Age related differences in affective face visual search among pareidolias under varying levels of stimulus prevalence

A Thesis submitted for the partial fulfillment of the requirements for the degree of

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Certificate

This is to certify that the thesis entitled *"Age related differences in affective face visual search among pareidolias under varying levels of stimulus prevalence"* submitted by Hargun Saluja (Roll No. 8624020018) is being submitted in partial fulfillment of the requirements for the award of the degree of Master of Arts in Clinical Psychology at the Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala.

This work is an original record of research carried out by the candidate under the supervision of Dr. Richa Nigam, Assistant Professor, Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala. It is further certified that this thesis has not been submitted, either in part or in full, for the award of any other degree or diploma at this or any other institution.

Date: 02.06.2026

Hargun Saluja
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This is to certify that the above statement made by the student concerned is true and correct to the best of my knowledge.

(Dr. Richa Nigam)
Assistant Professor,
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Candidate's Declaration

I, Hargun Saluja (8624020018), student of M.A. Psychology, declare that the work in this thesis titled "Age related differences in affective face visual search among pareidolias under varying levels of stimulus prevalence" is my original work. I completed this under the supervision of Dr. Richa Nigam, assistant professor at Thapar School of Liberal Arts and Sciences, Thapar Institute of Engineering and Technology, Patiala. This thesis is submitted in partial fulfillment of the requirements for the Masters of Arts in Psychology.

I also declare that this work has not been submitted either in part or full for any other degree or diploma at this or any other university. I have properly acknowledged and referenced all sources of information and previous studies in the thesis.

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Abstract

The goal of the current study was to examine how visual search performance is affected by how often the target appears (in low prevalence and high prevalence conditions) and emotional expression (angry vs happy faces). Visual search is an important cognitive function in which people look around them for a specific target among group of distractors. Earlier studies have shown that when the targets are rare, people are more likely to miss them. This is known as the Low Prevalence Effect (LPE). This study further explored the interactions between age and emotional content and its impact. In the current study participants performed a visual search task in which they were required to identify happy or angry faces among non-face distractors (pareidolia images). The task consisted of both low and high prevalence conditions that is sometimes the target appeared rarely and sometimes very often. The participants had to press "M" key whenever they saw a face and "Z" whenever thet thought that the face is not present. For both target present and absent trials reaction time and accuracy was noted. We also wanted to know when people would give up looking for the face when it was not there. So we also noted the reaction time for target-absent low prevalence trials. This was done to calculate the Quitting Threshold. In target-present high prevalence trials reaction time was used to assess the processing speed. The results showed that participants were less accurate in finding targets during low prevalence conditions supporting the presence of Low Prevalence Effect. Additionally reaction time patterns indicated that when targets are rare participants stopped searching. Emotional expression played a role as well as seen by the differences in the speed and accuracy for identifying angry and happy faces. Also compared to younger participants, older adults tended to search for longer periods of time and had slower reaction times, indicating age related variations in visual search behaviour.

Overall the findings suggest that both target frequency and emotional content influence how people search for and detect targets and that these processes may change with age.

Keywords: Cognitive Aging, Affective Bias, Visual Search, Target Prevalence, Pareidolias

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Chapter 1
Introduction

Visual search is a fundamental cognitive process that allows individuals to find relevant information in complex visual environments (Treisman and Gelade, 1980; Wolfe, 2021). It involves the allocation of attention to identify a target object among competing distractors in the visual field (Duncan, J., and Humphreys, G. W. (1989). In everyday life, visual search is involved in tasks such as finding a friend in a crowd, finding an object in a cluttered room, or watching displays for important signals. Laboratory-based visual search tasks create a controlled setting for exploring how attention is directed and how decisions are made during searches (Treisman and Gelade, 1980; Wolfe, 1994). Recent models of visual search highlight that attention is influenced by a mix of what stands out visually and what the observer wants to find. So, how efficiently someone searches depends on both the physical features of the stimuli and the thinking processes used to determine if a target is there (Jeremy M. Wolfe, 2021; Anne Treisman and Gelade, 1980).

1.1 Models of Visual Search

Earlier models of visual search such as Serial search models examined search patterns suggesting that attention focuses on one item at a time. On the other hand, parallel models argued that many items can be processed at the same time (Treisman and Gelade, 1980). However, growing evidence shows that this simple division is not enough. It is now found that visual search does not consider the differences in search performance across various tasks and conditions. Consequently, modern visual search models focus on how the features of stimuli and higher-level thinking work together to direct attention (Desimone and Duncan, 1995; ~~Wolfe, 2021~~).

Along with early serial and parallel models, several other frameworks have contributed to understanding visual search by focusing on different aspects of attention and perception. For instance the Feature Integration Theory proposed by Triesman and Gelade (1980) explains how simple visual features are processed automatically whereas the combination of multiple features requires focused attention. The Biased Competition Model (Desimone and Duncan, 1995) suggests that multiple stimuli in visual field compete for neural representation and in this competition attention is biased towards task-relevant items. In the same way Signal Detection Theory (Green and Swets, 1966) has been used to explain decision-making in visual search particularly how observers set decision criteria when they are not sure what to do. More recent perspectives also emphasize the role of decision making processes including quitting threshold and response biases in determining search outcomes (Wolfe and Van Wert, 2010; Peltier and Becker, 2017). These models together emphasize that visual search is not only a perceptual process but also involves attentional selection, cognitive control and decision making mechanisms.

One influential framework for understanding visual search is Wolfe's Guided Search Model (Desimone and Duncan, 1995; Humphreys, 1989;). According to this model, visual search is controlled by a priority map that is constantly updated. This map combines both bottom-up perceptual information and top-down task goals. Bottom-up processes involve factors driven by stimuli like color, contrast, orientation and other noticeable features that can draw attention automatically. On the other hand, top-down processes show the observer's intentions, expectations, and knowledge about the target, which affects how attention is directed. A central principle of the Guided Search model is that search efficiency depends on target and distractor similarity. When a target is very different from nearby distractors, it sends a strong priority signal and is detected more easily. On the other hand, when targets have many features in common with distractors, the search slows down and requires more effort. This principle has been backed by extensive research and helps explain differences in reaction time and accuracy in various visual search tasks (Duncan and Humphreys, 1989;). Importantly this approach shows that failures in visual search are not just due to perceptual limits, they also involve strategy and decision-making factors. While models like Guided Search explain search efficiency in many situations, they do not fully account for performance when targets are rare. Overall, the model suggests that visual search is both serial at some level as well as parallel at other levels while also emphasizing how perceptual salience interacts with cognitive control.

1.2 Target frequency and Visual Search

In real-world settings like medical screening, security monitoring, and surveillance tasks, targets are often rare yet locating them through a search process is crucial. This has led to an increased interest in how the rarity of targets affects visual search behavior. Studies have shown that when targets are rare, observers are more likely to overlook them, even when they stand out. This occurrence is called the low-prevalence effect (LPE; cite any paper other than wolfe describing LPE). LPE refers to a noticeable rise in missed errors and shifts in response patterns when target appear rarely. Wolfe et al., (2005) explored the influence of target prevalence in a search context which pertains to how often target shows up in a task. They showed that when target prevalence is low, people respond more quickly on target-absent trials and show less sensitivity on target-present trials. These effects cannot be completely explained by how hard it is to perceive the targets. They seem to reflect adjustments in decision-making strategies that observers use when they expect targets to be less frequent. As a consequence, people tend to stop searching sooner when they think targets will be rare instead of searching the display carefully. A key idea therefore related to the LPE is the quitting threshold. This is the point in the search process at which an observer decides to stop searching and concludes that a target is absent. Researchers often measure the quitting threshold by looking at the reaction times during target-absent trials. These trials typically show how long an observer is willing to keep searching before concluding that no target is present. Lower quitting threshold leads to a quicker end to the search and higher miss rates especially in low-prevalence situations. Individual differences in cognitive control, attentional capacity and response caution can affect quitting threshold (Peltier and Becker, 2017)). This suggests that ending a search is an active decision rather than just a result of perceptual failure (Wolfe et al., 2005; Peltier and; Becker, 2017).

1.3 Affective face stimuli and visual search

In addition to target prevalence and decision thresholds, the nature of the target itself plays an important role in visual search. Faces are strong visual cues and emotional facial expressions in particular can greatly affect attention. Emotional faces like angry or happy expressions may grab our attention more effectively than neutral faces because of their social and evolutionary importance. Human observers are very sensitive to faces and facial expressions convey key emotional information that can direct attention (Calvo and; Marrero, 2009).. Emotional expressions like anger or happiness may be prioritized during visual processing because they indicate possible threats or rewards (Wang, J., et al., 2015). Research on visual search for emotional faces shows that people detect certain emotional expressions, especially happy faces more efficiently than neutral ones (Calvo and Marrero, 2009). In contrast, other research finds that expressions like anger or sadness are detected more slowly or with less accuracy (Calvo and

Marrero, 2009) although these effects are often influenced by perceptual features like distinctiveness. For example, expressions with clear, distinctive features might be recognized faster than those that are less distinctive. This suggests that both emotional content and perceptual traits impact search performance (Calvo and Marrero (2009).

