Department of Psychology

Towards Effective leadership in organizations: Psychophysiological studies of the influence of organization hierarchy on gaze-following and emotional contagion

FINAL DISSERTATION

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Introduction

All over the animal kingdom, social species are based on a division of labor that leads to hierarchical structures in which individuals may play dominant vs subordinate roles. Leadership, i.e. the process of influencing, motivating, and guiding individuals towards the achievement of specific objectives, emerges in insect colonies as well as in complex human societies in response to challenges or opportunities with the aim of organizing and coordinating the activity of the followers (i.e. the individuals who follow or support a leader) and thus achieve common goals (Van Vugt M., Hogan R., Kaiser J. R., Kaplan R.B., 2008). In complex social species where effective actions are often based on collective decisions, leadership is crucial for shaping and optimizing the dynamics of groups, organizations and societies. The emergence of leadership in complex species is influenced by a variety of factors the study of which has been the subject of a very active social and work psychology research domain, namely the leadership theories one, aiming at characterizing styles and features of different possible leaders (Van Vugt M., Smith J. E., 2019).

It is held that a variety of dispositional and situational factors contribute to the emergence of leadership. Personality features, for example, may lead to adopting autocratic vs democratic styles. In a similar vein, the tendency to rely upon o short- vs long-term vision and the high vs low capability to tolerate and navigate uncertainty may characterize transformational vs transactional styles. What remains almost unknown is whether there is a specific pipeline for optimizing leadership development programs beyond the classical organizational and personality psychology approach. This is what probably fostered the birth of the comparatively research domains like that of psychophysio and neuro-leadership which will be discussed more extensively in chapters 2-3 and chapter 4 respectively. Understanding the different implications of leadership is of pivotal importance for public and private large-scale organizations where effective functioning implies not just the actions of the individual at the top but rather the dynamic and multifaceted interactions that take place at several levels and that

influence the contribution of everyone to optimal within- and across-team collaboration. Related to this, is the concept of followership, i.e., the role and behavior of individuals who follow or support a leader and thus are dedicated to the organization, cooperate with and trust the leader. Importantly, while initial studies thought of followers as passive, it is now held that the best followers follow the leader's guidance, the also show critical thinking, provide constructive feedback, ask questions, and contribute ideas that can enhance decision-making and problem-solving (Van Vugt M., Hogan R., Kaiser J. R., Kaplan R.B., 2008). Therefore, in healthy organizations, followership is dynamic, and individuals may shift between roles of leadership and followership depending on the context and the task at hand. A strong leader-follower dynamic promotes collaboration, innovation, and the overall success of the group or organization.

Describing decades of research on this topic is beyond the scope of the present thesis. However, a summary of the main concepts emerging from psychological studies of leadership is provided in the following table.

Leader "centered" Theories	Leaders and Followers Interactions focused Theories
Dominance/Authoritarian Leadership Leaders' perspective: dominance based on leader-follower and leader-leader asymmetry in physical or coalitional strength and power. Followership connection: followers motivated through threats and punishment.	Prestige Leadership Leaders' perspective: leaders draw followers by possessing highly valued knowledge, skills, and personal qualities, as well as by generously sharing resources. Followership Connection: prestige often stems from an information asymmetry between leaders and followers.

Leader "centered" Theories	Leaders and Followers Interactions focused Theories
Transactional Leadership Leadership Perspective: Involves a system of rewards and punishments. Followership Connection: Effective followers may respond to the transactional exchange, fulfilling their responsibilities in anticipation of rewards or to avoid punishments.	Transformational Leadership Leadership Perspective: Emphasizes inspiring and motivating followers. Followership Connection: Effective followers are likely to be inspired by transformational leaders, sharing a common vision and commitment to achieving extraordinary outcomes.
Trait Theory: Leadership Perspective: Focuses on the inherent traits of leaders. Followership Connection: Assumes that effective followers may also possess certain traits that complement or align with those of the leaders.	Behavioral Theories: Leadership Perspective: Examines leaders' behaviors, whether task-oriented or relationship-oriented. Followership Connection: Effective followers may respond differently to task-oriented and relationship-oriented leaders based on their own preferences and needs.
Other Leader centered theories: Path-Goal Leadership: leaders are focused on motivating followers to achieve goals. Charismatic Leadership: Leaders able to emphasize ideological aspects of the work, communicate high performance expectations, express confidence that subordinates can attain them, show self confidence, modeling exemplary behavior, and emphasizing collective identity.	**Other Leaders and Followers interactions theories** Situational Leadership: Adapts leadership style based on followers' readiness. Crafting Leadership: (Leaders can indirectly enhance job crafting by stimulating positive work-related affect of employees). Laissez-Faire Leadership: Leadership with minimal interference in decision-making.

Accordingly based on the analysis of the last 30 years of leadership studies (Gardner W.L. and Others 2019), recent research focused on transformational and charismatic leadership (or neo-charismatic). Emerging theories such as ethical/servant/spiritual/authentic/crafting leadership focused on the development and identification of leaders and contextual influences on followers (and vice versa) are also gaining attention. It is also worth considering that at least two main approaches to study in leadership are gaining momentum. The first implies that leadership is a multi-level phenomenon that requires combination of multiple competencies (e.g. pertaining to psychology, sociology, neurosciences, behavioral sciences, anthropology). The second deals with strategic leadership as enabler of organizational outcomes including financial performance, innovation, technology (e-leadership) corporate social responsibility, and sustainability (Gardner W.L. and Others 2019). Based on these assumptions, in this thesis, I will focus (Chapter 1) on a multi-theories approach to understand the connection of dominance- and prestige-based leadership in animals and humans (and the relative link between leaders and followers). Moreover, capitalizing on transformational and transactional leadership research, I will investigate this connection, aiming to understand the implications coming from other leadership studies on the relationship between leaders and followers. I will dedicate Chapter 2 and Chapter 3 to investigate dominance and prestige / transformational leadership styles through gaze following and contagion emotional experiments, respectively.

In Chapter 4, I will discuss emerging aspects of leadership that may support individuals, organizations and society in finding a new way of interpreting the future. In particular, I will focus on "Organizational Neuroscience" (Becker W. J., Cropanzano, R., 2010; Becker W.J. et Al., 2011) and on "Neuroleadership" (Rock D., 2010) as new perspectives to better understand leadership behaviors. I will also deep dive finally on Sustainable Leadership (Liao H., 2022, Armani A. B., Petrini M., Santos A.C., 2020, Iqbal Q. and Others, 2020, Tiderman S.G. and Others, 2013) as a framework,

coherent with the transformative leadership concept and able to further promote research of leadership in the current societal transformative scenarios.

The picture that emerges is an urgent need to combine some of these new types of emerging leadership constructs, designing a pragmatic perspective connected with the various societal issues that accompany economic development and the new challenges that leaders must face to integrate economic benefits, social responsibility, and environmental protection.

Chapter 1: Neurobiological and psychophysiological foundations of leadership

Abstract

This Chapter discusses the importance of leadership in times of uncertainty and the different leadership styles seen in animals and humans, including dominance-based and prestige-based hierarchies. The chapter highlights that leadership is a critical aspect of human cooperation and evolution, with two distinct leader prototypes: prestigious leaders who possess highly valued knowledge and skills and generously share resources and dominance-oriented leaders who motivate followers through threats and punishment. The document also explores the complex link between leaders and followers, emphasizing the need for transformational leadership, which promotes innovation and fosters a collective purpose made up of values that positively influence relationships. The Chapter also delves into the psychological and evolutionary aspects of leadership, noting that humans possess evolved psychological mechanisms that enable leader-follower relationships and help overcome coordination and collective action problems. It also discusses the different types of leadership styles, such as transactional and transformational leadership, and their implications in organizations.

1.1 Navigating social hierarchies - The emergence of dominance- and prestige-based leadership in animals and humans and relative implications

What are we talking about when we talk about leadership? To answer this question, it is necessary to examine multidisciplinary contributions capable of combining historical, philosophical, cultural, anthropological, neuroscientific knowledge. As mentioned by Van Vugt and Smith, "Eastern and Western philosophers have long recognized the difference between prestige-style and dominance-style leaders. Leadership is an active research area in the social, cognitive, and biological sciences,

but there has been limited synthesis among these fields. Recognition that there are two leader types can assist with this integration and generate new ideas for a comparative analysis. Dominance- and prestige-based hierarchies emerge early in development; children use a variety of social and physical cues to learn about different social hierarchies. Leadership is a crucial but under-recognized force in the evolution of human cooperation, aiding the transition from small-scale to large-scale societies" (Van Vugt M., Smith J. E., 2019).

