To address this gap, we created the Imagery and Vividness in Context (IMAVIC) dataset, which contains ratings on the vividness of mental representations, as well as the type and intensity of sensory imagery evoked by specific textual stimuli, focusing on adjectives and nouns presented both in isolation and within context. By examining the effects of the linguistic context, age and gender, this research seeks to provide information on how these factors shape sensory imagery in both conversational interfaces and healthcare/assistance systems, where it can be crucial to fully comprehend people's special needs and communicate about sensory experiences.

Motivation The motivation for this study stems from the need to better understand how age and gender influence sensory imagery in response to linguistic stimuli, particularly when considering the role of sentence context. The social relevance of this issue is related to the growing interest in

conversational interfaces and the trend toward an aging population. Previous research has shown that age-related declines in sensory and cognitive processing can affect the vividness of mental images (Li and Lindenberger, 2002), while gender differences suggest that women may engage more deeply with sensory and emotional stimuli than men (Canli et al., 2002). Despite these insights, the role of sentence context in modulating sensory imagery across these demographic groups remains understudied. The IMAVIC dataset offers the opportunity to explore these issues. Earlier findings have shown that context can enhance sensory imagery, especially for adjective-noun pairs. This study seeks to extend these findings by examining how demographic factors further influence these effects, offering cautious hypotheses about how age and gender can interact with contextual modulation of sensory imagery. In this setting, our work aims to explore four research questions:

- How does phrasal context affect the vividness of sensory imagery in nouns and adjectives?
- How and to what extent does gender influence the vividness of sensory imagery?
- How does gender influence sensory imagery across different modalities?
- How does age affect the vividness of sensory imagery?

Understanding these interactions has potential applications beyond sensorial/cognitive aspects. For instance, insights gained could inform the development of assistive technologies that adapt to the sensory and cognitive needs of various users, particularly older adults and individuals with sensory impairments.

This paper is structured as follows: First, we introduce the concept of sensory imagery and its cognitive relevance, with a particular focus on how demographic factors such as age and gender can influence this process. We then present the Imagery and Vividness in Context (IMAVIC) dataset and detail the methodology used to collect and analyze sensory imagery ratings in both decontextualized and contextualized linguistic forms. In the results section, we examine the effects of age and gender, and linguistic context on sensory imagery, highlighting key patterns and demographic differences. Following this, we discuss the implications of these findings for fields such as conversational interfaces and healthcare or assistive technologies, where sensory experiences are essential for personalized interaction. Finally, we conclude by outlining future research directions, emphasizing the potential for further exploration on the integration of sensory imagery data into machine learning models and assistive systems.

2 Related Work

Previous studies on perception, imagination and language have revealed how sensory experiences and bodily interactions fundamentally shape cognitive processes. Three key frameworks - sensory grounding (Chalmers, 2024; Spendlove and Ventura, 2019), embodied cognition (Lakoff and Johnson, 2008; Lakoff, 2012; Leitan and Chaffey, 2014), and body grounding (Gallese and Lakoff, 2005) - have provided valuable insights into these relationships. The intrinsic meaning of these frameworks lies in their shared emphasis on the interconnectedness of sensory experiences and cognitive functions. Sensory grounding posits that our thoughts and mental representations are not purely abstract but are anchored in the physical sensations we experience. Embodied cognition suggests that cognition arises from active bodily interactions with the world, meaning our mental processes are deeply tied to our physical state and actions. Body grounding, a more specific component, focuses on how posture and movement directly shape cognitive activities such as memory, attention, and language.

A key extension of embodied cognition theory is its implication for language processing. Unlike traditional views that treat language as an abstract symbolic system, embodied cognition proposes that linguistic comprehension is closely intertwined with sensory and motor experiences. Rather than being processed in isolation as abstract symbols, language comprehension activates the same neural circuits involved in direct interaction with the environment and external stimuli. This means that understanding language involves not only symbolic processing but also the activation of perceptual representations, which are grounded in past sensory experiences. These neural activations enable the brain to recreate sensory patterns, allowing it to simulate or imagine experiences without direct stimuli, thus integrating sensory and semantic information (Kosslyn et al., 2001; Schacter and Addis, 2007). Such mental simulations, triggered by linguistic input, allow individuals to construct mean-

ing based on the recreation of sensory experiences, contributing to a richer and more dynamic understanding of language. This process highlights how perception, imagination, and language are interdependent, working together through shared neural mechanisms that tie sensory experiences to linguistic and cognitive functions.

These principles directly relate to sensory imagery, the mental recreation of sensory experiences, as they highlight how imagination and perception share neural mechanisms. When we engage in sensory imagery, such as visualizing an object or imagining a sound, we activate the same brain regions involved in actual sensory perception. This overlap underscores the idea that our mental imagery is grounded in the same sensory systems that process real-world experiences, reinforcing the connection between body, mind, and environment.

While perception and imagination are universal cognitive processes, substantial research (Schacter et al., 2013; de Dieuleveult et al., 2017) has shown that they are influenced by demographic variables, particularly gender and age. Studies indicate that men and women exhibit notable differences in sensory processing and mental imagery, shaped by both biological and cultural factors.