1.4 Aging and affect-based visual search

In addition, age-related differences make the relationship between visual search, target prevalence and emotional processing more complex. Research on visual search throughout life shows that changes in age can impact processing speed, attention control and decision-making strategies, which in turn influence search performance (Goodhew et al., 2024; Thomas A. Salthouse, 1996; Arthur F. Kramer et al., 1999; Madden, 2007; Humphrey and Kramer, 1997).. Research over time showed that older adults usually have slower reaction times in visual search tasks than younger adults (Madden,2007; Humphrey and; Kramer, 1997). However, extant researches have been effectively reporting the existence of a ‘positivity effect’ among elderly population in comparison to younger adults while processing positive stimuli (Nigam and Kar, 2025; Nigam and Kar 2021). What this pertains to is that older adults prioritize positive emotions over negative or neutral emotions (Mather and Carstensen, 2005).

Socioemotional Selectivity Theory (SST) proposed by Laura L. Carstensen (1992) provides an important framework for understanding age related differences in emotional processing. According to SST, individuals’ goals and priorities change across the lifespan as their perception of time changes. Younger adults generally perceive time as expansive and future oriented, leading them to prioritize goals related to knowledge acquisition, exploration and future planning.

On the other hand, older adults perceive time as more limited and therefore give greater importance on emotionally meaningful experiences and emotional regulation (Carstensen, 1992; Carstensen et al., 2003).

This motivational change makes older adults attend more to positive emotional information and less to negative or threatening stimuli. This phenomenon is commonly known as the positivity effect. Research indicates that older adults are more likely to pay attention, remember and process positive information more than negative information, while younger adults are more sensitive towards negative or threatening stimuli (Mara Mather and Carstensen, 2005; Susan Turk Charles et al., 2003). Such differences in emotional priorities may affect attentional processes and visual search behavior in tasks with emotional stimuli.

Socioemotional Selectivity Theory predicts that older adults might respond differently to emotional facial expressions compared to younger adults when engaged in emotional visual search. and visual search behavior in tasks with emotional stimuli.

Attention captured by negative emotions (eg. angry faces) are more likely to affect younger individuals due to greater sensitivity to threat related information (Arne Öhman et al., 2001). However older adults may show relatively decreased responsiveness to negative stimuli and may instead attend more to positive or emotionally salient stimuli (Mara Mather and Laura L. Carstensen, 2005). Thus the emotional valence differentially affect visual search performance across different age groups.

The present study draws upon Socioemotional Selectivity Theory to explain potential age related differences in emotional visual search performance. By examining responses to happy and angry facial expressions under different target prevalence conditions the study aims to understand how age-related motivational and emotional processing differences influence distribution of attention, reaction time and search decision.

In addition to the above findings, evidence indicates that older adults might use more careful decision-making strategies during complex visual searches. This can lead to higher quitting thresholds or changes in response criteria in some situations (Ratcliff et al., 2006; Goodhew et al., 2024). These findings may implicate that differences in cognitive control and response strategy related to age may affect performance in low-prevalence search situations which need careful examination.

Overall, we may see that despite much research on visual search, target prevalence and emotional face processing, specific research is limited on how target prevalence affects reaction time, accuracy and quitting threshold when the targets are emotional faces as well as when the target shares characteristics with the distractors that so often is found to be the case in real life sitautions. It is important to address this gap to improve theoretical models of visual search and to understand how emotional significance interacts with decision-making when targets are rare.

Chapter 2

Literature Review

Visual Search is a basic cognitive process that involves finding a target stimulus among various distractors in a visual setting. Research in cognitive psychology has examined how attention is directed during visual search (Wolfe,2021). Early theories of visual search like Feature Integration Theory suggested that visual features such as color and orientation are processed at the same time. On the other hand more complex combinations of features need focused attention and step by step processing (TriesmanandGelade,1980). However later models showed that visual search is not simply serial or parallel. Modern models such as Wolfe’s Guided Search Model says that attention is directed by a combination of visually salient features and the observer’s goals or expectations (Wolfe,2021). Recent researches have focussed on various factors that may drive visual search thereby increasing search efficiency and hence decision making.

2.1 Factors influencing visual search

a) Wolfe and Van Wert (2010) suggested that two different decisions are made during a search for target. There are two types of decisions- a perceptual decision about the presence of a target and a decision about when to stop a search. In situations where target is rare decisions about quitting is made. This means that a search is stopped sooner resulting in quicker reactions to target absent trials and more missed targets. This leads to the emergence of **quitting threshold** which is determined by the amount of evidence or time a person may need before concluding that the is absent in a trial and stop the search. Studies have shown that individuals with higher quitting thresholds or those who continue to look longer perform better I low prevalence conditions (Peltier and Becker, 2017; Thomson and Goodhew, 2021). This shows that low prevalence effect is not only due to perception but decision making is also involved.

b) An important factor influencing quitting threshold is **target prevalence**. It is another aspect of visual search that has been widely studied, particularly with regard to how frequently a target is presented. In real world scenarios a target is typically rare like in cancer detection or forbidden in baggage screening. Studies have consistently shown that when target is rare, it is more likely to be missed, phenomenon referred to as low prevalence effect (Wolfe et al.,2005). This is not only an attention related effect but also involves decision-making. The low prevalence effect consists of increased miss rate and response times in target absent trials when the target has low prevalence. Wolfe et al (2005) found that when targets are rare the subjects are more likely to end the search too early which results in an increased miss rate. This finding is very important for real world tasks where failing to detect a target can have serious consequences. A possible reason for the low prevalence effect is change in decision criteria.

Decision criteria refers to the internal threshold that people use to determine whether a target is present or absent in visual search task. In other words, it shows how much evidence a person requires before responding that a target is present. When targets are rare individuals tend to adopt a more conservative decision criterion which means they need more proof before confirming a target's existence. This raises the possibility of missing real targets. As a result participants may end their search earlier which reduces search time in target-absent trials but also decreases overall detection accuracy (Wolfe, J. M., Horowitz, T. S., and Kenner, N. M. (2005).

On the other hand when targets are more frequent individuals may adopt a more liberal decision criteria where they are more willing to respond that a target is present present even with less evidence. This can increase detection rates but may also lead to more false alarms. Thus changes in decision criteria directly influence both the efficiency and accuracy of visual search as they determine how long an individual continues searching and how confident they need to be before making a response.

c) Other than prevalence and decision making, another important factor in visual search is the nature of target stimulus. For eg. Human **faces** as target stimuli have been of particular interest in the visual search researches due to their social significance. It has been noted that humans have the ability to process faces quickly. Also faces are of great importance as they convey emotional states like threat or reward (Vuilleumier,2005). Research on emotional faces in a visual search task however have yielded mixed results. Some have found an anger superiority effect which indicates that threatening stimuli such as angry faces are detected faster because of heir evolutionary importance (Hansenand Hansen, 1988; Ohman et al, 2001). In this case the faster detection of threatening stimuli would benefit the search. Whereas other research findings have challenged this perspective arguing that emotional expressions are not necessarily more efficient in detection. Calvo and Marrero (2009) found that happy expressions are more likely to be detected quickly than angry or neutral expressions. This was explained by the distinctiveness of happy faces characterized by the presence of teeth in the stimulus which makes them easier to detect. In another study, Juth et al (2005) showed that detection efficiency was influenced by the presence of certain visual features and emotional expressions. These results suggested that visual search of emotional faces is not only affected by their affective meaning but also by their perceptual characteristics. The more visually distinctive the emotional expression is, the more it is likely to guide attention. This is in line with general models of visual search that emphasize the role of perceptual distinctiveness in guided attention (Duncan and Humphreys 1989).