Historically, two distinct perspectives on leadership have been prevalent in classical philosophical writings, each corresponding to the prestige-dominance dichotomy. One perspective, closely linked to the teachings of Confucius, Plato, and Jesus Christ in Judeo-Christian traditions, portrays leaders as humble, generous, competent, and inspiring individuals (Adair, J.E., 2002). As Confucius once said, a leader "is modest in his speech, but exceeds in his actions." This view emphasizes leaders as role models who exert influence through their exceptional knowledge, skills, and personal attributes. On the other hand, an alternative philosophical approach, often associated with Niccolò Machiavelli and the Greek philosopher Xenophon, depicts leaders as rulers who wield influence by enforcing costs through punishment or the threat thereof. In The Prince, Machiavelli asserts that "since love and fear can hardly exist together, if we must choose between them, it is far safer to be feared than loved" (Machiavelli N., 2008). In essence, the Confucian-Christian tradition envisions leaders as exemplary individuals leading by example, while the Machiavellian tradition perceives them as powerful rulers leading through force, coercion, and manipulation.

Van Vugt and Smith (Van Vugt M., Smith J. E., 2019) argue that both perspectives are partially supported by existing evidence, but each on its own provides an incomplete understanding of the multifaceted and dynamic nature of leadership. Both constructs share a common flaw: they mistakenly treat leadership as a singular behavioral concept. There are at least two distinct leader prototypes, each with contrasting expressions, functions, and cognitive-developmental pathways.

Prestigious leaders draw followers by possessing highly valued knowledge, skills, and personal qualities, as well as by generously sharing resources. Prestige often stems from an information

asymmetry between leaders and followers. Conversely, dominance-oriented leaders motivate followers through threats and punishment, which are frequently based on their asymmetry in physical or coalitional strength and power.

The human literature often equates leadership with power (French J.R.P. and Raven B., 1959), dominance (Bass B. M. and Bass R., 2009), or status (Cheng J.T., 2010). This can be somewhat perplexing from a comparative standpoint. For instance, not all high-status individuals are necessarily leaders, and not all leaders are high-status individuals. In various species, low-ranking individuals lead group movements, and followers benefit from their efforts without impacting their rank (Van Vugt M., Von Rueden C. R., 2020). For example, in most non-human mammal species, females are socially subordinate to males, yet they often lead group travel, particularly when moving towards food or water sources, as seen in orcas (Holekamp K.E., 1997) and zebras (Smith J.E., 2018). In human societies, status and leadership are frequently correlated, but this is not always the case, especially when leadership entails significant personal costs. In small-scale societies, young, low-status men organize war parties, and in large, complex societies, low-ranking individuals emerge as charismatic leaders of social movements (e.g., the young environmental activist Greta Thunberg).

Evolutionary perspectives, summarizes in Van Vugt and Von Rueden (Van Vugt M., von Rueden C.R., 2020) play a crucial role in understanding leadership and hierarchy formation within groups. They submit that: i) leadership has significantly impacted the biological and cultural evolution of human sociality. Humans have developed various cognitive and behavioral mechanisms (adaptations) that enable leader-follower relationships, including safeguards against overly dominant leaders; ii) the interaction of these adaptations with local ecological and cultural contexts results in cultural variations in leadership preferences and the structure of human organizations; iii) an evolutionary approach bridges the gap between social and natural sciences by integrating leadership theories from diverse fields such as biology, psychology, neuroscience, anthropology, economics, and political science; ii), evolutionary approaches, particularly the collection of articles in this theme issue, generate and test new hypotheses concerning the critical role of leadership in cooperation, the

significance of contextual factors in leader emergence and effectiveness, the interplay between genetic and cultural influences on leadership, and the challenges and opportunities for women leaders (Van Vugt M. and Von Rueden C. R., 2020).

Within this framework, one main question concerns the evolutionary functions of leadership. Did psychological traits that facilitate leader-follower relationships evolve because they increased group members' reproductive success? To reap the benefits of group living, group members must often overcome coordination and collective action problems (Glowacki R. and von Rueden C. R., 2015). Game theoretic and other analytical models, as well as experimental paradigms, have been crucial in demonstrating that leader-follower relationships can be uniquely instrumental in overcoming coordination and collective action problems. The evidence supports the argument that natural selection favors (context-dependent) adoption of leader-follower relationships within group-living animals. In such situations, it can be advantageous to coordinate by simply following the "first mover" (Cartwright E., Gillet J. & van Vugt M., 2013).

A main theoretical question concerns the evolutionary history of leadership - the phylogeny-question. How did leadership emerge and change over the evolutionary history of different species, particularly our ape ancestors? While we lack a time machine, comparative research offers clues. In multiple species from insects to humans, dominant individuals have been observed to police their groups, e.g., impartially intervene in fights (Singh M. & Boomsma J., 2015). In studies of macaques and chimpanzees, policing by dominants resulted in greater social connectivity and stability of their groups (Flack J., Girvan M., de Waal F. & Krakauer D., 2006; von Rohr C., Koski S., Burkart J. et al., 2012). Such connectivity and stability are a public good that may benefit all group members but be particularly beneficial to dominants, who increase their mating opportunity. A complementary explanation is that policing evolved because, by policing, dominants thwart the ability of competitors to gain status.

Leadership and followership also evolved in the context of migration or group movement towards valuable resources. In some species, dominants tend to initiate such movement. For example,

elephants benefit by following the oldest females, who have knowledge of watering holes and other resources that may be particularly useful during periods of scarcity (McComb K., Shannon J., Durant S. et al., 2011). Where ecological knowledge is less important to group movement, it can be advantageous to coordinate by simply following the "first mover". For example, zebra herds often follow the lead of lactating zebras, who are most likely to be the first to move in new directions because of their greater water or energy needs (Fischhoff I., Sundaresan S., Cordingley J. et al., 2007; Van Vugt M., 2006). Spotted hyenas are mammalian carnivores that live in female-dominated societies structured by fission–fusion dynamics in which the relative dominance status varies from hour to hour, as individuals leave (fission), or members of one subgroup join (fuse) members of another subgroup (Smith J.E. et al., 2008). Stable dominance relationships are inherited based on the dominance status of an individual's mother such that physically smaller, natal juveniles are socially dominant to physically larger immigrant, adult males. However, an individual's relative status varies within each subgroup based on that subgroup's immediate composition. In a similar vein, the individual assuming leadership roles to influence collective behavior also varies across ecological major contexts. In some contexts, high-ranking hyenas lead most often, whereas in other contexts, such as during group hunting, individuals of low social status lead most often (Van Vugt M., 2006). Leaders vary over time, and who assumes a leadership role is based on context-dependent traits.

When examining hierarchy and leadership in humans, they appear to be somewhat unique. Sometime since the split from our last common ancestor with bonobos and chimpanzees, some 6 million years ago, our human or even earlier hominin ancestors became more egalitarian, largely by forming group-wide coalitions against dominants (Boehm C., 1999; Gavrilets S., Duenez-Guzman E. & Vose M., 2008). Such large-scale coalition-building was facilitated by the evolution of a more complex theory-of-mind through which individuals can simultaneously represent the intentions of multiple other individuals, as well as language abilities to improve coordination (Dunbar R. I., 2018; Tomasello M., 2009). Humans also evolved motivations to engage in relatively monogamous pair-bonding, which may have decreased competition among prospective coalition partners (Chapais B., 2008). Inferences

about the egalitarianism of our ancestors have been made in part via observation of modern hunter-gatherers and other small-scale societies. While many such societies are quite egalitarian, they still show evidence of informal status differentiation and leadership (Anderson C. et al., 2015; von Rueden C. R. & Van Vugt M., 2015). Certain individuals tend to be granted more active influence in collective decision-making, not because they dominate others but because they have demonstrated their value to others, that is, they have prestige (Henrich J. & Gil-White F. J., 2001). Prestige likely contributes more to human hierarchy and leadership relative to other animals, not just because humans are good at forming coalitions against dominants, but also because humans are rather interdependent. Indeed, humans rely on more extractive means of producing food that requires sharing, coordination in groups, and culturally acquired knowledge (Kaplan H., Hill K., Lancaster J., & Hurtado M., 2000). As a result, reputations for knowledge, skill, and especially generosity influence individuals' choice of whom to marry, befriend, or follow (Bliege Bird R. & Power E., 2015; von Rueden C. R., Redhead D., O'Gorman R., Kaplan H., & Gurven M., 2019). Even in egalitarian human societies, where there is minimal variation in status and wealth and where dominance is suppressed, individuals who are prestigious or who are recognized as leaders often have greater reproductive success (von Rueden C. R. & Jaeggi A., 2016). Thus, traits that facilitated the acquisition of leadership likely experienced positive natural selection throughout recent human evolution.