Women have been found to outperform men in tasks involving olfactory and tactile sensitivity, suggesting a heightened perceptual acuity in these modalities. Research shows that hormonal variations play a key role in these differences. For example, estrogen levels have been linked to increased sensitivity in olfactory perception, leading to higher detection rates of odors (Doty and Cameron, 2009). Similarly, women generally exhibit superior performance in tactile discrimination tasks, potentially due to differences in skin receptor density and hormonal influences (Brand and Millot, 2001). Conversely, men often excel in visuospatial tasks, particularly those requiring mental rotation and spatial navigation. Studies have consistently shown that men tend to perform better on tasks involving the rotation of objects in three-dimensional space, an ability linked to enhanced activation in parietal regions of the brain (Halpern, 2000). These differences may be partly attributed to evolutionary pressures, where spatial navigation was crucial for survival in male-dominated activities such as hunting and exploration.

Age also profoundly affects both perception and imagination, with distinct developmental trajectories across the lifespan. In children, perceptual systems are highly plastic, rapidly adapting to new sensory stimuli and refining perceptual and imaginative abilities. For example, the capacity to visualize and manipulate mental images develops alongside increasing exposure to complex visual stimuli during childhood (Cascio et al., 2019). As cognitive and sensory functions peak in adulthood, individuals demonstrate highly efficient multisensory integration and rapid mental images generation (de Dieuleveult et al., 2017).

However, with advancing age, perceptual and imaginative abilities tend to decline. Older adults often experience reduced sensitivity in sensory modalities such as vision and hearing, alongside decreased vividness and accuracy of mental images. Studies suggest that this decline is associated with structural and functional changes in the brain, particularly in areas related to sensory processing and memory, such as the prefrontal cortex and hippocampus (Li and Lindenberger, 2002). Despite this, many older individuals compensate for sensory deficits through cognitive strategies and accumulated knowledge, maintaining a degree of perceptual and imaginative capacity well into old age (Baltes and Smith, 2003).

Gender differences persist across the lifespan, with some evidence suggesting that the decline in sensory and cognitive functions may manifest differently between men and women. For example, while both sexes experience age-related declines in sensory acuity, women tend to retain greater olfactory sensitivity and verbal memory, whereas men maintain a relative advantage in spatial tasks (Lindenberger and Baltes, 1994). These gendered patterns of cognitive aging highlight the importance of considering both biological and experiential factors in understanding the evolution of perceptual and imaginative abilities.

Cultural background also significantly influences how individuals perceive and imagine the world. Research by (Nisbett and Masuda, 2013) indicates that individuals from Western cultures tend to focus more on isolated objects in their environment, while those from Eastern cultures exhibit a greater sensitivity to context and relationships between objects. These cultural differences shape not only perceptual tendencies but also the content and structure of mental imagery. Additionally, educational background and socioeconomic status contribute to the variability in imaginative and perceptual skills, with greater exposure to diverse stimuli often enhancing these abilities (Wang, 2021).

In summary, while perception and imagination are universally shared processes, they are deeply influenced by factors such as gender, age, and culture. These differences underscore the importance of accounting for demographic variables in cognitive research, particularly in understanding how sensory experiences and mental imagination evolve across the human lifespan.

3 Methodology

This section provides a brief overview of the key methodological aspects here adopted. It includes a summary of the variables measured, task structure for annotators, and data processing techniques, focusing on the selection of sentences and target words.

Participant Recruitment and Sample Composition The study recruited a total of **903** native English-speaking participants, aged 18–80 years, through the Prolific crowdsourcing platform. The sample was balanced across genders, with 52.2% identifying as female and 47.8% as male, and showed the highest representation among participants aged 30–39 years, followed by 20–29 years. This distribution reflects a younger-skewed sample typical of online recruitment platforms. Of the recruited participants, 835 effectively completed the annotation tasks, providing a total of 5,611 valid responses across approximately 27,000 questions. Each target (adjective, noun, or adjective-noun pair) was rated by 3 annotators for both vividness and sensory imagery, ensuring robust data quality. Control questions were incorporated to identify and exclude incomplete or invalid responses, maintaining high reliability in the aggregated results.

Variables and Rating Scales Key variables include the vividness of mental imagery and the intensity of sensory imagery across different senses. Both variables measure the intensity of mental imagery: the first provides a general measure of the overall vividness of the mental image, while the second offers a detailed measure of intensity across individual sensory modalities - vision, hearing, touch, smell, and taste. Both are rated on a Likert scale from 0 to 4.

Task Structure for Annotators The annotation tasks are designed to optimize completion time and ensure reliable data. Tasks are divided into sections with and without context, and each target is evaluated by multiple annotators to ensure consistency.

Linguistic Data Selection and Processing The corpus was curated to include texts with high potential for sensory engagement, focusing on adjective-noun relationships. Data were sourced from reviews and comments, selected for their multisensory descriptions.

Validation Criteria and Analysis Appropriate statistical tests, including non-parametric methods and mixed linear regression models, were used to validate the results.