In addition to target characteristics, the type of distractor stimuli can also affect visual search performance. In most traditional visual search experiments distractors were neutral objects. However some recent visual search experiments have used pareidolia stimuli which are stimuli with images of objects with face like features. Pareidolia refers to the tendency of seeing meaningful patterns, especially faces in ambiguous visual stimuli (Liu et al 2014). Previous studies have shown that pareidolia images can generate similar responses to face processing mechanisms as actual faces (Wardle et al 2020). This implies that face distractors may have similar effects on attentional competition as those of real faces. Therefore it can be stated that pareidolia stimuli can be considered as useful tools for examining the effects of similarity and ambiguity on visual search. Pareidolia stimuli is relevant in the study of facial targets as they add a competitive element that is more representative of the real world. The addition of face like distractor stimuli in the study provide the ability to examine the division of attention when multiple objects have similar structural properties. The role of distractor type is becoming more important in current visual search research. The traditional method of using simple or easily distinguishable distractor types is different from the complex and undistinguishable objects that we see in real life. The use of pareidolia images can make the task more difficult because they can trigger face processing systems (Liu et al,2014; Wardle et al,2020).

d) Another important factor that determines the efficiency of visual search is the **similarity between target and distractors.** Duncan and Humphreys (1989) suggest that visual search is more difficult when the target and distractors have common features and easier when the targets are unique. Visual search is not only dependent on the presence of the target but also on the ability of the target to be unique. There hasn't been much research on human faces as targets and face pareidolia as distractors in the recent past in an affective context to explore the efficiency of visual search.

e) Recent research has shown that in addition to perception , decision making also plays an important role in visual search performance (Wolfe and Van Wert, 2010; Peltier and Becker, 2017). People are always making adjustments to how they respond based on what they are doing, what they expect and what they have done in the past. In complex tasks with emotional and ambiguous stimuli these adjustments may become even more prominent influencing search outcomes.

2.2 Visual Search and emotions:

Even though a lot of research has been done on visual search not a lot has been explores over the interaction of target prevalence, emotional expression and distractor features together. For example research on low prevalence effect has mostly been done using neutral targets or object targets rather than emotional targets (Wolfe et. al., 2005; Wolfe et al, 2007). Similalry research on emotional face processing has rarely manipulated target prevalence (Calvo and Marrero,2009; Juth et al, 2005) and research on distractor processing has mostly used neutral or non face distractors which may not be representatives of real world tasks (Duncan and Humphreys, 1989; Wolfe, 2021). It is just in the recent times that the researches have begin to indicate that attention is greatly influenced by how well the stimuli of the task align with task demands, target prevalence, emotional relevance and perceptual features of the stimuli. This means the effectiveness of attention depends on how well the features of the stimuli align with the demands of the task such as how frequently the target appears, how emotionally relevant it is and how visually different it is from the distractors. For instance, emotional significance may influence attention differently depending on aforementioned factors such as how frequently stimuli appear and how liberal or conservative individuals tend to be (Vuilleumier,2005; Ohman et al,2001). When stimuli appear rarely and individuals tend to be conservative in their decisions emotionally significant stimuli can both increase or decrease the number of misses depending on how salient and relevant they are (Peltier and Becker,2017; Goodhew and Edwarda, 2024). Thus it is important to examine emotional and cognitive factors together rather than alone. The way that emotional targets and face like distractors work together is important because it can have similar effects on perception. This can mean that there is more competition for attention which may make reactions slower and less accurate. However there has been little research on the way that this competition occurs especially under different prevalence conditions. This helps to improve models of visual search which often look at perception or decision making but not the way that the two interact.

The current study aims to fill these gaps by examining how people perform visual searches for emotional face targets under different prevalence conditions using pareidolia distractors. By combining emotional significance, target prevalence and perceptual ambiguity within one step the study aims to give a clearer understanding on how attention and decision making work together during visual searches.

2.3 Visual search and Aging:

Visual search performance has been widely studied in relation to aging. Research has consistently shown that aging is related with changes in attention, processing speed and search efficiency. Studies have found that older adults generally show slower reaction times in visual search tasks compared to younger adults even when accuracy remains similar. This slowdown is more noticieable in tasks that need greater attention control or have complex distractors.

Recent work has improved our understanding of visual search in aging by emphasizing changes in both processing speed and decision making strategies. The research has indicated that older adults have a more conservative response criteria especially in tasks involving uncertainity or low prevalence of targets. That means that they may search longer for determining that a target is absent rather than terminating the search early. Such findings show that age related differences in visual search are not only due to perceptual decline but also on decision strategies made during the task. Additionally recent work has found that aging influences the interaction between attentional guidance and target prevalence showing that older adults may rely more on top-down control mechanisms compared to younger individuals (Hannah J. Goodhew et al., 2024; Jeremy M. Wolfe, 2021).

Furthermore older adults tend to be less efficient in scanning visual environments often and require more time to locate targets (Hayes et al., 2023). Research also suggests that aging is related with reduced ability to ignore irrelevant distractors and increased sensitivity to interference, which further impacts search efficiency (Hasher and Zacks, 1988; Kramer et al., 1999; Hayes et al., 2023). These changes may be due to decline in cognitive control, attentional flexibility and perceptual processing speed.

However it is important to note that older adults may make up for these declines by relying more on contextual or semantic information during search. For example they may use their past knowledge about the environment to guide their attention which can sometimes help maintain performance despite of slower processing. Thus visual search in aging is a reflection of both decline in basic processing mechanisms and compensatory strategies that help maintain task performance.

2.4 Emotional Visual Search And Aging

While general visual search has been widely studied in aging, little studies have looked how emotional cues affect visual search in older persons. Age related changes in emotional processing make this important. According to earlier studies older persons tend to process emotional information differently compared to younger adults often showing bias towards positive information and decreased sensitivity to negative stimuli a process known as the positivity effect Laura L. Carstensen et al. (2003).

Because of this age related differences in emotional processing the addition of emotional stimuli in visual search tasks may influence performance differently in older adults as compared to younger individuals. For example emotional expressions such as happy or angry faces may capture attention in different ways depending on their emotional relevance and salience. While younger adults may not show the same pattern due to changes in emotional priorities and attentional biases.

Therefore including different emotional stimuli (eg. Positive vs negative) in visual search tasks is important as it shows different effects on attention, response time and accuracy across age groups. Emotional content may either enhance or improve or impair search effectiveness. Because of this emotional visual search is an important topic to explore in relation to aging.

More recent research has begun to look at the interaction between emotional information and attentional processes in aging populations. Emotional stimuli can differently influence visual search depending on their valence and observer's relevance (Ralph Adolphs, 2002; Andrew J. Calder et al., 2011). Since older adults often focus on emotionally significant information including emotional stimuli in visual search tasks is very important.

Socioemotional Selectivity Theory (SST) provides an important explanation for age related differences in emotional processing. According to SST, as individuals grow older and begin to perceive their remaining time in life as limited, their motivational goals gradually shift from future oriented goals such as knowledge acquisition towards emotionally meaningful goals and emotional satisfaction (Carstensen et al., 1999). Because of this motivational shift, older adults tend to prioritize positive emotional experiences and avoid negative emotional information in order to maintain emotional well being. This phenomenon is commonly referred to as the "positivity effect" (Mather and Carstensen, 2005). In the context of emotional visual search, this suggests that older adults may allocate greater attention towards positive emotional stimuli such as happy faces, while showing reduced attentional bias towards negative stimuli such as angry faces. Therefore, SST helps explain why emotional valence may influence visual search performance differently across younger and older adults.

Future Time Perspective (FTP) theory is closely related to SST and further explains how perception of time influences emotional and cognitive processing. FTP suggests that when individuals perceive their future as expansive, they are more likely to focus on information seeking, exploration, and future goals. In contrast, when future time is perceived as limited, as commonly observed in older adulthood, individuals become more focused on emotionally meaningful experiences and emotional regulation (Lang and Carstensen, 2002). This shift in future time perception can influence attentional processes and decision making during visual search tasks. Older adults may therefore show greater attentional preference for emotionally rewarding or positive stimuli while paying less attention to threatening or negative emotional cues. These motivational and attentional shifts provide an important framework for understanding emotional visual search performance across aging populations.

2.5 Research Objective

The present study aimed to examine how target prevalence influences visual search performance in the context of emotional face detection. This study builds on earlier research about the low prevalence effect (LPE). It specifically looks at how the rarity of frequency of targets impacts both attention and decision making during search tasks.

The study also aimed to explore how emotional valence of the stimuli affects visual search performance. Emotional facial expressions especially negative ones like angry faces and positive ones like happy faces are known to capture attention differently. Therefore this study included emotional face targets- happy and angry expressions to check if emotional content works with target prevalence to influence reaction time and accuracy. This made possible the testing of whether stimuli related to threats (angry faces) are more efficiently recognized than non threatening or positive stimuli and whether such differences vary depending on whether the targets are rare or frequent.

A key objective of the study was to examine whether age related differences exist in visual search performance particularly in relation to the low prevalence effect. Specifically the study compared younger and older adults to determine whether older adults exhibit reduced LPE particularly due to differences in attentional strategies or decision criteria. Overall the study aimed to provide a detailed understanding of how target prevalence, emotional valence and aging interact to affect visual search performance, attentional processes and decision making strategies.