On the other hand, chimpanzees and bonobos display a reduced inclination towards upholding or rewarding generous reputations (Engelmann H., Hermann E., & Tomasello M., 2012). While both function and phylogeny delve into the depths of evolutionary time, a third aspect focuses on the developmental elements of leadership and followership, known as the ontogenetic question. Twin studies indicate that approximately 40% of the variance in leadership emergence among individuals can be attributed to genetic factors, implying a significant heritable component (Chaturvedi S., Zyphur M. J., Arvey R. D., Avolio B. J., & Larsson G., 2012). This does not imply that genes account for 40% of leadership, but rather that 40% of the differences in leadership emergence can be explained by distinct genetic factors within the studied population. Genes invariably play a role in any behavior,

whether they vary across individuals or not, and the interaction between genes and environments can be intricate. The emergence of leaders is shaped by gene-environment interactions (Zhang Z., Ilies R., & Arvey R. D., 2009), and genes can impact the environments that individuals create or choose throughout their development (De Neve J., Mikhaylov S., Dawes C. T., Christakis N. A., & Fowler J. H., 2013).

In general, evolutionary approaches propose that humans possess a range of evolved psychological mechanisms, supported by genes, that enable them to establish and maintain effective leader-follower relationships to overcome various coordination and collective action challenges. However, this perspective is not deterministic. The emergence of leaders and the factors that determine effective leadership are context dependent. Evolutionary behavioral scientists are increasingly differentiating between two methods of acquiring social status in human hierarchies: dominance and prestige (Cheng J. T., Tracy J. L., & Henrich J., 2010; Henrich J.& Gil-White F. J., 2001).

In situations with difficult collective action problems, growing evidence suggests that group members tend to prefer leaders who exhibit traits associated with dominance (von Rueden C. R. & Van Vugt M., 2015). When there is a heightened risk of free-riding or when free-riding poses a significant threat to the group, such as in collective defense against other groups, followers may be less wary of dominant individuals as leaders. These leaders' ability and willingness to coerce can facilitate collective action and deter free riding (von Rueden C. R. & Van Vugt M., 2015). This preference is not for the dominance hierarchies that characterize many other animal societies, but rather an intuition that a leader's targeted use of dominance can benefit the entire group. Threats and crises provide opportunities for leaders to strategically manipulate group members' emotions to create cohesive political identities for personal, if not collective, gain.

Summarizing the various contributions:

1. Leadership is an ambivalent concept in nature and there are no leaders without followers.

2. In the various animal species and in humans, dominant and prestige styles can represent a good heuristic for categorizing the phenomenon and ultimately exploring the psycho-physiological and the neural bases of leadership.

3. The leadership styles that are adopted at the group are influenced by the context, understood in a general sense. This is particularly true in humans, with nuances of complexity deriving from the specific characteristics of this living species which is particularly sophisticated in models of collaboration and in decoding relationships between leaders and followers.

In the next paragraph we will go into the leadership-followership dynamic in depth to try to better understand how it develops and takes place within a multidisciplinary framework.

1.2 The complex link between leaders and followers

The theme of followership is central to all models of leadership. That of the follower is in fact a complementary figure to that of the leader. The term follower is often used with different meanings in relation to the hierarchical and therefore organizational structure within which the individual finds himself inserted and often also reflects the prevailing type of culture. It is known, for example, how in some situations and organizational roles the term follower connotes a real subordinate, such as a simple soldier, or someone who holds less authority, power, and influence than his superiors. In other cases, we speak of an individual inserted, with certain rules and mechanisms, within a group where certain objectives, interests and situations are shared in whole or in part. There are also the most complex contexts where the knowledge of individuals within the group is mediated by precisely a digital medium which makes the relationships and actions partially respond to the same logics or to different logics from those of the physical world. Our focus concerns the contexts of organizations and institutions in the public and private world.

In any case, we believe it is useful to start with an excursus on the structural and human foundations of the leader-follower relationship. Cognitive scientists and organizational psychologists have recently been exploring the neural processes that enable certain leaders to attract and exert influence on their followers. Firstly, leading and following are strategies that have evolved to address social coordination issues in ancestral environments, such as group movement, maintaining intragroup peace, and managing intergroup competition. Secondly, the leader-follower relationship is inherently ambivalent due to the potential for leaders to exploit their followers. Thirdly, contemporary organizational structures may not always align with our evolved leadership psychology, which could explain the dissatisfaction and disconnection experienced by many citizens and employees (Van Vugt M., Hogan R., Kaiser J. R., Kaplan R. B., 2008).

Notably, most leadership studies tend to overlook the critical role of followers and how leadership contributed to the survival and reproductive success of our ancestors (Hogan R. & Kaiser J. R., 2005). Leadership serves as both a group resource and an individual attribute. The "selfish-gene" perspective of evolution (Dawkins R., 1976) implies that everyone should aspire to become a leader, making it unclear why some would willingly choose to be subordinates. The origins of followership are seldom considered by researchers, but this topic is essential to an evolutionary analysis and is now being revisited through the lens of evolutionary psychology.

Evolutionary psychology suggests that the human mind consists of mechanisms, known as psychological adaptations, which were favored by natural selection because they resolved adaptive challenges faced by our ancestors. Examples of these mechanisms include mating strategies, cheater detection, status sensitivity, and language (Barkow J., Cosmides L. & Tooby J., 1992; Buss D. M., 2005; Schaller M. et al., 2006; cf. Darwin C., 1871; Appadurai A. 2013; Baumard N. et al, 2023).

From another perspective, the Leader Game studies, derived from evolutionary game theory (Maynard-Smith J., 1982), have demonstrated how this approach can be applied to model the leader-follower coordination problem. This analysis indicates that in species frequently confronted with coordination issues, adaptations for leadership and followership are likely to develop (Van Vugt M.

& Kurzban R.K., 2007). Coordinated action benefits both leaders and followers, but leaders enjoy relatively greater rewards as they gain advantages when others adopt their goals (e.g., status and prestige; Buss D. M., 2005; Henrich J. & Gil-White F. J., 2001). Given that natural selection is based on relative rather than absolute fitness, the existence of followership may seem perplexing. It is possible that followers simply make the most of an unfavorable situation when they cannot assume leadership roles themselves (Dawkins R., 1976).

On the flip side, the growing confidence of followers against leadership is becoming more evident. There are several decision-making rules that may have developed to allow individuals to reap the benefits of being a follower without being taken advantage of by leaders. Boehm (Boehm C., 1993, 1999) outlined a few of these "equalizing strategies." One approach is to only accept leadership in areas where the leaders possess expertise. Another method involves utilizing gossip, mockery, elections, and other public examination techniques to keep leaders in check.