The IMAVIC dataset A corpus of 303 sentences, each containing at least one adjective and one noun. The initial corpus included a well-established dataset of wine reviews available on Kaggle[1], which was extended by scraping descriptions, reviews, and comments on consumer products (e.g., cosmetics, beverages, artworks) from platforms such as Fragrantica, Reddit, Google Art and Culture, and YouTube. The collection and selection of texts were automated using custom Python scripts to ensure the quality and variety of the dataset. The corpus was processed to select sentences following an adjective-noun structure, in which the adjective directly modifies the noun. This particular structure was chosen due to its relevance in studying synesthetic metaphors, which are often instrumental in examining how the human mind integrates and associates sensory experiences through language. To maintain consistency with the Lancaster Sensorimotor Norms (Lynott et al., 2020) and allow for meaningful comparisons, the analysis focused on singular nouns, as words in the reference corpora are annotated in this form. Each selected sentence also included at least two additional words from the reference dataset, in addition to the target adjective-noun pair, and sentences were limited to a maximum of 20 words. This constraint aimed to optimize annotation time while also enabling an assessment of how context affects linguistic interpretation. Following classification, 303 sentences were retained. A total of 303 adjectives and 303 nouns were annotated, as each sentence contained at least one of each. However, given that many target words appear multiple times, often functioning as both adjectives and nouns, the actual number of annotations exceeds this base count. Terms such as "light," "clean," "stone," and "wood" exhibit flexibility in meaning and grammatical role depending on context, which is particularly valuable for examining the influence of linguistic surroundings

[1] https://www.kaggle.com/datasets/zynicide/wine-reviews/data

on sensory interpretation. This repetition was considered beneficial, as it allows for a more in-depth investigation into how context, meaning, and grammatical function interact, laying a foundation for exploring linguistic and perceptual dynamics.

4 Results and Discussion

In this section the results are reported and discussed according to the above-defined research questions.

4.1 How and to what extent does gender influence the vividness of sensory imagery?

Our findings address this research question by revealing some gender differences in the vividness of mental imagery in response to textual stimuli, particularly as age increases. However, these differences are not uniformly substantial and may be influenced by other factors such as age-related cognitive changes and the type of targets. Overall, both men and women experience a decline in mental vividness with age, but this decline appears more pronounced in women, particularly for categories such as adjectives and nouns after the age of 50. Men, on the other hand, show an initial increase in the vividness of nouns between the ages of 50 and 60, followed by a sharp decline between the ages of 70 and 80 as reported in Fig. 1. These observations suggest that age and gender interact in shaping sensory imagery, with potential influences from cognitive aging and contextual cues. Despite the general decline with age, women tend to maintain higher mental vividness than men in some modalities, such as smell and, in certain cases, touch (Fig. 2). These differences in mental vividness are not always substantial, but they are consistent with the findings of (Canli et al., 2002), who reported greater activation of brain regions in women during the recall of emotional memories. This suggests a predisposition in women for processing and integrating sensory and emotional information. The more pronounced decline observed in women may indicate that, although they tend to exhibit greater mental vividness overall, aging affects their ability to sustain this vividness more significantly than it does for men.

Additionally, our results indicate that phrasal context differentially influences mental vividness across genders. Men show greater olfactory intensity when stimuli are presented with contextual support compared to women, as shown in Fig. 2, where men exhibit a peak in intensity in the 40–50 age range, followed by a sharp decrease after age 60. Conversely, women demonstrate more stable olfactory intensity across age groups, catching up to and surpassing men in the 60-70 age range. This suggests that context may play a more significant role in enhancing sensory imagery for men, while women maintain a steadier sensory response across conditions. These results align with the findings of Ehrlichman and Halpern (Ehrlichman and Halpern, 1988), who demonstrated that olfactory stimuli enhance the recall of emotional memories, with women typically showing a more intense response to such stimuli, especially at older ages.

In summary, while gender differences in sensory vividness are present, they are not uniformly substantial and may be mediated by factors such as age-related cognitive decline. Our data, alongside prior research, suggest that gender and age interact in complex ways to influence the vividness of sensory imagery. Although women generally exhibit greater mental vividness in certain modalities, particularly in smell and touch, aging appears to have a more significant impact on their ability to maintain this vividness over time. At the same time, contextual factors seem to amplify mental vividness for men, particularly in the olfactory domain, although this effect diminishes with age.

4.2 How does phrasal context affect the vividness of sensory imagination on nouns and adjectives?

Our findings indicate that context enhances sensory imagery for both men and women, although the effect is more pronounced in women. In terms of olfactory intensity without context, men exhibit an average score of 0.26, with a minimum of 0.20 and a maximum of 0.33 across age groups. For women, the average score is 0.24, with a minimum of 0.19 and a maximum of 0.33. When context is considered, the scores increase: for men, the average score is 0.62, with a minimum of 0.42 and a maximum of 0.74. For women, the average score is 0.57, with a minimum of 0.48 and a maximum of 0.70. This suggests that women may derive greater benefits from narrative or contextual cues, which help them form richer mental images, particularly in sensory modalities such as touch and smell, as reported in Fig.2. However, the degree to which context influences mental imagery varies with age, and this modulation may be influenced by age-related cognitive changes. For example, in