2.6 Hypothesis

H_1: Participants will show a low prevalence effect (LPE) such that they will make more errors in low prevalence conditions and respond faster in high prevalence conditions.

H_2: Emotional facial expressions (angry and happy faces) will affect visual search performance differently in both the age groups. AGE RELATED SLOWING in RTs

H_3: Older adults will show slower reaction times and higher quitting thresholds compared to younger adults during the visual search task. Higher LPE in younger adults than older adults.

Chapter 3

Methodology

3.1 Participants

A total of 120 participants- 60 young and 60 old (Mean age Young: 28.5 years, Old- 67.5 years) volunteered for the study from Thapar Institute of Engineering And Technology, Patiala and the city of Ludhiana. All participants had normal or corrected vision and provided informed consent before taking part in the experiment. Neuropsychological profiling was conducted to control for any neurological or psychological disorders.

3.2 Measures:

Demographic information was collected using a structured demographic form that included details regarding age, gender, educational qualification, occupation and family history of neurological or psychiatric conditions. In addition, all participants underwent cognitive and neuropsychiatric screening to ensure their suitability for participation in the study. The final sample included only those participants who met the inclusion criteria and screening requirements (refer to Table 1).

3.2.1 Addenbrooke's Cognitive Examination–Revised (ACE-R; Mioshi et al., 2006) *;*

In order to examine the cognitive functioning of older people and detect the presence of any impairment, the English or Hindi version of Addenbrooke's Cognitive Examination- Revised

(ACE-R) was used on them which was created by Mioshi et al., (2006). ACE-R is an effective neuropsychological screening test that examines different areas of cognitive functioning.

The examination assesses five major cognitive domains: attention and orientation, memory, verbal fluency, language and visuospatial abilities. The total score ranges from 0-100, with higher scores indicating higher cognitive functioning, whereas lower scores suggests the presence of cognitive impairment.

The administration of the ACE-R ensured that older participants included in the study did not show significant cognitive deficits that could interfere with task performance. Only participants who obtained scores within the normal cognitive functioning range were included in the final sample for analysis.

3.2.2 Neuropsychiatric Inventory (NPI; Cummings et al., 1994)

The Neuropsychiatric Inventory (NPI), developed by Jeffrey L. Cummings et al. (1994) was administered to assess the presence and severity of neuropsychiatric and behavioral symptoms among different participants. The NPI is a widely used clinical assessment tool designed to evaluate behavioral and psychological disturbances that may affect cognitive functioning, emotional processing, attentional control, and everyday behavior. The use of NPI in the present study helped ensure that participants included in the sample did not have clinically significant neuropsychiatric symptoms that could interfere with performance on the emotional visual search task.

The inventory assesses twelve major behavioral domains namely: Delusion; Hallucinations; Agitation or Aggression; Depression or dysphoria; Anxiety or indifference; Disinhibition;

Irritability or Emotional lability; Aberrant motor behavior; Night time behavioral disturbances and Appetite and eating abnormalities.

Each domain was rated in terms of frequency, severity and associated distress. Frequency was scored on a scale of 1-4, severity on a scale of 1-3 and distress on a scale of 0-5. A total NPI score was calculated with higher scores indicating greater neuropsychiatric disturbance. Participants showing clinically significant neuropsychiatric symptoms were excluded from the study to ensure that emotional and behavioral disturbances did not influence visual search performance.

Table 1: Demographics

Category	**Demographic Variables**	**Young**	**Old**
	Mean Age	**28.5**	**67.5**
	Mean Education in years	17.80	14.90
Occupation	Student	100%	Not applicable
Language	Monolingual	0%	0%
	Bilingual	100%	100%
Health	Diabetes	Non applicable	40%
	Hypertension	Non applicable	43%
	others	Non applicable	17%
Neuropsychological Profile score	MMSE	29	27.92
	NPI	1.84	3.12

3.3 Design

The present study used a mixed factorial experimental design to examine the age related differences (among young vs old) that served as between subject variables over emotional visual search (angry vs happy) under varying levels of target prevalence (high, low) both of which served as within subject variables and on visual search performance.

Participants completed visual search trials under both high and low target prevalence conditions and were required to identify emotional facial targets (angry or happy) among distractor stimuli (pareidolias) Performance was assessed across different trial types, including target-present and target-absent trials.

3.4 Materials and stimuli

Target stimuli consisted of facial images representing two emotional expressions: angry and happy faces. A total of 220 emotional facial images were used including 110 angry faces and 110 happy faces. All facial stimuli were standardized in terms of size, resolution, and visual presentation to maintain uniformity across trials. The target images were presented on a neutral gray background and were included in the visual search arrays during target-present trials.

Both low prevalence and high prevalence blocks shared 36 target present images (18-happy and 18-angry) to account for possible image specific effects across prevalence conditions. In the high-prevalence condition, multiple emotional facial stimuli were presented across the target-present trials. This helped ensure that the differences observed between prevalence conditions were not simply due to participants becoming familiar with or repeatedly exposed to the same target images.

Distractor stimuli consisted of 64 pareidolia images. These distracting stimuli were chosen from previously conducted experiments that used face like items in visual search paradigms as well as publicly accessible image databases (Wardle et al.,2020). The distractor images were further carefully excluded in the current study if they do not visually resemble facial patterns. The primary requirement for inclusion was that the object must be perceived as having a face while yet being a non facial stimulus. Additionally, a number of exclusion criteria were used while choosing stimuli. The stimulus set did not include any images with real human faces, cartoon faces, exaggerated facial representations or easily identifiable facial features. Moreover, images with strong emotional content, excessive visual complexity or extremely noticeable visual cues that might help target recognition were excluded. This prevented distracting stimuli from unintentionally serving as emotional targets and kept them perceptually ambiguous.

All distractor stimuli were standardized in terms of image size and resolution to reduce low level perceptual differences between stimuli and ensure consistency between trials. By generating face like competition during visual search the addition of pareidolia distractors increased the task's perceptual difficulty and made it more sensitive to differences in attentional and emotional processing across age groups and prevalent conditions.

3.5 Experiment Structure and Procedure

Participants were tested individually in a quiet and well lit environment. Before the experimental task, participants provided written informed consent and completed a demographic questionnaire containing information regarding age, gender, educational qualification, occupation and relevant medical history. After this participants underwent cognitive and neuropsychiatric screening procedures to assess their neurological and cognitive functioning and to ensure their stability for participation in the study. Participants then received standardized instructions explaining the nature of the visual search task and the response procedure.

The experiment was programmed and administered using OpenSesame version 4.1 experimental software. All stimuli were presented on a desktop or laptop computer monitor and participants' responses were recorded using a standard computer keyboard. The design of the trials were similar to Goodhew and Edwards (2024). Participants were told that an array of 10 images would be shown on the screen at a time for each trial. Their job was to identify whether the array contained a target emotional face or not. They were told to press the “M” key when they saw a target face and the “Z” key when they didn’t. Participants were told they may take enough time to make their choice but they were still expected to react as fast and precisely as possible. Every trail presented the target emotional face at a randomly chosen location within the array during target present trials. All 10 images displayed in target absent trials served as distracting stimuli. The positions of all images within the array were randomized across trials and arranged along an imaginary circular layout around the center of the screen with each image’s placement being randomized throughout trials. The images were placed with proper spacing so that there was little or no overlap with each other.

A total number of 880 trials were there in the experiment with 440 low prevalence trials and 440 high prevalence trials. The low prevalence condition was presented with a target only 8% of the time (36 trials out of 440 were target present trials). Out of these 36 target-present trials, 18 trials consisted of angry facial expression and 18 consisted of happy facial expression. In the high prevalence block, targets were presented 50% of the time (220 trials out of 440 were target present trials) where 110 trials consisted of angry facial expressions and 110 of happy facial expressions.