In hunter-gatherer societies, chiefs who misbehave are openly criticized, and those who attempt to issue orders are often met with resistance (Freeman R. E., 1970, as cited in Boehm C., 1999). Followers can simply choose to disobey domineering leaders. Freeman (1970, as cited in Boehm C., 1999) observed that Philippine chiefs who give orders rather than suggestions are often disregarded by their followers. This act of disobedience is effective because it penalizes leaders without replacing them, which could potentially destabilize and weaken the group. Another option for reluctant followers is to ostracize leaders who exploit their position. Ostracism typically has severe repercussions for those who are excluded (Bloom H. K., 1997; Williams K.D. & Sommer K. L., 1997). Moore (1972, as cited in Boehm C., 1999) noted that when an aggressive tribal leader initiates a feud without the backing of the group, fellow tribesmen can disown him, allowing rival factions to eliminate him without consequences. Followers also have the option to abandon tyrannical leaders. Van Vugt et al. (Van Vugt M. et al., 2004) discovered that attrition rates were four times higher in groups led by autocrats compared to those led democratically. Lastly, followers can take matters into their own hands by overthrowing or even kill an oppressive leader. These analyzes prove to

convincingly explain the current phenomenon of great resignations. In moments of great disruption (as in the recent pandemic crisis), resignations, especially among young people or within contexts of "asymmetric" power relationships between leaders and followers, seem to progressively escape the traditional rules of functioning of the labor markets and adhere more and more to ancestral mechanisms of leadership-followership alignment, strongly conditioned by emotional and relational aspects.

From the Prehuman Origins to the present, the natural history of the leadership goes through different leadership structures, leadership models and, consequently, Leaders-Followers relations, summarized from the following table:

A Natural History of Leadership

Stage	Time period	Society	Group size	Leadership structure	Leader	Leader–follower relations
1	>2.5 million years ago	Prehuman	Any size	Situational or dominance hierarchy	Any individual or alpha	Democratic or despotic
2	2.5 million to 13,000 years ago	Hominid bands, clans, tribes	Dozens to hundreds	Informal, situational, prestige based	Big man, head man	Egalitarian and consensual
3	13,000 to 250 years ago	Chiefdoms, kingdoms, warlord societies	Thousands	Formal, centralized, hereditary	Chiefs, kings, warlords	Hierarchical and unilateral
4	250 years ago to the present	Nations, states, businesses	Thousands to millions	Structural, centralized, democratic	Heads of state, managers, executives	Hierarchical but participatory

(Van Vugt M., Hogan R., Kaiser J. R., KaplanV R. B., 2008).

Progressively, the dominance style became "obsolete" or less effective in solving issues and situations. According with William Storr (Storr W., 2021), "What mattered increasingly was not how brutal we were, but what our co-players thought of us. We could earn this kind of prestige-based status by showing we were useful to the group".

Regular climate surveys reveal that in most organizations, 60%-70% of employees consider their direct supervisor to be the primary source of stress in their jobs (Hogan R., 2006, chap. 6). Additionally, the managerial failure rate in corporate America stands at 50% (Hogan R. & Kaiser J. R., 2005). These statistics suggest a potential disconnect between the innate leadership psychology

of humans and the actual practice of leadership in today's world (Van Vugt M., Johnson D. D. P., Kaiser R. B., & O'Gorman R., 2008). The demand for a distinct leadership approach is likely more significant in the present day, as organizational members are unrelated, and the sheer size of corporations can hinder group identification.

Interestingly, research on social identity indicates that transformational leadership operates by encouraging followers to associate with the group and adopt its goals (Shamir B., House R. J., & Arthur M. B., 1993; Van Knippenberg D., Van Knippenberg B., De Cremer D., & Hogg M. A., 2004; Van Vugt M. & De Cremer D., 1999). Transformational leaders alter followers' self-perception, shifting from self-centered individuals to members of a broader group, almost as if they were kin. They achieve this by exemplifying collective dedication, highlighting group member similarities, and reinforcing shared objectives, values, and interests. However, transformational leaders remain a rarity in today's world (Bass B. M., 1985; Burns J. M., 1978).

In more recent studies, followers are progressively viewed in the following ways: as targets of the leader's influence; as moderators of the leader's impact, thus becoming subjects of interest to determine which traits can enhance the leader's effectiveness in the eyes of the follower; and as potential leadership creators and substitutes, gradually questioning the need for a strict separation between the two roles and introducing the idea of shared, distributed, and diffused leadership (Shamir B., 2007).

Crossman and Crossman (Crossman B. & Crossman J., 2011) put forth a categorization of followership literature, dividing it into three primary models: descriptive behavioral typologies, prescriptive behavioral typologies, and situational typologies. More recently, Kellerman (Kellerman B., 2007) expanded on this by suggesting a classification of followers into five main categories, ranging from isolated followers to those who are deeply engaged. The theories mentioned share several recurring themes. One such theme is the fundamental asymmetry between leaders and followers, which is primarily determined by the differing power dynamics of each role. Additionally, all approaches acknowledge the potential for followers to counterbalance this power disparity by

exerting their own influence on the leader. In the context of a specific organization, leaders and followers emerge because of the interplay between contextual factors (such as core culture, values, role nature, organizational climate, and objectives) and the individual traits of the actors involved (including temperament, personality, personal abilities, and level of organizational socialization). As environmental conditions shift, the types of leaders and followers deemed functional also change. Lastly, a common thread among these theories is the notion that a follower's characteristics can either facilitate or hinder their ability to assume various roles.

In the last paragraph of this Chapter, I will elaborate on some emerging theories focused on the development and identification of leaders and contextual influences on followers (and vice versa).

1.3 Leadership styles in organizations: from transformational and transactional leadership to some other recent emerging leadership theories and relative implications

In the past few decades, the notion of leadership has evolved and become more intricate, particularly within the business world. The true purpose and attributes of a leader are being questioned, given the current business landscape that has been altered by transformative changes such as volatility, economic interconnectivity shifts, and the impact of new technologies on the workplace and workforce. The debate remains open, but one thing is clear: today's organizations require different types of leaders or leadership "styles" than in the past. As organizational hierarchies flatten, responsibility is delegated downwards, and professionals view themselves as peers rather than in superior-subordinate relationships. The idea of job security and lifelong company loyalty is fading (Bass B. M., 1999). The media is filled with stories about prominent leaders in business, government, and education. Renowned journals like Harvard Business Review and Educational Administration Quarterly dedicate significant space to leadership studies. Bestselling books by notable business authors such as Jim Collins, Jack Welsh, Peter Drucker and, more recently, Andrew Liveris (Liveris A. N., 2023) explore various aspects of leadership. Society is increasingly scrutinizing its leaders in

the quest for more effective and efficient ways to manage organizations. Foster and Young (Foster, R., & Young, J., 2004) observe that when goals are not met, people tend to lose faith in and blame those deemed responsible for leadership as cited by Stewart (Stewart J., 2006).

Roughly half a century ago, organizations began to demand new leadership theories, leading to the introduction of more comprehensive frameworks in the literature. This replaced the hierarchical and procedural notion with a more "shared" leadership concept. Burns (Burns J.M., 1978) asserts that while leadership is well-represented in literature, no central concept has emerged due to scholars working in separate disciplines to address specific questions unique to their fields. However, the work conducted in humanistic psychology has enabled generalizations about leadership across cultures and time.

In his seminal book "Leadership," Burns lays the foundation for the development of the transformational leadership concept. According to Burns (Burns J.M., 1978), leadership must be aligned with a collective purpose, and effective leaders should be evaluated based on their ability to effect social change. He proposes that the roles of leader and follower be conceptually united, with the leadership process involving the interplay of conflict and power. Burns distinguishes between two fundamental types of leadership: transactional and transformational. Transactional leaders engage with followers intending to exchange one thing for another, such as rewarding a hard-working teacher with an increased budget allowance. In contrast, "The Transforming leader looks for potential motives in followers, seeks to satisfy higher needs, and engages the full person of the follower." This leadership style results in a reciprocal relationship that transforms followers into leaders and leaders into moral agents. Burns defines leadership as "leaders inducing followers to act for certain goals that represent the values and the motivations – the wants and needs, the aspirations and expectations – of both leaders and followers" (Burns J.M., 1978).

The research conducted by Avolio and Bass (Avolio B.J. & Bass B.M., 1995, 2002, and Avolio B.J., 1999; Bass B.M., 1997, 1998) has been acknowledged (Stewart J., 2006) as addressing certain limitations and gaps present in Burns' work, particularly the absence of empirical evidence supporting

Burns' theory. Bass discovered that transformational leadership was especially potent and had the potential to inspire followers beyond expectations. He argued that transformational leaders went beyond merely establishing exchanges and agreements, and that they acted in specific ways to increase followers' commitment. Bass and his colleagues identified components of transformational leadership, which were further assessed using the Multifactor Leadership Questionnaire (MLQ). Numerous subsequent studies have been conducted to examine the frequency of behaviors observed by subordinates in various settings, such as businesses, agencies, and the military.