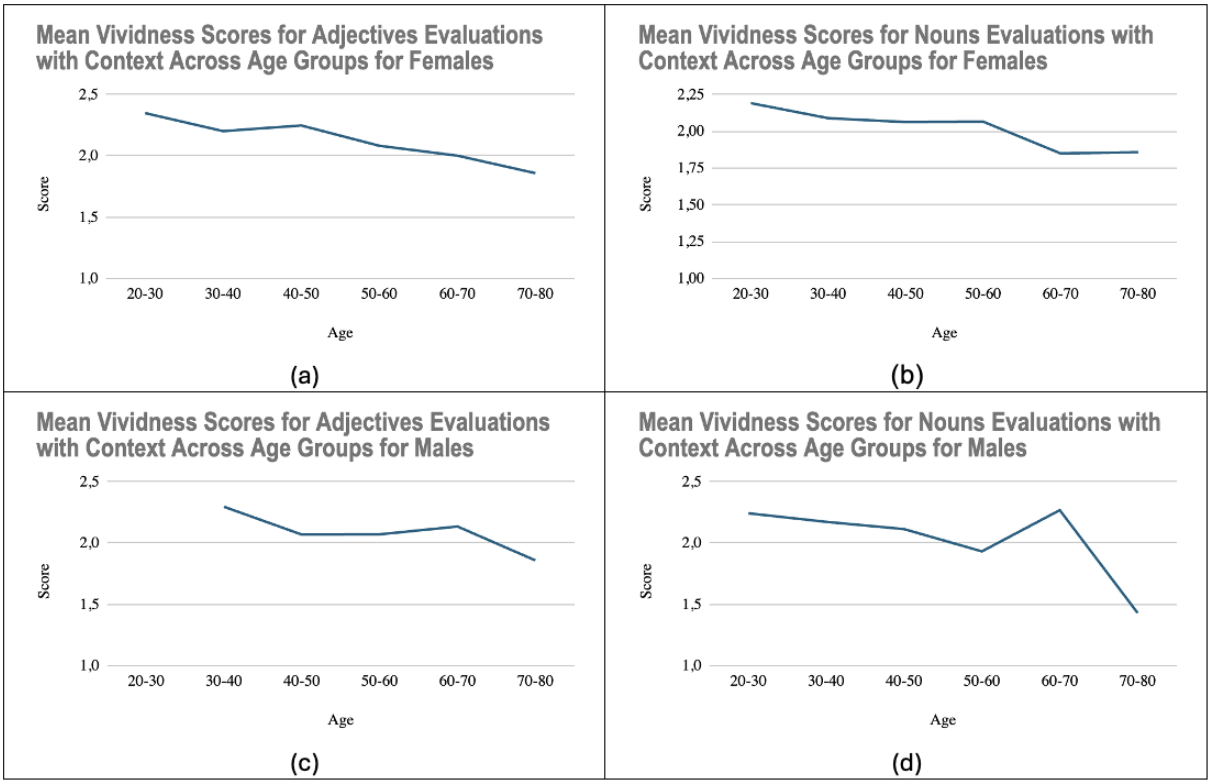

Figure 1: The graphs show age-related changes in mental vividness for adjectives and nouns with contextual support, comparing men and women. Both genders experience a decline in vividness with age, but the decline is steeper for women. Men show a temporary increase in the vividness of nouns between ages 50-60 before a sharp decline in the 70-80 range, while women demonstrate a more consistent decline.

the 60-70 age group, women exhibit more stable olfactory intensity scores, with an average of 0.33 without context and 0.70 with context, surpassing men whose scores are 0.20 without context and 0.70 with context. In contrast, men tend to respond more strongly to visual and auditory stimuli, often even without contextual support. As shown in Figure 4, men demonstrate a peak auditory response in early adulthood (20-30 years), followed by another increase between 50-60 years, after which the response declines sharply. These age-related variations may reflect deeper cognitive differences between genders in the processing of sensory information. Men's reliance on direct sensory stimuli, such as auditory and visual cues, supports previous findings by Kring and Gordon, who observed stronger male responses in these modalities compared to females (Kring and Gordon, 1998). Our interpretation aligns with research suggesting that women are more likely to integrate contextual details into their sensory experiences. Davis demonstrated that women tend to recall emotionally charged autobiographical events more vividly, confirming their propensity for processing emotional and sensory information (Davis, 1999). This is consistent with our findings, which show that women benefit more from context in enhancing mental vividness. Conversely, studies like that of Mann et al. suggest that men tend to favor more analytical, practical modes of information processing, particularly in visual and auditory domains, which could explain their stronger response to these modalities without the need for additional context (Mann et al., 1990).

In summary, the modulatory effect of context on sensory imagery varies between genders, with women showing a greater sensitivity to contextual cues that enrich sensory imagery, while men are more responsive to unembedded targets, particularly in the auditory and visual domains. These findings suggest that age and cognitive changes may further modulate how context impacts sensory imagery, with gender playing a critical role in shaping these dynamics.