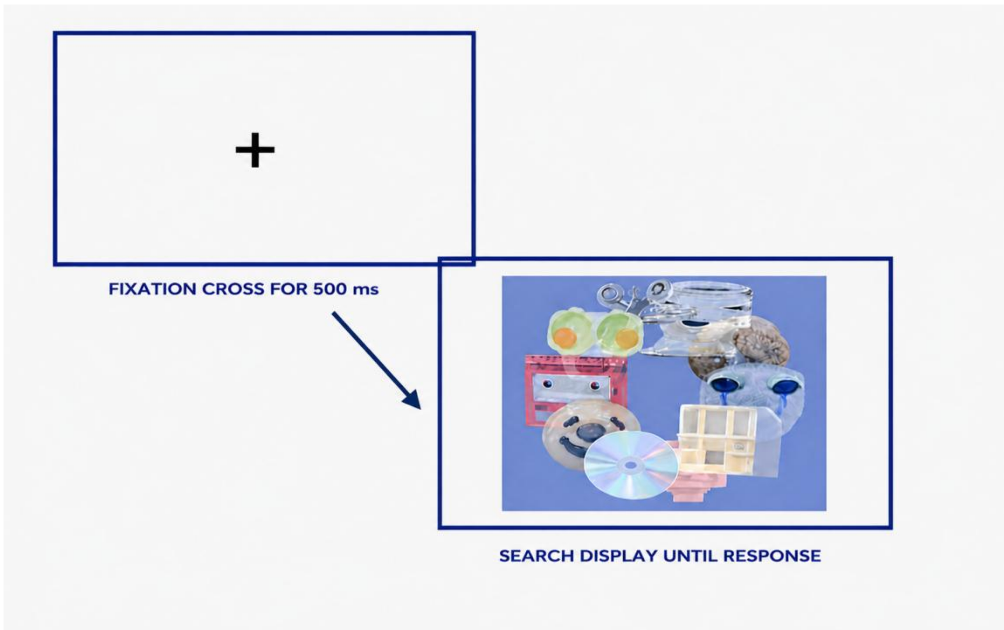

Figure 1 (Trial Structure)

3.6 Statistical Analysis

The primary dependent variables measured in the study were:

a) Reaction time (RT) measured in miliseconds. Median RT was compute to reduce data sensitivity to outliers. Median reaction time was computed separately for target present trials, target absent trials and across each prevalence condition.

b) Accuracy assessed using hit rates and correct rejection rates. Another derived measure was LPE, a score computed as a difference between Low prevalence trials accuracy from that of high prevalence trials accuracy.

c) Quitting Threshold (RTs of low prevalence target absent trials). Quitting Threshold showed the amount of time participants needed to determine that the target was missing from the display. The study's design made it possible to examine how target prevalence, emotional valence, and aging affect attentional distribution, visual search effectiveness and decision making processes.

To examine the effects of age, emotional valence and target prevalence, on visual search performance, a three-way mixed factorial repeated measures analysis of variance (ANOVA) was conducted. Target prevalence (high vs low) and target emotion (angry vs happy) were treated as within subject variables and age group (young vs old) was treated as between subject variable. Reaction time, accuracy and quitting threshold served as primary dependent variables.

Independent sample t-tests were conducted to compare younger and older adults on overall reaction time, overall accuracy and low prevalence effect (LPE). Paired sample t-tests were additionally used to compare participants' performance across prevalence conditions and emotional conditions within subjects.

Before analysis assumptions of normality and homogeneity of variance were assessed. Levene's test was used to examine equality of variances across groups. After the repeated measures Anova, Welch's Anova was additionally conducted in cases where the assumption of homogeneity of variance was violated, in order to obtain more robust results under conditions of unequal variance. Effect sizes were interpreted using partial eta squared (η^2p) for Anova analyses and Cohen's d for t-tests. Statistical significance for all analyses was determined at $p < .05$.

Spearman's rank order correlations were also conducted to examine the relationship between quitting threshold and LPE magnitude, and the relationship between processing speed and LPE. The purpose of this research was to gain a better understanding of age related processing differences and search ending choices affect low prevalence effect during emotional visual search.

Chapter 4
Results

4.1 Repeated Measures ANOVA: 2 age (young, old), 2 target emotion (angry vs. happy), and 2 target prevalence (high vs. low) using median RTs

A three-way ANOVA was conducted using 2 age (young, old), 2 target emotion (angry vs. happy), and 2 target prevalence (high vs. low) using median RTs. The results revealed the main effect of age as significant, F (1, 118) = 1210.00, $p < .001$, $\eta^2p = .911$, indicating that younger adults (234.7ms) were faster in comparison to older adults (460.1ms) across conditions.

The main effect of emotion was significant, F (1, 118) = 518.10, $p < .001$, $\eta^2p = .815$, indicating overall faster responses by both the age groups for angry (336.132ms) targets in comparison to happy (356.375ms) targets.

A significant main effect of target prevalence was observed, F (1, 118) = 1465.00, $p < .001$, $\eta^2p = .925$, indicating that both the age groups were faster in high-prevalence condition (318.25ms) in comparison to low-prevalence conditions (374.25ms).

The two-way interaction between age and prevalence was significant, F (1, 118) = 141.20, $p < .001$, $\eta^2p = .545$. *Post hoc* analysis revealed that younger adults were faster in both high-prevalence condition (M = 187.2 ms) in comparison to older adults (430.1 ms) as well as low prevalence conditions (young = 256.8 ms, old = 470.4 ms), t (118) = -38.16, $p < .001$ and t (118) = -42.31, $p < .001$, respectively.

The interaction between emotion and age was not significant, F (1, 118) = 2.22, $p = .139$, $\eta^2p = .018$, suggesting that both younger and older adults showed similar patterns of reaction time across angry and happy emotional conditions, with no substantial variation in emotional processing between the two age groups.

The interaction between emotion and prevalence was not significant, F (1, 118) = 1.21, $p = .274$, $\eta^2 p = .010$, indicating that the combined effect of emotional valence and prevalence did not significantly influence reaction times.

The three-way interaction among emotion, prevalence, and age was significant, F (1, 118) = 8.57, $p = .004$, $\eta^2 p = .068$, indicating that the effect of emotional valence under high- and low-prevalence conditions differed between younger and older adults for difference levels of target prevalence. Specifically, younger and older adults showed different reaction time patterns for angry and happy faces across prevalence conditions, suggesting that age influenced how emotional targets were processed when target frequency changed.

Among younger adults, reaction times in the Angry High condition (M = 187.22, SD = 35.43) were significantly faster than in the Angry Low condition (M = 256.83, SD = 46.25), $t(59) = -34.53$, $p < .001$. Similarly, Happy High trials (M = 205.05, SD = 37.10) were responded to significantly faster than Happy Low trials (M = 282.16, SD = 48.69), $t(59) = -32.71$, $p < .001$. Younger adults also showed significantly faster responses for Angry High compared to Happy High conditions, $t(59) = -11.78$, $p < .001$, indicating quicker detection of angry emotional targets under high-prevalence conditions. In addition, Angry Low trials were significantly faster than Happy Low trials, $t(59) = -15.32$, $p < .001$. Overall, younger adults demonstrated faster responses for angry targets and for high-prevalence conditions.

Among older adults, reaction times in the Angry High condition (M = 430.08, SD = 35.10) were significantly faster than in the Angry Low condition (M = 470.39, SD = 28.51), $t(59) = -17.14$, p

< .001. Happy High trials (*M* = 450.71, *SD* = 35.34) were also significantly faster than Happy Low trials (*M* = 487.62, *SD* = 26.23), $t(59) = -12.37$, $p < .001$. Older adults further showed significantly faster responses for Angry High compared to Happy High conditions, $t(59) = -10.01$, $p < .001$. They also showed significantly faster responses in Angry Low prevalent trials than Happy Low trials, $t(59) = -8.60$, $p < .001$. Overall, both younger and older adults responded faster to angry emotional targets compared to happy targets and showed quicker responses in high-prevalence conditions compared to low-prevalence conditions. However, older adults demonstrated generally slower reaction times across all emotional and prevalence conditions relative to younger adults.

Post hoc independent samples *t*-tests were conducted to further examine age-related differences across emotional and prevalence conditions. Results showed that younger adults responded significantly faster than older adults in all conditions.

For the Angry High condition, younger adults demonstrated significantly faster reaction times compared to older adults, $t(118) = -37.73$, $p < .001$, with a mean difference of -242.86 ms. Similarly, in the Angry Low condition, younger adults responded significantly faster than older adults, $t(118) = -30.45$, $p < .001$, with a mean difference of -213.56 ms.

In the Happy High condition, younger adults again showed significantly faster responses than older adults, $t(118) = -37.14$, $p < .001$, with a mean difference of -245.66 ms, 95% CI [-258.76, -232.57]. Likewise, for the Happy Low condition, younger adults responded significantly faster than older adults, $t(118) = -28.77$, $p < .001$, with a mean difference of -205.46 ms, 95% CI [-219.60, -191.32].

Levene's tests for equality of variances were significant across all conditions, indicating violation of homogeneity of variance assumptions: Angry High, $F(1,118) = 7.69$, $p = .006$; Angry Low, $F(1,118) = 31.40$, $p < .001$; Happy High, $F(1,118) = 7.80$, $p = .006$; and Happy Low, $F(1,118) = 38.33$, $p < .001$. Overall, the findings indicate that older adults exhibited slower reaction times than younger adults across both emotional valence and prevalence conditions.