Four key components of transformational leadership were developed:

1. Charismatic Leadership or Idealized Influence: Transformational leaders serve as role models, earning the respect and admiration of their followers. Followers identify with and strive to emulate these leaders, who possess a clear vision and sense of purpose and are willing to take risks.

2. Inspirational Motivation: Transformational leaders act in ways that inspire and energize others, fostering enthusiasm and challenging individuals. They effectively communicate expectations and demonstrate commitment to goals and shared visions.

3. Intellectual Stimulation: Transformational leaders actively seek new ideas and innovative approaches. They encourage creativity in others and refrain from publicly correcting or criticizing them.

4. Individualized Consideration: Transformational leaders attend to the needs and development potential of others. They create a supportive environment that respects individual differences, encourages interaction with followers, and remains aware of individual concerns (Bass B.M., 1998).

Bass' leadership model also encompasses three dimensions of transactional leadership: contingent reward, management-by-exception, and laissez-faire or non-leadership behavior. Contingent reward refers to the leader assigning tasks and rewarding followers for their completion, as described by Burns (Burns J. M., 1978). Management-by-exception (MBE) involves the leader monitoring followers and correcting them, if necessary, with passive (MBE-P) and active (MBE-A) variations. MBE-P entails waiting for errors to occur before taking corrective action, while MBE-A may be

required in situations where safety is a concern, such as supervising a group of workers. Laissez-faire leadership essentially avoids leadership behaviors, with no transactions being carried out.

Bass posits that every leader exhibits each of these styles to some degree, referring to this as the "Full Range of Leadership Model" (Bass B. M., 1998). Ideally, a leader would practice transformational components more frequently and transactional components less frequently.

Leaders who exhibit greater satisfaction among their followers and demonstrate higher effectiveness tend to be more transformational and less transactional in nature (Avolio B. J. & Bass B. M., 1991). Transformational teams are characterized by members who genuinely care for one another, intellectually challenge each other, inspire one another, and align with the team's objectives. Such teams typically exhibit high performance. Organizational policies and practices can foster employee empowerment, creative adaptability, and a strong sense of unity.

Transformational leadership contributes to increased commitment, engagement, loyalty, and performance among followers, while transactional leadership may lead to heightened stress (Bass B. M. 1998). It is crucial to emphasize the significance of transformational leadership in addressing the diversity of ethnicity, race, and gender among followers. There is a need to explore how individualistic cultures can reap the advantages of collectivist cultures in transformational leadership without compromising creativity, personal freedom, and initiative.

It is only important to consider that the diversity in previous empirical studies on leadership and innovation led Rosing et al. (Rosing K. et al., 2011) to the conclusion that a more precise model of leadership for innovation was needed. In order to describe such a model, they proposed an ambidexterity theory of leadership for innovation. The term ambidexterity literally refers to the ability to use both hands equally. Management researchers (e.g. Benner M. J. and Tushman M. L., 2003; Gupta A. K. et al., 2006; Tushman M. L. and O'Reilly C. A., 1996) have used the term ambidexterity to describe the ability of organizations to establish and maintain a balance of exploration activities and exploitation activities (such as implementation and execution).

Recent studies by House and Shamir (House R.J. and Shamir B., 1993) and Shamir et al. (Shamir B. et. Al., 1993) have started to delve deeper into this subject. These researchers suggest that transactional leaders concentrate on practical approaches to achieving goals, while transformational leaders instill in their followers a heightened awareness of their collective identity, elevated self-esteem, an increased sense of self-worth, a stronger belief in collective efficacy, and a heightened sense of purpose in their work and lives.

In other studies, transformational leadership appears to be a "radical departure" (Conger J. A., 1991: 31; Lee M., 2014) from the classical management approach. While the classical approach speaks of discipline, transformational leadership speaks of persuasion. Instead of setting rigid rules for others to follow, transformational leaders aim to set out a compelling vision for followers to pursue. Instead of giving orders, transformational leaders arouse, motivate and excite followers. Instead of providing recognition and remuneration when a task is completed, transformational leaders "morally uplift" their followers to go beyond their own self-interest for a common goal.

The moral nature of leaders is now seen (Lemon G.J., Hartnell C. A., Leroy H., 2016) not only necessary for the good of society but also essential for sustainable organizational success (Freeman R. E., Wicks A. C., & Parmar B., 2004; Gulati R., Nohria N., & Wohlgezogen F., 2010; Padilla A., Hogan R., & Kaiser R. B., 2007). As a result, many new morally-focused approaches and theories of leadership have emerged in the literature that pertain to just three of these: ethical leadership (Brown M.E., Treviño L. K., & Harrison D. A.G, 2005), authentic leadership (Gardner W. L., Cogliser C. C., Davis K. M., & Dickens M. P., 2011), and servant leadership (Liden R. C., Wayne S., Liao C., & Meuser J., 2014b; van Dierendonck D., 2011), avoiding The Dark Triad of personality: Narcissism, Machiavellianism, and Psychopathy (Paulhus D.L., Williams K.M., 2002).

Finally, some authors (Wang, H. J., Demerouti E., 2016) have argued that bottom-up job redesign such as job crafting should be promoted by leaders or managers and combined with traditional top-down approaches to improve the working conditions of employees. After all, the individual employee knows his/her job best and can recognize which part of the job should be improved (Bakker &

Demerouti E., 2014). They suggest leaders can stimulate job crafting by developing personal resources of employees and designing resourceful jobs with urgency to craft. In addition, leader behaviors like promoting employees' organizational identification and building a trusting, open, and supportive work climate may also influence employee job crafting supporting the Development of the Personal Resources, primarily Self-efficacy as suggested to be the core foundation of human motivation, performance accomplishments, and well-being (Bandura A., 1997). Crafting Leadership could be a strong enabler of Transformative Leadership giving both a "by-directional sense" to the relationship between Leaders and Followers and a new "toolkit" to modern leaders in the way they can exercise their practical job.

1.4 Why is important today to investigate Leadership in organizations

In today's world, we face growing uncertainty and increasingly unstable environments. This has led to heightened risks for businesses that resist change. Ironically, employees within organizations are becoming more defensive, hindered by fear and susceptible to demotivation and decreased well-being. The priority of institutions and companies to support the transformation that comes from all sectors is accompanied and even becomes prevalent by the ability to pay attention to the material and psychological needs of people who lack direction and motivation. For example, data point indicates an increase in the incidence of stress and depression across the labor market. The phenomenon of mass resignations ("great resignation") has started to spread in 2020 during the Covid pandemic situation and still remains very consistent in some part of the global workforce. The biggest mismatch in the world of work is not the one between required-available skills, but between how workers' needs have evolved and real leadership models. The opportunities offered by new technologies and the unstoppable arrival of the metaverse/web 3.0 raise new questions about what is good for society and the economy, and what is good for the individual. It becomes central to support the development and

application of innovative technologies capable of keeping the development needs of the person at the center, with growing attention to transparent information, dignity, decision-making autonomy of individuals, privacy and data security and above all fair access to possibilities offered by technologies. Leadership becomes transformational when it is able to promote innovation by favoring people's stimuli and perspectives to inspire individual motivation and create a collective purpose made up of values that positively influence the relationship between people and in activities towards other people, citizens and customers. It is necessary in the economic environment to build a context where people can express their opinions in an inclusive way in resonance with corporate objectives to achieve sustainable business results by generating a positive impact on individuals, the environment and society. Leadership thus becomes a daily exercise in building the future capable of mobilizing generations and making room for diversity and inclusion to restore trust. In a world that threatens to create new barriers, true leaders change the way people see themselves and their place in the world. As a result, leadership behaviours must adapt to these new circumstances, evolving from individual actions to those observed at the group or organizational level.