4.3 How does gender influence sensory imagery across different modalities?

Our analysis of sensory modalities - taste, smell, touch, sight, and hearing - reveals notable gen-

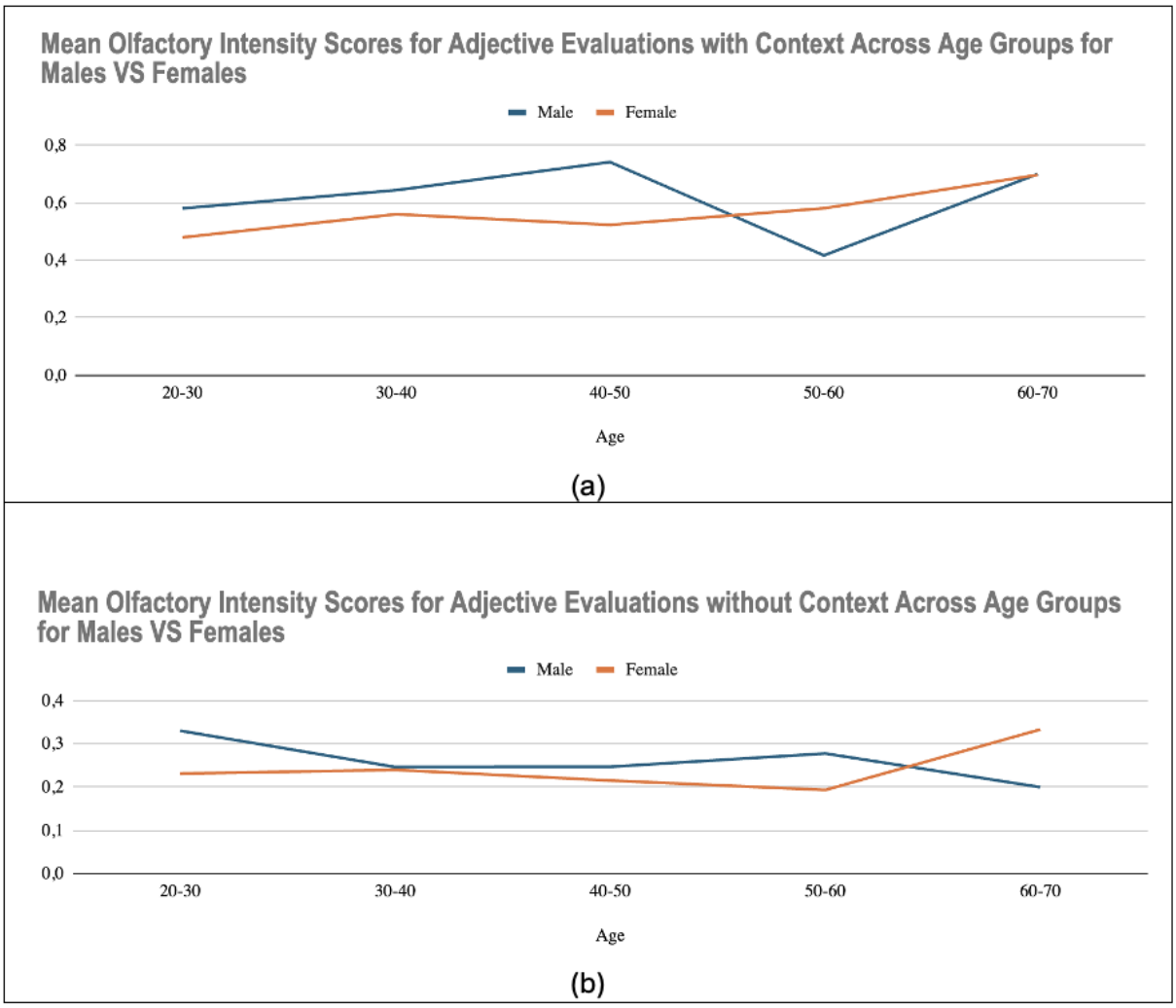

Figure 2: The graphs display mean olfactory intensity scores for adjective, both with and without context, across age groups. Men show higher olfactory intensity with context until the age of 50-60, after which females catch up and surpass them. Without context, men score higher in younger age groups, but women surpass them in the 60-70 range. Context has a greater impact on olfactory intensity for men, while women maintain steadier responses.

der differences in the vividness of sensory imagery. Here, women consistently exhibit stronger responses , particularly in sensory domains that are associated with intimate and personal experiences as reported in Fig. 2. This observation aligns with the findings of (Schaefer and Philippot, 2005), who showed that women tend to relive autobiographical memories with greater sensory vividness than men. In our study, women's olfactory intensity remains more stable across age groups, surpassing men in the 60-70 age range, particularly when context is not provided. Conversely, men show somewhat stronger responses than women to auditory stimuli. For instance, in the 60-70 age group, men have an average auditory score of 0.17, while women register a score of 0.00. This suggests a potential difference in auditory processing between the two groups, although further investigation is needed to confirm the extent of this variation, as reported in Fig 3. These findings support the results of Hofer et al. (Hofer et al., 2007), who observed that men exhibit greater brain activation in visual and auditory regions when processing emotional words. This suggests that these sensory modalities are more integral to men's cognitive processing of imagery. For example, as in Fig. 3, men's auditory load peaks in the 20-30 age range, followed by another increase between 50-60 years, before declining sharply after 60. Women, however, demonstrate a more stable auditory response across age groups, with less pronounced fluctuations.