4.2 Welch Anova

Since Levene's test for equality of variances was significant, $F\ (1,\ 118) = 32.27$, $p < .001$, the assumption of homogeneity of variance was violated. Therefore, Welch's ANOVA was conducted as a more robust alternative to the standard ANOVA.

The Welch ANOVA revealed a significant effect of age on overall reaction time, $F\ (1,\ 101.2) = 1174.00$, $p < .001$, $\eta p^2 = .909$. Descriptive statistics showed that older adults ($M = 460.1$ ms, $SD = 27.75$) demonstrated significantly slower reaction times compared to younger adults ($M = 234.7$ ms, $SD = 42.74$).

These findings indicate that age had a strong effect on visual search performance, with older adults showing substantially slower processing speed during the task compared to younger adults.

4.3 Independent Sample T-test

An independent sample *t*-test was conducted to examine age-related differences in LPE scores. The results revealed a significant difference between younger and older adults, $t\ (118) = 3.03$, *p*

= .003, Cohen's *d* = 0.55. Younger adults (*M* = 6.41, *SD* = 6.12) demonstrated significantly higher LPE scores compared to older adults (*M* = 3.70, *SD* = 3.26), indicating a stronger low prevalence effect among younger participants.

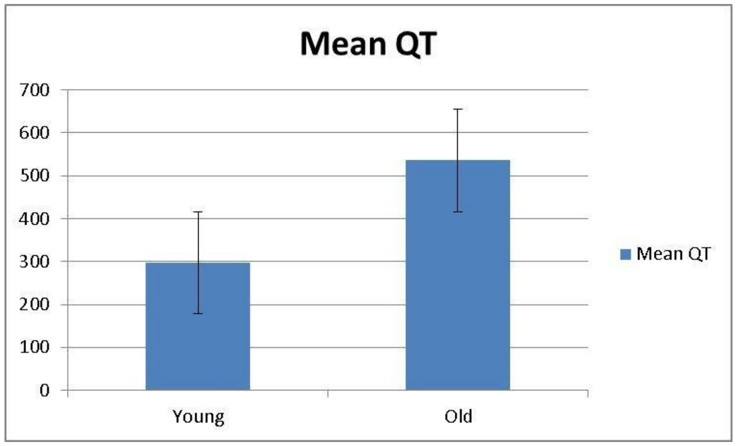

Figure 2: Quitting Threshold Magnitude among young and old

Assumption testing using the Shapiro–Wilk test indicated that the LPE scores significantly deviated from normality, *W* = 0.945, *p* < .001. Therefore, a non-parametric Mann–Whitney *U* test was additionally conducted. The Mann–Whitney test also revealed a significant group difference, *U* = 2537, *p* < .001, confirming that younger adults showed higher LPE scores than older adults.

Furthermore, an independent sample *t*-test was conducted to examine age-related differences in quitting threshold (QT) between younger and older adults. The analysis revealed a significant difference between the two age groups, *t*(118) = -29.58, *p* < .001, *d* = -5.40. Younger adults (Group 1; *M* = 297.80, *SD* = 47.56) demonstrated significantly lower quitting threshold scores compared to older adults (Group 2; *M* = 536.30, *SD* = 40.52). These findings indicate that older adults took significantly longer before deciding that the target was absent during the visual search task, suggesting a more cautious and extended search strategy compared to younger adults.

4.4 Paired Sample T-test

A paired samples *t*-test was conducted to compare accuracy scores between low-prevalence and high-prevalence conditions among younger adults. The results revealed a significant difference between low accuracy and high accuracy conditions, $t(59) = -8.16$, $p < .001$, Cohen's $d = -1.05$, indicating that younger adults demonstrated significantly lower accuracy during low-prevalence trials compared to high-prevalence trials.

Similarly, a paired sample *t*-test conducted for older adults also revealed a significant difference between low-prevalence and high-prevalence accuracy scores, $t\ (59) = -8.78$, $p < .001$, Cohen's $d = -1.13$, indicating that older adults also showed significantly lower accuracy in low-prevalence conditions compared to high-prevalence conditions.

Assumption testing using the Shapiro–Wilk test indicated significant deviations from normality for both younger adults, $W = 0.936$, $p = .004$, and older adults, $W = 0.928$, $p = .002$, suggesting violation of the normality assumption.

4.5 Spearman Rank Correlation for Age and LPE

A spearman rank order correlation was conducted to examine the relationship between age and low prevalence effect (LPE). The analysis revealed a significant negative correlation between age and LPE, $\rho = -.355$, $p < .001$. This finding indicates that as age increased, LPE scores decreased. In other words, older adults showed lower low prevalence effect scores compared to younger adults. The correlation was moderate in strength, suggesting that age was significantly associated with changes in visual search performance and target detection under low-prevalence conditions.

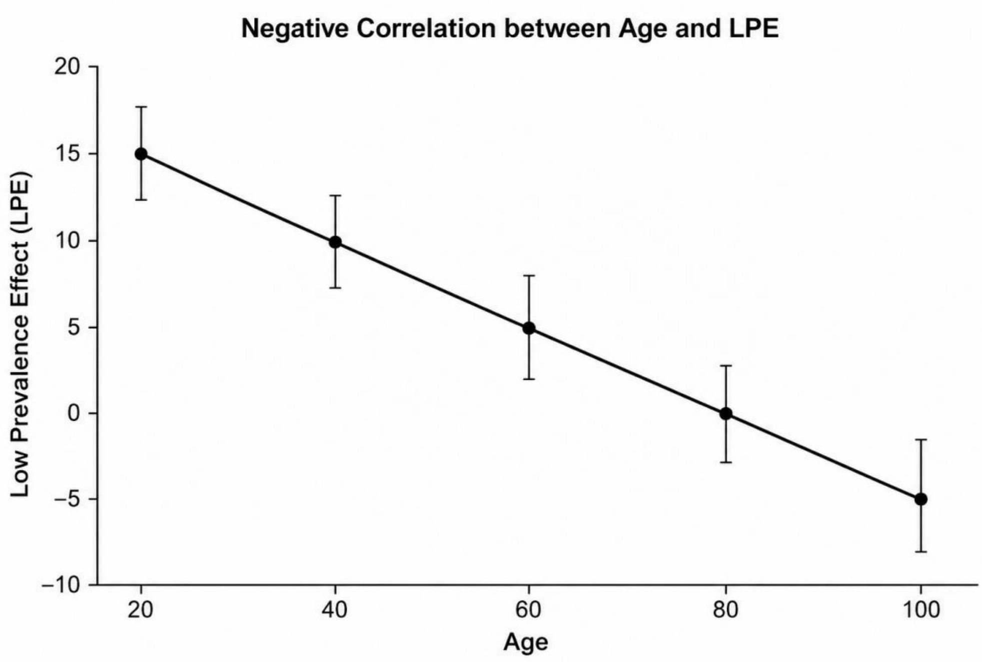

Figure 2 Negative Correlation between Age and LPE

Chapter 5

Discussion

The present study examined the influence of target prevalence, emotional valence, and aging on visual search performance using emotional facial expressions. Specifically, the study explored how younger and older adults performed during a visual search task involving angry and happy facial targets presented under high- and low-prevalence conditions. Reaction time, accuracy, quitting threshold, and low prevalence effect (LPE) were examined to understand age-related differences in emotional visual search and attentional decision-making. The findings of the study largely supported the proposed hypotheses and provide important insights into how emotional processing and aging interact during visual search tasks.

One of the major findings of the present study was the significant effect of target prevalence on visual search performance. Participants demonstrated slower reaction times and lower accuracy during low-prevalence conditions compared to high-prevalence conditions. This finding confirms the existence of the low prevalence effect (LPE), where rare targets are more likely to be missed during visual search tasks.This proves our hypothesis that participants will show a low prevalence effect (LPE) such that they will make more errors in low prevalence conditions and respond faster in high prevalence conditions. The results are consistent with previous research suggesting that individuals tend to terminate their search earlier when targets occur infrequently, resulting in increased miss errors and reduced detection accuracy (Wolfe et al., 2005; Wolfe and Van Wert, 2010).

The study also found a significant main effect of age on reaction time, suggesting that older adults were consistently slower than younger adults across all emotional and prevalence conditions. Older adults demonstrated significantly longer reaction times and higher quitting thresholds, indicating slower processing speed and greater caution during visual search. These findings are in line with previous aging literature which suggests that cognitive slowing, reduced attentional control, and age-related declines in processing efficiency negatively affect visual search performance in older adults (Madden, 2007; Humphrey and Kramer, 1997). The slower responses observed among older adults may reflect general cognitive slowing as well as increased difficulty in maintaining attentional focus during demanding search tasks.