Weber (Weber M., 1924-1947) theorized that charismatic leaders would emerge more frequently during turbulent times and crises. This raises the question of whether transformational or charismatic leadership would be more prevalent during crisis conditions, while transactional leadership would dominate during stable periods. Research by Bass and colleagues has demonstrated that effective leaders exhibit both transactional and transformational qualities (Hater J.J. & Bass B.M., 1988; Howell J.M. & Avolio B.J., 1993). However, it is crucial to consider the context in which a leader's behaviour occurs and to systematically examine this context when measuring leadership. A leader who consistently focuses on developing their followers' potential is likely to establish group norms that encourage continuous learning and development among colleagues. Individualized consideration can be seen as a characteristic of a leader's behaviour, a group's behaviour towards individuals, a normative aspect of an organization's culture, or an expectation of the leader, group, and culture. Furthermore, individualized consideration can be perceived differently by the same person or group

over time, depending on the follower's developmental stage. This difference in perception may be connected to how individuals interpret meaning in their surroundings, which can be directly related to their cognitive and moral development (Kegan R., 1983).

The demand for transformational leadership presents new challenges for those in leadership roles, as they navigate their personal development process (Kegan R., 1983; Kegan R., 1998) and confront their internal resistance to change (Laskow Lahey L., Kegan R., 2009). Individualized consideration can also be examined "at a distance" (Yammarino F.J., 1994), as a CEO may demonstrate this quality without directly interacting with a specific follower, through indirect influence on direct reports and/or established policies. Expanding the boundaries of individualized consideration, transformational leadership, and its application across multiple levels of analysis will help to better understand this concept.

Individualized consideration can refer to how leaders, groups, and organizations treat followers, as well as how behaviour within each level of analysis may vary across different followers. Fully transformational leaders continually adapt their behaviour to match the developmental level of their followers. By treating each group member as an individual rather than a uniform entity (Burns J.M., 1978), the leader can have an impact on their followers through the four components of transformational leadership: charisma or idealized influence, inspiration, intellectual stimulation, and individualized consideration.

The harmonization of individuals and units within an organization's culture can occur at three distinct analytical levels, centering around a construct ingrained within the organization itself. I use the term "harmonization" to indicate that the behavior observed at one level aligns with the behavior and norms described at higher, more comprehensive levels of analysis. For instance, considering mistakes as a chance for learning and growth allows one to see such statements as indicative of a trait or behavior expected in an organization, a group, or an individual. However, the method of measuring "learning from mistakes" will vary across these three separate levels (individual, team and organizational

learning). In a learning organization (Senge P., 1990), teams are characterized by rules that permit mistakes without penalties.

Harmonization can also be achieved according with House and Rousseau (House R.J. and Rousseau D.M., 1993) by constructing an "organizational behavior" through "cascading" and "entrainment." Cascading refers to the degree to which a concept is translated and observed across multiple levels, while entrainment denotes the process that either hinders or enables the cascading of a concept across levels. A leader's behavior, when reinforced by the leader over time and within the context (including the people), can emerge at higher levels of analysis, representing a group norm or cultural characteristic.

The development of an organization's culture is largely influenced by its leadership, and the organization's culture can, in turn, impact the development of its leadership. For example, transactional leaders operate within their organizational cultures by adhering to existing rules, procedures, and norms; transformational leaders modify their culture by first understanding it and then realigning the organization's culture with a new vision and a revision of its shared assumptions, values, and norms (Bass B.M., 1985).

There is a continuous interplay between culture and leadership. Leaders create mechanisms for cultural development and reinforcement of norms and behaviors expressed within the cultural boundaries. Cultural norms emerge and evolve based on leaders' focus, their responses to crises, the behaviors they exemplify, and the people they attract to their organizations. Leaders must be mindful of the conservatism reflected in beliefs, values, assumptions, rites, and ceremonies embedded in the culture that can impede efforts to change the organization.

The connection between leadership, context and culture is becoming more and more relevant. Especially in this era of increasing uncertainty and more volatile environments where people seem to have a completely different motivation, affiliation, and mental connection with the social environment construct of modern organizations. It becomes relevant start thinking organization like a complex architecture where people are the crucial element to be put "at the centre" to support

business agendas. This is particularly true when we consider the frequency and the intensity of the transformation cycles required by the business context. In such a context, Psychological Safety (Edmondson A.C., 2018) is a prominent organizational design principle or, if we prefer, a new business Key success factor.

Given the complexity of the majority of contexts in which organizations have to work today, the main demand for leaders is to be charismatic without being dominant and to be able to manage positive and negative emotions and relative contagion that can influence behavioural patterns dynamics. This may explain the increasing interest towards quantitative analysis of leadership at psycho-physiological (examples of experimental studies are provided in chapter 2 and 3) and neuroscientific -discussed in chapter 4-level.

In conclusion, in the Chapter 2 and 3 we will present some experiments oriented to answer to the main research questions presented in this Chapter and in the Introduction. We think that obtained results of the experiments integrated with future studies in the same direction can bring a paradigmatic shift in leadership research, as they would induce organizations to:

1. review the methods of organizing relationships, activities and interactions between leaders and followers, moving from a functional hierarchical model to one more oriented towards leader-follower interaction, motivation, inspiration and engagement of people, according to a concept of "widespread" leadership and more oriented towards a concept of sustainability as expressed by the UN ESG models

2. adopt a more concrete managerial and work organization method to manage the new generations who will increasingly work in a digital and hybrid context where it will be fundamental to manage the trade-off between productivity and people's well-being and satisfaction

3. rethink the way organizations identify and develop future leaders (in term of selections process, potential assessment and development programs), e.g. assessing social skills for new hired or assessing managers on transformational leadership, adapting training program orienting them to emotion management for male and female future leaders.

In a nutshell, times could be considered mature to introduce a specific area of R&D on leadership in all the organizations based on psychology and neurosciences studies and experiments to support people management and evolution.

Chapter 2   Dominance style and gaze-following in leaders

Abstract

The neurobiological and psychophysiological aspects of leadership and its emergence are still poorly studied in humans. The ability to quickly infer the social status of others is an essential skill for navigating social hierarchies (Cummins, D., 2000). The ability of primates, especially humans, to judge the direction of the gaze of other individuals is accompanied by implicit or explicit attentional focus. An example of the latter is the gaze following behavior that consists of making eye movements in the direction in which other individuals are looking (Friesen, C. K. & Kingstone, A., 1998). The behavior of gaze following, although largely automatic, is subject to the influence of variables such as status (Dalmaso, M., Pavan, G., Castelli, L. & Galfano, G., (2012), Shepherd, S. V., Deaner, R. O. & Platt, M. L., 2006) and political leadership (Liuzza, M. T. et al., 2011); Liuzza, M. T. et al., 2013). Studies of monkeys and humans show how the faces of high-status individuals capture attention more than those of low-status individuals (Dalmaso, M., Pavan, G., Castelli, L. & Galfano, G., 2012); Shepherd, S. V., Deaner, R. O. & Platt, M., 2006). It has recently been shown that the oculomotor behaviour of members of a group during a social interaction is able to reveal its leader (Capozzi, F. et al., 2019) suggesting that the gaze may be a general indicator of leadership. Most studies have manipulated the status in faces used as stimuli for gaze following tasks. In this research, we aim to explore the social status of research participants. In particular, we will test, for the first time in gaze following tasks, a sample of participants for whom status has particular professional importance, namely managers.

Measures of oculomotor, socio-emotional, and physiological interference, will be linked with measures of competence and success of managers and with their hierarchical position, with the aim of identifying new biosocial markers associated with leadership.

2.1 Introduction

In humans specialized brain systems have evolved to process social signals coming from different sources, such as faces (Kanwisher N. & Yovel G., 2006), bodies (de Gelder B. et al., 2010), odours (Mutic S. et al., 2017), biological sounds (Geangu E. et al., 2015), and motion (Pavlova M. A., 2012). In the domain of social visual processing, several studies evidenced a stable human preference for the processing of social information (e.g., eyes, faces, body parts). In fact, compared to non-social stimuli, social stimuli are detected (Jiang Y. et al., 2007; Purcell D. J. & Stewart A. L., 1988) and discriminated (Lehky S. R., 2000) more accurately and quickly (Ro T. et al., 2007).

The allocation of attentional resources to other human beings or to parts of the environment they attend to (i.e., social or joint attention) is pivotal for inferring their intentions or for developing emotional reactions towards them (Adolphs R., 2010). In everyday social interactions, monitoring another individual's gaze is adaptive for various reasons, i.e., detecting salient environmental information, sharing attentional states or actively directing each other's attention (Zuberbühler K., 2008). This phenomenon, called *gaze-following*, occurs when individuals automatically shift their attention (and their own eye movements) in the direction in which other individuals are looking, to follow their gaze (Ricciardelli et al., 2013; Shepherd, 2010). Importantly, joint attention occurs both overtly, when actual eye movements are performed (gaze following tasks), and covertly, through automatic and implicit shift of spatial attention, when manual responses are required (gaze cueing tasks; (Driver et al., 1999; Friesen & Kingstone, 1998; Hietanen & Leppaenen, 2003).