In summary, gender plays a significant role in shaping how individuals experience and construct mental imagery across different senses. Women

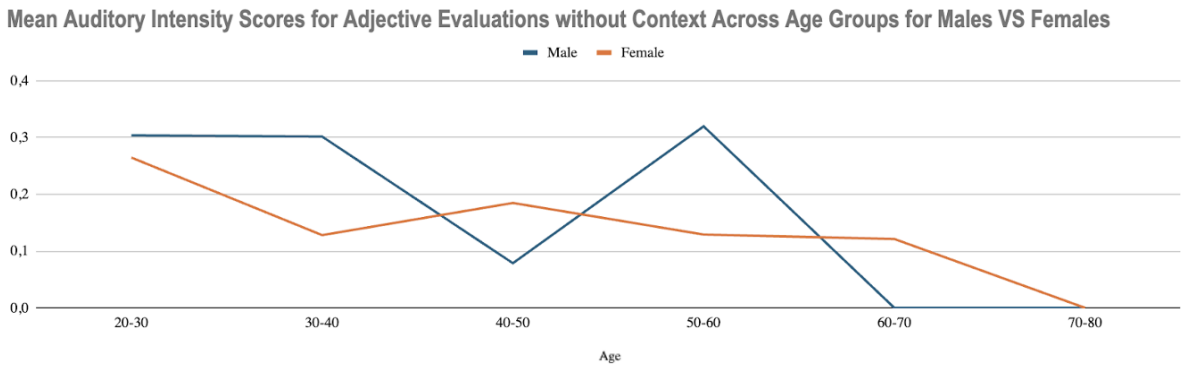

Figure 3: The graph illustrates the auditory load associated with nouns presented without context, across different age groups for male and female participants. Males show a stronger response initially, with a peak in the 20-30 age range and another in the 50-60 group, followed by a sharp decline after 60-70 years. Females, on the other hand, display a more stable auditory load across the age groups, with slight fluctuations and a steady decline starting from the 50-60 age range. These results suggest that, in the absence of contextual cues, auditory imagery for nouns varies more significantly with age in males than in females.

