ABSTRACT
Selective attention is an important cognitive resource to account for when designing effective human-machine interaction and cognitive computing systems. Much of our knowledge about attention processing stems from search tasks that are usually framed around Treisman’s feature integration theory and Wolfe’s Guided Search. However, search performance in these tasks has mainly been investigated using an overt attention paradigm. Covert attention on the other hand has hardly been investigated in this context. To gain a more thorough understanding of human attentional processing and especially covert search performance, the authors have experimentally investigated the relationship between overt and covert visual search for targets under a variety of target/distractor combinations. The overt search results presented in this work agree well with the Guided Search studies by Wolfe et al. The authors show that the response times are considerably more influenced by the target/distractor combination than by the attentional search paradigm deployed. While response times are similar between the overt and covert search conditions, they found that error rates are considerably higher in covert search. They further show that response times between participants are stronger correlated as the search task complexity increases. The authors discuss their findings and put them into the context of earlier research on visual search.

Keywords: Covert Attention, Feature Integration, Guided Search, Overt Attention, Psychophysical Experiment, Response Times, Visual Attention, Visual Search

1. INTRODUCTION
Human visual attention is a cognitive process deployed to reduce the complexity of visual scene analysis (Wolfe, Visual Attention, 2000). For this purpose, a subset of the available visual information is selected by shifting the focus of attention across the visual scene to the most salient objects, locations, and features (Bisley, 2011). It is because of visual attention mechanisms that the human visual system is able to cope with the abundant amount of visual information that it is confronted with at any instant in time. Understanding visual attention and eye movement mechanisms (Engelke, Maeder, & Zepernick, 2009), relating them to human cognition (Wang, 2014) and applying them in cognitive computing applications has been recognised as a valuable tool to improve system performance (Itti, Koch, & Niebur, 2000).
Wang et al. define attention as “a perceptive process of the brain that focuses the mind or the perceptive engine on external stimuli, internal motivations, and/or threads of thought by selective concentration and proper responses.” (Wang, Patel, & Patel, 2013). We here look at selective attention, which is characterised by turning our focus towards a specific stimulus when there are two or more stimuli present in the current field of view (Harada, Mori, Yoshizawa, & Mizoguchi, 2014). Visual attention is driven by two main mechanisms:

- **Overt attention** relates to the process of actively directing a sense towards an item or event. In terms of overt visual attention, this is exhibited as moving the eye gaze towards an object or location in visual space. Saccadic eye movements facilitate fast shifts of the focus of attention across the scene and high spatial sampling enables to perceive the foveal regions with high accuracy.

- **Covert attention** describes the mechanism of mentally shifting the focus of attention without moving the eyes. For instance, it is possible to gaze at a certain object while attending objects in the visual periphery. Humans do this frequently, consciously as well as sub-consciously, especially in stimulus intensive scenarios such as driving a car through a busy street. For handling such visually complex scenarios we need to be able to quickly and reliably process visual information and attend to multiple stimuli in the visual field (Duenser & Mancero, 2009).

The relation between overt and covert attentional processes has been studied widely in the literature (Posner, 1980) (Hunt & Kingstone, 2003) (De Haan, Morgan, & Rorden, 2008). Most studies evolve around the paradigm that covert attention enhances stimulus appearance in peripheral vision. Posner et al. (Posner, 1980) have shown this in their earlier work through cueing experiments.

One area that heavily involves overt and covert attention is visual search (Wolfe, Cave, & Franzel, 1989) (Duncan & Humphreys, 1989) (McPeek & Keller, 2002). In its simplest definition, visual search denotes the task of finding a target amongst a set of distractors. This is typically done through an active scan of the environment by moving the eye gaze to potential target locations. Hence, eye movements have frequently been used to study visual search performance. Measuring eye movements, however, was found not to provide sufficiently deep insight into visual search performance as visual search is largely driven by pre-attentive (parallel) mechanisms in addition to serial search through eye movements.

Overt visual search is well explored while covert visual search is a largely unexplored topic. In this article, we aim to contribute to a better understanding of covert attention in the context of visual search. Towards this goal, we performed a dedicated experiment on the basis of the work that Wolfe et al. (Wolfe, Cave, & Franzel, 1989) performed on visual search. The motivation being, that the guided search model and the related experimental results are well accepted and understood in the research community. Hence, we can consider the experimental results and design as a solid ground truth upon which to implement our experiments on. The main contribution of our work is a covert search condition in addition to the overt search condition explored in Wolfe’s work, with the aim to better understand the potential differences between the two attention mechanisms.

The remainder of the article is organised as follows. Section 2 provides background information on visual search and especially the work by Wolfe et al. (Wolfe, Cave, & Franzel, 1989). Section 3 explains the experiment we performed and Section 4 discusses the results of the experiment. The major findings are discussed and conclusions are drawn in Section 5.
Neural Networks for Language Independent Emotion Recognition in Speech
Yongjin Wang, Muhammad Waqas Bhatti and Ling Guan (2010). Discoveries and Breakthroughs in Cognitive Informatics and Natural Intelligence (pp. 461-484).
www.igi-global.com/chapter/neural-networks-language-independent-emotion/39280?camid=4v1a

On System Algebra: A Denotational Mathematical Structure for Abstract System Modeling
www.igi-global.com/article/system-algebra-denotational-mathematical-structure/1559?camid=4v1a