Despite gaze following is an automatic-reflexive behavior in which another's oculomotor pattern is imitated (Ricciardelli P. et al., 2002), recent evidence shows how social attention orientation can be affected by both stimulus-driven and top-down mechanisms. Several studies highlighted that social attention can be influenced by the physical characteristics of the face the observer is attending to, e.g., gender (Ohlsen G. et al., 2013), age (Ciardo F. et al., 2014), masculinity/dominance (Jones B. C. et al., 2010), emotional expression (Bonifacci P. et al., 2008; Gallup A. C. et al., 2014; Tipples J., 2006),

self-similarity (Hungr C. J. & Hunt A. R., 2012), or presence of eye contact (Dalmaso M., Alessi G., et al., 2020). For example, Jones and colleagues (Jones B. C., 2010) manipulated facial dominance by changing sexually dimorphic shape cues (i.e., masculinity-femininity traits) in prototypical faces employed in a gaze-cueing task, without altering colour and texture (as in Penton-Voak I. S. et al., 2001; Perrett D. I.et al., 1998). They found that facial dominance facilitated the short-term (200 ms) reflexive gaze-cueing effect, i.e., participants' attention was oriented faster to target stimuli presented at spatial locations cued instead of miscued by dominant eye gaze.

As for top-down mechanisms, social attention orientation can be influenced by higher-order socio-cognitive variables like familiarity (Dalmaso M. et al., 2016; Deaner R.O. et al., 2007), goal relevance (Ricciardelli P. et al., 2013), group membership (Dalmaso M. et al., 2015; Pavan G. et al., 2011), political affiliation (Cazzato V. et al., 2015; Liuzza M. T. et al., 2011, 2013; Porciello G. et al., 2016) and, importantly for the present research, social status (Dalmaso M. et al., 2012). It has been observed that information related to social status i.e., the relative rank of an individual along one or more social dimensions within a given social hierarchy (Mattan B. D. et al., 2017), may be able to modulate the observer's attentional orientation, regardless of the physical characteristics of the face itself. From an evolutionary point of view, the ability to quickly and accurately infer the status of another individual represents an essential skill for effectively navigating through social hierarchies (Cummins D., 2000). Crucially, gaze following increases the probability of witnessing important social interactions, such as cooperation, competition or rank reversals, thus helping individuals to keep track of the existing relationships among the other group members (Zuberbühler K., 2008).

In a well-known study performed in non-human primate, Shepherd and colleagues (Sheperd S. V., 2006) demonstrated that the strength and timing of gaze-following behavior are modulated by the social status of the observed individual. In particular, low status rhesus macaques reflexively followed the gaze of all individuals familiar to them, while high status macaques followed only the gaze of other high status individuals (Shepherd S. V. et al., 2006). Dalmaso and colleagues (2012) replicated these findings in a human study whereby participants had to look at the faces of individuals whose

CVs, they had previously read, identified them as being of low or high social status). 900 milliseconds (ms) after the faces were presented, these individuals' gaze moved to the right or left of the screen. After 200 ms a letter (L or T) appeared on the right or left of the face. The participants' task was to press the right button when the L appeared and the left button when the T appeared. The authors found an interaction between cue-target spatial congruence and social status on participants' reaction times (RT). In particular, a greater gaze-cueing effect was found for high compared to low status faces, that is participants shifted faster their attention in response to the averted gaze of high-status but not low-status individuals (Dalmaso M. et al., 2012). In another study, Dalmaso and colleagues (2014) replicated this effect but only at shorter (200 ms) rather than longer (1000 ms) temporal intervals occurring between the averted gaze and the target onset (Dalmaso M. et al., 2014).

Furthermore, recent evidence suggests that the role played by individuals in a group during social interactions modulates the amount of attention assigned to their oculomotor behaviour. Capozzi and colleagues (Capozzi F. et al., 2016) presented participants with videos of individuals who consistently behaved as leaders or followers. Then, they employed their faces as stimuli in a gaze-cueing task and found that the followers did not elicit the gaze-cueing effect (Capozzi F. et al., 2016). In a following study, Capozzi and colleagues (Capozzi F. et al., 2019) found that individuals leading natural group interactions were looked less toward other individuals , and elicited more mutual gaze, suggesting that gaze can be considered a marker of leadership (Capozzi F. et al., 2019). In the previously described studies, social status information was provided to participants. Interestingly, social status information can be also spontaneously inferred from verbal and non-verbal behaviour observed in brief dynamic group interactions (Brand C. O. & Mesoudi A., 2019; Cheng J. T. et al., 2013). Consistently, Foulsham and colleagues (Foulsham T. et al., 2010) found that individuals who were attributed high social status were fixated more often, for longer on each gaze, and for a longer total time, compared to people perceived as medium or low social status (Foulsham T. et al., 2010). Also, Gerpott and colleagues (Gerpott F. H. et al., 2018) videotaped real meetings of project teams and collected leadership ratings for the team members. Then, they showed short, muted videos taken from

these videoclips to naïve participants, while recording their gaze behaviour. They found that observers gazed at emergent leaders more often and longer with respect to non-leaders (Gerpott F. H. et al., 2018). Notably, the reverse effect may also be true, with humans using gaze following behaviour as an indicator of social status and social relevance (Emery N. J., 2000). In line with this hypothesis, 3- and 4-year old children display a *prestige bias*, that is a preference to learn from individuals to whom others have preferentially oriented their social attention in previous interactions (Chudek M. et al., 2012).

Most studies have manipulated the stimulus-driven or top-down information related to the faces that served as experimental stimuli for gaze-cueing tasks, but few have investigated the social status of the observers. To evaluate whether social power affected gaze following, Cui and colleagues (Cui M. et al., 2014) manipulated the observers' social power by means of priming techniques. In two experiments, they found that, compared with participants primed with high social power, the ones primed with low social power displayed a stronger gaze-cueing effect (Cui M. et al., 2014). Similarly, Weisbuch and colleagues (Weisbuch M., 2017) compared faces with a historically privileged social identity (European American/"White") to face with a historically underprivileged social identity (African American/"Black") in a gaze-cueing task. In Study 1, they found that White faces elicited gaze following from both White and Black observers, whereas Black faces only elicited gaze following from Black perceivers. In Study 2, the authors manipulated the power felt by the observer and found that White faces elicited gaze following from both high-power and low-power White observers, whereas Black faces only elicited gaze following from low-power White observers.

In this study, we experimentally manipulated the social status of the observers (Professional, Manager ranks within an organizational social hierarchy), in addition to that of the gaze-following stimuli, which consisted of computer-reconstructed face selectively manipulated for the dominance trait (Oosterhof N. N. & Todorov A., 2008). This approach allowed us to dissociate the role of the social status of the observers from the one ascribed to the identities employed in the task in affecting social attention orientation.

2.2 Materials and Methods

Participants

To estimate the sample size needed for this study we ran an a priori power analysis by means of the software MorePower 6.0 (Campbell J. I. D. & Thompson V. A., 2012). For a 2 x 3 x 2 mixed factorial design with two within-subjects factors, one with 2 levels (*Spatial* c*ongruency* between the instruction given by the cue and the distractors' gaze direction: congruent vs. incongruent), and one with 3 levels (distractor's *Dominance*: dominant, intermediate, non-dominant), and one between-subjects factor with 2 levels (participants' *Rank* in the organizational hierarchy: Managers vs. Professionals), with $\eta_p^2 = 0.12$ (as in the cue-target congruency by social status interaction reported in Dalmaso M. et al., 2012), $\beta = .95$ and $\alpha = .05$, the required number of participants was 60 (30 per group).

We recruited 60 caucasian participants (31 females, age: $M = 34.4$, $SD = 7.17$, range = 25-53) all working at the company Ernst & Young (EY), headquartered in Rome (Italy).

EY is a multinational professional services partnership and one of the largest professional services networks in the world. It provides assurance, tax, information technology services, consulting, and advisory services to different client to support their own transformation, growth and operation.