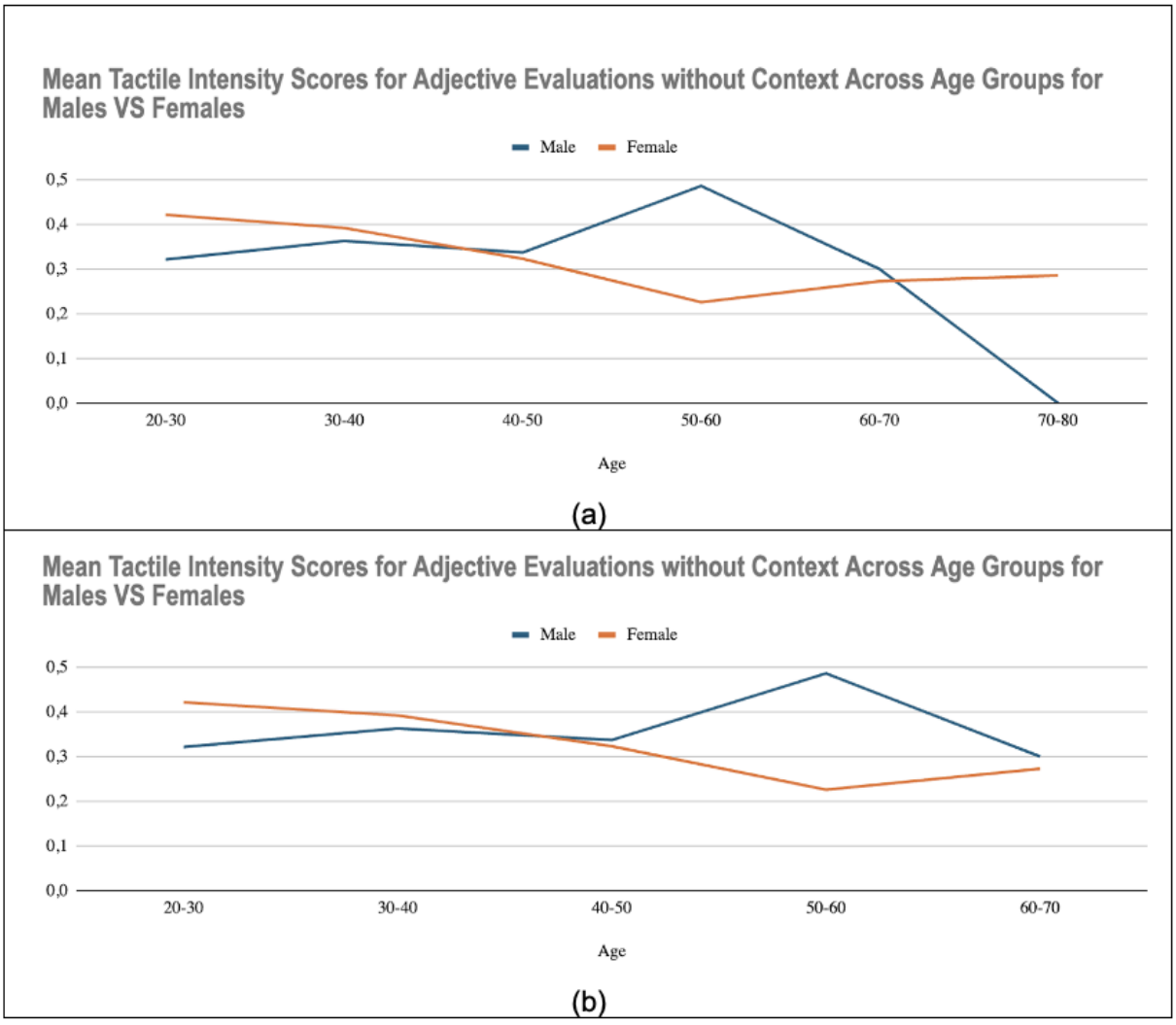

Figure 4: The graph shows tactile load variations by age for men and women in response to tactile stimuli. Both genders start with similar values, but men show a slight increase between 40-60, followed by a sharp decline after 60-70. By 70-80, men's tactile load drops to zero, while women maintain a more stable response, suggesting they sustain tactile vividness longer as they age.

tend to have a heightened response in modalities related to personal and emotional experiences, whereas men rely more on visual and auditory stimuli, particularly when context is absent. These findings align with prior research, suggesting deeper cognitive differences in how men and women process sensory information.

4.4 How does age affect the vividness of sensory imagery?

A relevant finding relates to the resilience of women's sensory responses in older age groups. Therefore, it is important to note that while the data suggest a trend, the limited sample size warrants further investigation to confirm it with greater certainty. Our data suggest that after the age of 50, women may maintain a slightly higher level of tactile sensory vividness compared to men. For instance, in the 60-70 age group, women have an average tactile score of 0.18, which is about 9% higher than the average score of 0.17 for men. However, given the small difference, further research is needed to confirm this trend (Fig. 4). This is particularly evident in modalities such as touch, where women show more stable tactile responses across age groups. In contrast, men experience a noticeable decline in tactile vividness after the age of 60, with their average score dropping from 0.32 in the 50-60 age group to 0.17 in the 60-70 age group. This reduction suggests a sharper decrease in tactile responses as they age. These results align with Uzer and Gulgoz (Uzer and Gulgoz, 2015), who found that older women tend to retain more vivid sensory and emotional memories than men, particularly in relation to olfactory and gustatory stimuli, which decline more rapidly in men. The observed differences in sensory processing and mental imagery between men and women may be influenced by social and cultural factors. Grossman and Wood (Grossman and Wood, 1993) suggest that women's socialization often encourages a focus on sensory experiences linked to physical contact and emotional intimacy. This emphasis on emotional expression and interpersonal sensitivity may contribute to the greater sensory vividness observed in women, as their mental representations are often more grounded in sensory and emotional experiences. Conversely, Halpern (Halpern, 2000) argues that men are generally socialized to be more emotionally detached and practical, with societal expectations emphasizing visual and auditory skills rather than proximal sensory experiences like touch. As a result, men may construct mental images that prioritize sight and hearing, while being less connected to emotional or intimate physical experiences. This could explain the steeper decline in sensory vividness observed in men, especially in tactile modalities, as they age. In summary, the data suggest that women maintain more stable sensory vividness into older age, particularly in tactile modalities, while men exhibit a sharper decline in sensory imagery after 60. These gender differences in sensory resilience may be shaped by socialization patterns, which influence how men and women process and prioritize different sensory experiences throughout their lives.

5 Conclusions and Future Work

In conclusion, this research has highlighted how sensory grounding - the anchoring of cognitive experiences in sensory systems — affects imagination and perception in response to textual stimuli. Age and gender play significant role in modulating the construction and understanding of sensory references, revealing meaningful differences in embodied simulation and mental imagination across demographic groups. These findings encourage further large-scale annotation efforts campaigns and the development of computational models for text generation that account for gender and age differences in human-computer communication. Future work will focus on using the collected data to analyze the influence of context on variations in vividness of the mental images and sensory imagery. This in-depth investigation will help delineate the neurocognitive mechanisms governing the interaction between perception and imagination, offering new insights for the development of advanced assistive devices based on language. Integrating these data will allow the design of personalized tools that dynamically adapt to patients' needs, promoting functional recovery and improving individual autonomy through advanced interfaces.

Acknowledgements

This publication was produced with the co-funding of European Union - Next Generation EU, in the context of The National Recovery and Resilience Plan, Investment Partenariato Esteso PE8 "Conseguenze e sfide dell'invecchiamento", Project Age-It (Ageing Well in an Ageing Society), CUP: B83C22004800006. The work of Viviana Patti and Rossana Damiano is partially supported by

"HARMONIA" project - M4-C2, I1.3 Partenariati Estesi - Spoke 2 Cascade Call - FAIR - CUP C63C22000770006 - PE PE0000013 under the NextGenerationEU programme.

References

P.B. Baltes and J. Smith. 2003. New frontiers in the future of aging: From successful aging of the young old to the dilemmas of the fourth age. *Gerontology*, 49(2):123–135.