Interestingly, although older adults showed slower reaction times overall, the correlation analysis revealed a significant negative relationship between age and LPE. This finding suggests that as age increased, the magnitude of the low prevalence effect decreased. In other words, younger adults demonstrated stronger LPE compared to older adults. One possible explanation for this finding is that older adults may adopt a more conservative search strategy and spend longer examining visual arrays before terminating the search. Such cautious responding may reduce the likelihood of missing low-prevalence targets, thereby decreasing LPE magnitude. Previous research has similarly suggested that older adults often prioritize accuracy over speed, especially in cognitively demanding tasks (Ratcliff et al., 2006).

The findings further demonstrated significant effects of emotional valence on visual search performance. Angry and happy facial expressions produced differences in reaction time across conditions, indicating that emotional stimuli influence attentional allocation during visual search. Emotional facial expressions are biologically and socially important stimuli and are therefore processed differently from neutral stimuli (Öhman et al., 2001). In particular, angry faces are often associated with threat detection and may automatically capture attention more rapidly than positive expressions. The present findings partially support this interpretation, as emotional valence significantly influenced participants' responses during the task.

The interaction between prevalence and age was also significant, suggesting that younger and older adults were differently affected by target prevalence during visual search. Older adults showed greater slowing in low-prevalence conditions compared to younger adults. This finding may reflect increased decision uncertainty and delayed search termination among older adults when targets are rare. In contrast, younger adults may have adopted faster but less cautious search strategies, contributing to stronger LPE scores. These findings highlight how age-related differences in attentional control and decision-making strategies can influence visual search behavior. Significant differences in LPE also demonstrates that older adults are more accurate across Low prevalence conditions as compared to younger adults.

Independent Sample T-tests further demonstrated that older adults had significantly higher quitting thresholds compared to younger adults. This suggests that older adults continued searching for a longer duration before deciding that the target was absent. In contrast, younger adults terminated the search process more quickly.

These results align with the previous work by Goodhew and Edwards (2024) who found that low prevalence visual search deficits were less impactful on older adults than younger adults. Their results suggested that older adults tend to show slower processing speed in visual search tasks but tend to adopt more cautious and accuracy-driven search strategies in the presence of rare targets. Older adults will be less likely to respond quickly, but will search for longer before deciding that a target is absent. This may decrease the likelihood of missing infrequent targets.

However, the interaction between emotion and age was not significant, indicating that younger and older adults responded similarly to angry and happy facial expressions during the visual search task. Although older adults were generally slower overall, emotional valence influenced both age groups in a comparable manner. This suggests that emotional facial expressions continue to capture attention effectively across adulthood despite age-related slowing in processing speed.

Another important finding of the study was the significant three-way interaction among emotion, prevalence, and age. This suggests that the combined effects of emotional valence and target prevalence varied across age groups. Emotional stimuli appeared to interact differently with attentional processing in younger and older adults, particularly under low-prevalence conditions. These findings may be understood in light of Socio-emotional Selectivity Theory (SST; Carstensen, 1992), which proposes that older adults show motivational shifts toward emotionally meaningful and positive information with increasing age. Older adults may therefore process emotional facial stimuli differently due to altered emotional goals and attentional priorities. The tendency of older adults to prioritize emotional regulation and positive affect may influence how they allocate attention during emotional visual search tasks.

Chapter 6

Conclusion

The present study explored the effects of emotional valence, target prevalence, and aging on visual search performance using angry and happy facial expressions. The findings demonstrated that target prevalence significantly influenced visual search performance, with participants showing slower reaction times and lower accuracy under low-prevalence conditions. These findings confirm the existence of the low prevalence effect (LPE), where rare targets are more likely to be missed during visual search tasks.

The study further revealed important age-related differences in search performance. Older adults demonstrated significantly slower reaction times and higher quitting thresholds compared to younger adults, suggesting reduced processing speed and more cautious search behavior with increasing age. At the same time, the significant negative relationship between age and LPE indicated that older adults showed relatively lower low prevalence effects than younger adults, possibly because they adopted more conservative and accuracy-oriented search strategies.

Emotional valence also played an important role in visual search performance. Angry and happy facial expressions influenced reaction times across conditions, highlighting the role of emotional stimuli in attentional processing. However, the non-significant interaction between emotion and age suggested that emotional facial expressions influenced younger and older adults in relatively similar ways. This finding indicates that emotional attentional processing may remain comparatively stable across adulthood despite age-related slowing in overall cognitive performance.

6.1 Implications

The findings of the present study have several practical implications. Visual search processes are highly relevant in real-world environments such as airport security screening, medical diagnosis, surveillance monitoring, and driving, where targets are often rare and missing important information can have serious consequences. Understanding how aging and emotional processing influence search behavior can help in developing better training programs, age-sensitive screening systems, and interventions aimed at improving attentional efficiency and reducing target miss errors in such high-risk settings.

6.2 Limitations and Future Directions

Despite its contributions, the study has certain limitations. The sample consisted mainly of healthy younger and older adults recruited through voluntary sampling, which may limit the generalizability of the findings. The study also focused only on angry and happy emotional expressions, whereas other emotions such as fear, sadness, or disgust were not examined. Additionally, reaction time and accuracy measures alone may not fully capture the complex attentional and cognitive processes involved in visual search behavior.

Future research can address these limitations by including larger and more diverse samples, incorporating additional emotional expressions, and using advanced methodologies such as eye-tracking or neurophysiological measures to better understand attentional allocation during visual search. Future studies may also further explore the role of processing speed, quitting threshold, and emotional regulation strategies in explaining age-related differences in low prevalence effect. Longitudinal research could additionally help clarify how visual search and emotional attentional processes change across the lifespan over time.

Overall, the present study contributes to the growing literature on visual attention, emotional processing, and aging by demonstrating that target prevalence, emotional valence, and age collectively influence visual search behavior. The findings highlight the importance of considering both cognitive and emotional factors when understanding attentional decision-making across adulthood.

Chapter 7

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APPENDIX 1

CONSENT FORM

Participant Consent Form

Title of the Study: Visual Search Task in Low and High Prevalence Conditions

Researcher: Hargun Saluja, Master's Student, TSLAS

Supervisor: Dr. Richa Nigam, TSLAS

Purpose of the Study

You are invited to participate in an academic research study that aims to examine performance in a visual search task under low and high prevalence conditions. The experiment will take approximately 30 minutes.

Your participation in this study is entirely voluntary. You may withdraw at any time without providing a reason and without any negative consequences. Your responses will be kept strictly confidential and will be used only for academic and research purposes.

By completing the form below, you acknowledge that you have read and understood the purpose and procedure of the study. You confirm that you agree to participate.

Participant Information

Email: ____

Name: ____

Age: ____

Gender: ____

Educational Qualification: ____________________________

■ I voluntarily give my consent to participate in this experiment.

Signature of Participant: _____________________________

Date: ____________________

Appendix 2

ADDENBROOKE'S COGNITIVE EXAMINATION - ACE-R
English version (2006) NIMS, Hyderabad

Name :
Age :
M C No. :
Sex :
Language : R W S

Date of testing :..
Tester's Name :..
Years of Education :..
Occupation :..
Handedness :..

ORIENTATION

➢ Ask : What is the	Day	Date	Month	Year	Season	[Score 0-5]
➢ Ask : Which	Hospital	Floor	Town	State	Country	[Score 0-5]

REGISTRATION

➢ Tell : 'I'm going to give you three words and I' d like you to repeat after me: lemon, key and ball
After subject repeats, say 'try to remember them because I'm going to ask you later'. Score only the first trial (repeat 3 times if necessary).

Register number of trials...........

[Score 0-3]

ATTENTION & CONCENTRATION

➢ Ask the Subject : Could you take 7 away from a 100 ?After the Subject responds, ask him or her to take away another 7 to a total of 5 subtractions. If Subject make a mistake, carry on and check the subsequent answer (i.e. 93, 84, 77, 70, 63-Score 4)
Stop after subtractions (93, 86, 79, 72, 65) ....

➢ Ask the Subject : Could you please spell **WORLD** for me ? Then ask him / her to spell it backwards :
....

[Score 0-5]
(For the best performed task)

MEMORY - Recall

➢ Ask : 'Which 3 words did I ask you to repeat and remember ?'
....

[Score 0-3]

MEMORY - Anterograde Memory

➢ Tell : ' I' m going to give you a name and address and I'd like you to repeat after me. We'll be doing that 3 times, so you have a chance to learn it. I'll be asking you later'

Score only the third trial

[Score 0-7]

	1st Trail	2nd Trail	3rd Trail
Sunil Kumar Singh	....	....	....
52, Station Road,	....	....	....
Gandhinagar,	....	....	....
Allahabad	....	....	....