L. W. Barsalou. 1999. Perceptual symbol systems. *Behavioral and Brain Sciences*, 22(4):577–660.

L. W. Barsalou. 2008. Grounded cognition. *Annual Review of Psychology*, 59(1):617–645.

G. Brand and J.L. Millot. 2001. Sex differences in human olfaction: between evidence and enigma. *The Quarterly Journal of Experimental Psychology: Section B*, 54(3):259–270.

T. Canli, J. E. Desmond, Z. Zhao, and John D. E. Gabrieli. 2002. Sex differences in the neural basis of emotional memories. *Proceedings of the National Academy of Sciences*, 99(16):10789–10794.

C.J. Cascio, D. Moore, and D McGlone. 2019. Social touch and human development. *Developmental cognitive neuroscience*, 35:5–11.

D. J. Chalmers. 2024. Does thought require sensory grounding? from pure thinkers to large language models. *arXiv preprints*, page arXiv:2408.09605.

P.J. Davis. 1999. Gender differences in autobiographical memory for childhood emotional experiences. *J. of personality and social psychology*, 76(3):498.

Alix L. de Dieuleveult, Petra C. Siemonsma, Jan B. F. van Erp, and Anne-Marie Brouwer. 2017. Effects of aging in multisensory integration: a systematic review. *Frontiers in aging neuroscience*, 9:80.

R.L. Doty and E. L. Cameron. 2009. Sex differences and reproductive hormone influences on human odor perception. *Physiology & behavior*, 97(2):213.

H. Ehrlichman and J.N. Halpern. 1988. Affect and memory: effects of pleasant and unpleasant odors on retrieval of happy and unhappy memories. *Journal of personality and social psychology*, 55(5):769.

V. Gallese and G. Lakoff. 2005. The brain's concepts: The role of the sensory-motor system in conceptual knowledge. *Cognitive neuropsychology*, 22(3-4):455–479.

M. Grossman and W. Wood. 1993. Sex differences in intensity of emotional experience: a social role interpretation. *Journal of personality and social psychology*, 65(5):1010.

D.F. Halpern. 2000. *Sex differences in cognitive abilities*. Psychology press.

A. Hofer, C. M. Siedentopf, A. Ischebeck, M. A. Rettenbacher, M. Verius, S. Felber, and W. Wolfgang Fleischhacker. 2007. Sex differences in brain activation patterns during processing of positively and negatively valenced emotional words. *Psychological medicine*, 37(1):109–119.

S.M. Kosslyn, G. Ganis, and W. L. Thompson. 2001. Neural foundations of imagery. *Nature reviews neuroscience*, 2(9):635–642.

A.M. Kring and A.H. Gordon. 1998. Sex differences in emotion: expression, experience, and physiology. *Journal of personality and social psychology*, 74(3):686.

G. Lakoff. 2012. Explaining embodied cognition results. *Topics in Cognitive Science*, 4(4):773–785.

G. Lakoff and M. Johnson. 2008. *Metaphors we live by*. University of Chicago Press.

N. Leitan and L. Chaffey. 2014. Embodied cognition and its applications: A brief review. *Sensoria: A Journal of Mind, Brain & Culture*.

K. Z. Li and U. Lindenberger. 2002. Relations between aging sensory/sensorimotor and cognitive functions. *Neuroscience and Biobehavioral Reviews*, 26(7):777–783.

U. Lindenberger and P.B. Baltes. 1994. Sensory functioning and intelligence in old age: a strong connection. *Psychology and aging*, 9(3):339.

D. Lynott, L. Connell, M. Brysbaert, J. Brand, and J Carney. 2020. The lancaster sensorimotor norms: multidimensional measures of perceptual and action strength for 40,000 english words. *Behavior research methods*, 52:1271–1291.

V.A. Mann, S. Sasanuma, N. Sakuma, , and S. Masaki. 1990. Sex differences in cognitive abilities: A cross-cultural perspective. *Neuropsychologia*, 28(10):1063–1077.

R.E. Nisbett and T. Masuda. 2013. Culture and point of view. In *Biological and cultural bases of human inference*, pages 49–70. Psychology Press.

D.L. Schacter and D.R. Addis. 2007. The cognitive neuroscience of constructive memory: remembering the past and imagining the future. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 362(1481):773–786.

D.L. Schacter, B. Gaesser, and DR Addis. 2013. Remembering the past and imagining the future in the elderly. *Gerontology*, 59(2):143–151.

A. Schaefer and P. Philippot. 2005. Selective effects of emotion on the phenomenal characteristics of autobiographical memories. *Memory*, 13(2):148–160.

B. Spendlove and D. Ventura. 2019. Modeling knowledge, expression, and aesthetics via sensory grounding. In *Proc. of the Tenth Int. Conference on Computational Creativity, ICCC 2019, Charlotte, North Carolina, USA, June 17-21*, page 326. Association for Computational Creativity (ACC).

T. Uzer and S. Gulgoz. 2015. Socioemotional selectivity in older adults: Evidence from the subjective experience of angry memories. *Memory*, 23(6):888–900.

Q. Wang. 2021. Cultural pathways and outcomes of autobiographical memory development. *Child Development Perspectives*, 15(3):196–202.