MEMORY - Retrograde Memory

➢ Name of current Chief Minister ....
➢ Name of the women who was Prime Minister..
➢ Name the actor who was hero in the film "Mera Naam Joker "..
➢ Name the Father of our nation..

[Score 0-4]

ATTENTION & ORIENTATION

MEMORY

VERBAL FLUENCY- Letter 'P' and animals

FLUENCY

➢ Letters

Say: 'I'm going to give you a letter of the alphabet and I'd like you to generate as many words as you can beginnig with that letter, but not names of people or places. Are you ready? You've got a minute and the letter is P'

[Score 0-7]

total	Correct
>17	7
14-17	6
11-13	5
8-10	4
6-7	3
4-5	2
2-3	1
<2	0

➢ Animals

Say: 'Now can you name as many animals as possible, beginning with any letter?

[Score 0-7]

total	Correct
>21	7
17-21	6
14-16	5
11-13	4
9-10	3
7-8	2
5-6	1
<5	0

LANGUAGE-Comprehension

LANGUAGE

➢ Show written instructions

[Score 0-1]

Close Your Eyes

➢ 3 Stage command

'Take the paper in your right hand. Fold the paper in half. Put the paper on the floor'

[Score 0-3]

LANGUAGE - Writing

➢ Ask the subject to make up a sentence and write in the space below :
Score 1 if sentence contains a subject and a verb (see guide for examples)

[Score 0-1]

LANGUAGE-Repitition

- Ask the subject to repeat: **'hippopotamus'; 'eccentricity; 'unintelligible'; 'statistician'**
  score 2 if all correct ; 1 if 3 correct; 0 if 2 or less.

[Score 0-2]

- Ask the subject: **'Above, beyond and below'**

[Score 0-1]

- Ask the subject: **'No ifs , ands or buts '**

[Score 0-1]

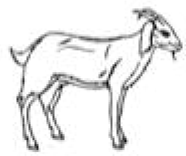
LANGUAGE-Naming

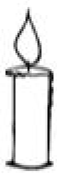
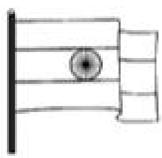
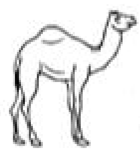
- Ask the subject to name the following picturese:

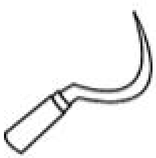
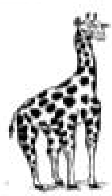
[Score 0-2]
pencil+
watch

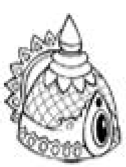
[Score 0-10]

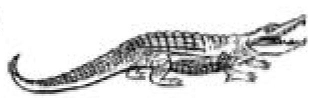






LANGUAGE-Comprehension

- Using the pictures above, ask the subject to:
  - Point to the one which shows time..
  - Point to the one which emits light..
  - Point to the one which is associated with farming...
  - Point to the one which is found in deserts ....

[Score 0-4]

LANGUAGE

ADDENBROOKE'S COGNITIVE EXAMINATION - ACE-R

LANGUAGE - Repetition

LANGUAGE

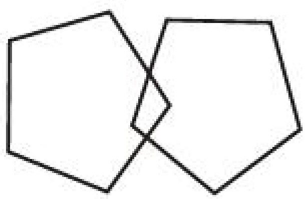
- Ask the subject to repeat the following words : [score 1 only if all correct] [Score 0-1]

sew
pint
soot
dough
height

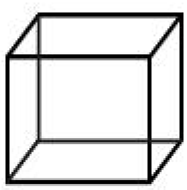
VISUO SPATIAL ABILITIES

VISUOSPATIAL

- Overlapping figure : Ask subject to copy this diagram : [Score 0-1]



- **Ask the subject to copy this drawing (for scoring, see instructions guide)** [Score 0-2]

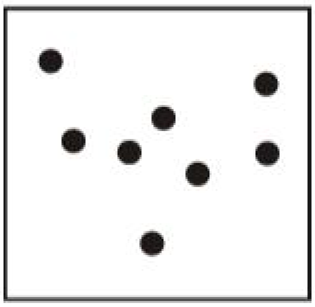


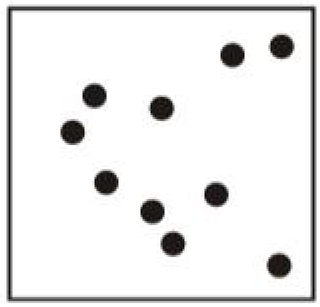
- Clock : Ask the Subject to draw a clock and the hands showing three. Instead of Numbers draw lines [for scoring see instructions guide ; circle=1, numbers=2, hands=2 if all correct-5] [Score 0-5]

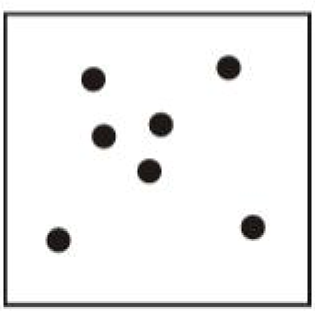
PERCEPTUAL ABILITIES

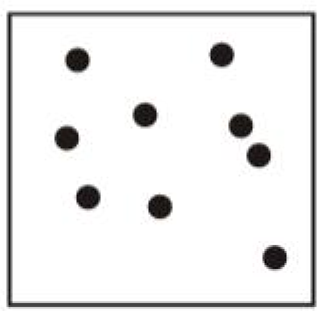
➢ Ask the subject to count the dots without pointing them

[Score 0-4]









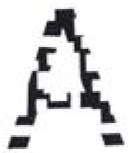
VISUOSPATIAL

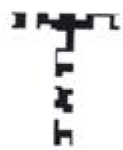
ADDENBROOKE'S COGNITIVE EXAMINATION - ACE-R

PERCEPTUAL ABILITIES

➢ Ask the subject to identify the figures

[Score 0-4]





VISUOSPATIAL

RECALL

➢ Ask "Now tell me what you remember of that name and address we were repeating at the beginning"

Sunil Kumar Singh ______ ______
52, Station Road, ______ ______ ______
Gandhinagar, ______
Allahabad ______

[Score 0-7]

RECOGNITION

➢ This test should be done if subject failed to recall one or more items .If all items were recalled, skip the test and score 5.If only part is recalled start by ticking items recalled in the shadowed column on the right hand side Then test not recalled items by telling "ok, I'll give you some hints : was the name X,Y or Z ?" and so on. Each recognised item scores one point which is added to the point gained by recalling.

Sunil Kumar Sharma	Sunil Kumar Singh	Rakesh Yadav	recalled	[Score 0-5]
25	52	37	recalled	
Market Road	Sastri Marg	Station Road	recalled	
Prakash Nagar	Gandhi Nagar	Patel Nagar	recalled	
Allahabad	Gwalior	Indore	recalled	

MEMORY

General Scores

MMSE	/30
ACE-R	/100

Subscores

Attention & Orientation	/18
Memory	/26
Fluency	/14
Language	/26
Visuospatial	/16

SCORE

APPENDIX 3

DEMOGRAPHICS FORM

Thapar Scool of Liberal Arts and Sciences
Thapar Institute of Engineering and Technology
Patiala, Punjab

S.No. MC Date:

Name:

Age:

Gender:

Address:

Mobile no.:

Education:

Occupation:

Languages known:

Medical history:

Prevalence of :

- Hypertension
- Diabetes
- Thyroid
- Alcoholism or substance abuse
- Head injury
- Epilepsy
- Anxiety

CURRENT MEDICATION:

ACTIVITY PROFILE:

- How do you spend your day?

- Meditation/ Exercise:

FAMILY HISTORY:

- Genetic disorder
- Dementia
- Neurological/ psychiatric disorder

APPENDIX 4

Neuropsychiatric Inventory (NPI):

Behaviors	F	S	D	FxS
Delusions				
Hallucinations				
Agitation				
Depression				
Anxiety				
Euphoria				
Apathy				
Disinhibition				
Irritability				
Aberrant motor behavior				
Night-time behaviors				
Appetite and eating disorders				
Total				

Frequency is rated as

1. Occasionally- less than once per week
2. Often- about once per week
3. Frequently- several times a week but less than every day
4. Very frequently- daily or essentially continuously present

Severity is rated as

1. Mild- produce little distress in the patient
2. Moderate- more disturbing to the patient but can be redirected by the caregiver
3. Severe- very disturbing to the patient and difficult to redirect.

Distress is rated as

0- No distress 1- Minimal 2-Mild 3- Moderately severe
4- Moderately severe 5- Very severe or extreme