Within this research, a sample of workers representative of the different consulting sectors EY works on was involved. Based on EY organizational chart, the 5 ascending levels have been grouped in 2 macro cluster (Managers and Professionals) considering the level of complexity and management responsibilities of each rank. Regarding Professionals ranks, we considered Staff employees that represent the entry level professionals that support team in operational tasks and support senior workers in delivering projects and meeting expectations; we considered also Senior employees have a strong technical background related to their tasks, deliver projects on site and ensure that deadlines are met with high quality standards. Regarding the Manager ranks, Mangers manage several projects

in parallel and are responsible for the communication with clients; Senior Managers are in charge of large team with the aim of expand client relationships and focus into sales activities and the development of team members; in the Manager cluster we considered also Partners that develop and manage relationships across the business, defining top-level strategies over long term.

According to EY Performance Management process each year employees are assessed in a multi-rater approach with respect to their achievements and adherence to the organizational leadership model, identifying the level of readiness to fill the next ranks.

The 60 caucasian participants were divided in 32 Professionals (19 females) and 28 Managers (11 females) participants based on their seniority within the company. We excluded 5 participants (2 Professionals and 3 Managers) because of technical issues with the eye-tracker or lack of attention or motivation during the experiment. Thus, the final sample consisted of 55 participants (28 male, age: $M = 34.80$, $SD = 7.24$, age range = 25-53). They were divided in 29 Professionals and 26 Managers participants. Demographic and descriptive information is provided in Table 1. All participants had a normal or corrected-to-normal vision, and did not have intra-cranial metal clips, suffer from epilepsy (or having relatives who suffer from this condition), use drugs, or be affected by any kind of psychiatric or neurologic syndrome. All participants read and signed the informed consent.

	Professionals (*n* = 29) Mean±SD (%)	Managers (*n* = 26) Mean±SD (%)
	Demographic information	
Age	31.76±6.30 years	38.19±6.79 years
Age range	25-51 years	28-53 years

	Professionals (*n* = 29) Mean±SD (%)	Managers (*n* = 26) Mean±SD (%)
Gender	12 male (41.38%)	16 male (61.54%)
	Descriptive information of self-report scores	
QCAE Cognitive empathy	58.69±6.07	58.52±8.23
QCAE Affective empathy	34.72±5.26	31.12±5.42
QCAE Perspective taking	31.28±4.14	32.20±4.67
QCAE Online simulation	27.41±3.30	26.32±4.79
QCAE Emotion contagion	10.55±2.76	9.28±2.76
QCAE Proximal responsivity	12.17±1.91	11.36±1.98
QCAE Peripheral responsivity	12.00±2.66	10.48±2.85
BFQ Extraversion	3.72±0.45	3.95±0.63
BFQ Agreeableness	4.19±0.48	4.07±0.46
BFQ Conscientiousness	4.00±0.61	4.13±0.63
BFQ Neuroticism	3.38±0.67	3.52±0.72
BFQ Openness	4.20±0.36	4.00±0.58

Table 1. Demographic and descriptive information of self-report scores, reported for the Professional and Manager groups. Self-reports' acronyms are the following: QCAE = Questionnaire of Cognitive and Affective Empathy, BFQ = Big Five Questionnaire.

Apparatus

Eye movements were recorded monocularly with a high-resolution infrared eye-tracker, with a sampling rate of 1000 Hz (35mm lens, EyeLink 1000, SR Research). The eye-tracker was positioned at a fixed distance of 55-60 cm from the participants. Stimuli presentation was programmed and controlled through Experiment Builder (SR Research). The task was displayed on a monitor (1920 x1080 pixels, 120 Hz refresh rate), placed behind the eye-tracker.

Stimuli

25 Caucasian faces previously were used for the gaze-following task. We selected the faces whose traits were manipulated to display different levels of Dominance as validated by Todorov and Oosterhof (Todorov A. and Oosterhof N. N., 2011). Specifically, we used faces whose evaluation scores were -3 SD (non-dominant), 0 SD (intermediate), +3 SD (dominant) from the mean. Then, since the original faces displayed only a straight gaze, we used the same software with which they were generated (Facegen 3.1; http://facegen.com) to create faces with their gaze averted to the left and to the right. It is worth noting that, although we planned to include in the sample also female participants, we decided to employ only male identities. In fact, the creation of new female faces would have required a further validation. Moreover, this would have implied presenting different stimuli for different participants, creating further complexity in the experimental design. To address this potential issue, we included participants' gender as control variable in the analyses (see Results section).
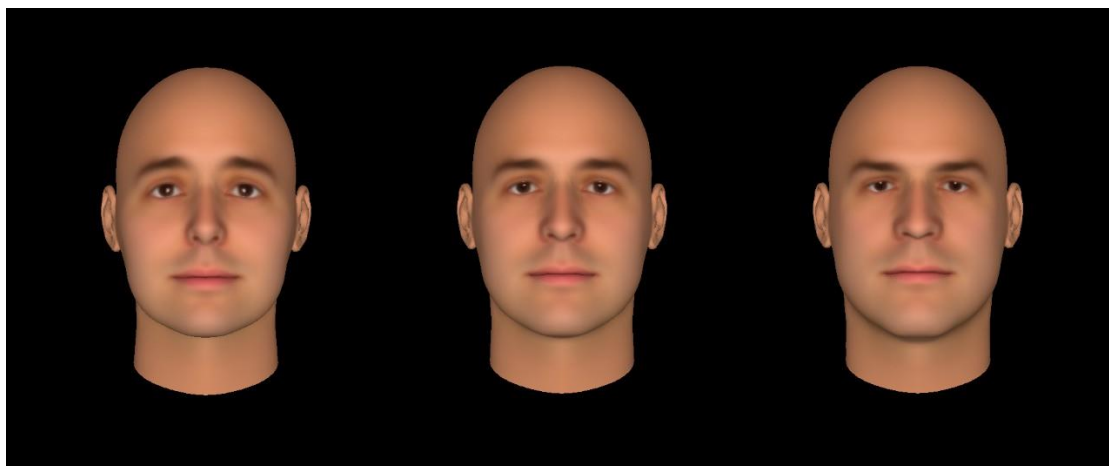
Figure 1. Example of the computer-reconstructed face stimuli selectively manipulated for the dominance trait (Oosterhof N. N. & Todorov A., 2008), employed as experimental stimuli in the gaze-following task. **Face a**: Low dominance (-3 SD). **Face b**: Intermediate (0 SD). **Face c**: High dominance (+3 SD). SD = Standard Deviation.

Procedure

The task consisted of a gaze-following task, an adaptation of the classic Posner paradigm (Driver J. et al., 1999; Posner M. I., 1980) in which participants must respond by performing saccadic eye movements instead of pressing buttons. Colour background was set to grey (R = 180, G = 180, B = 180). For each participant, a calibration/validation procedure (13 points) was performed. Since this procedure served to accurately create a correspondence between the real position of the participants' eyes and their gaze direction, if the calibration/validation procedure failed, participants had to repeat it until the resulting values were considered acceptable for ensure a good quality of the data (maximum error for each point <1°; average error <0.5°). After participants were instructed about the task, they completed 24 practice trials. Each trial started with a central black fixation dot (16 x 16 pixels) appearing at the centre of the screen. Participants had to look at the central dot and maintain their eyes on it for at least 300 ms. If they failed this gaze-contigent procedure within 4000 ms, the trial was discarded and recycled in a second moment during the experiment, and a new validation procedure was performed by the experimenters. Otherwise, in case of successful fixation, a central face (637 x 697 pixels) with straight gaze appeared for 500 ms under the central dot, flanked by two

small, squared targets (22 x 19 pixels) placed on the left and right side of the screen. Then, depending on the experimental condition, the same face was presented for 75 ms with either leftward or rightward gaze. Then, the imperative cue was presented for 800 ms, turning either red or blue. If the dot was red or blue, participants were instructed to make a leftward or a rightward saccadic movement, respectively. The association between dot colour and saccade direction was counterbalanced across participants. Participants had to follow the instruction as accurately and quickly as possible without being interfered by the gazing face. Finally, a blank was presented for a random time ranging from 700 to 900 ms. Examples of trials are depicted in Figure 2.
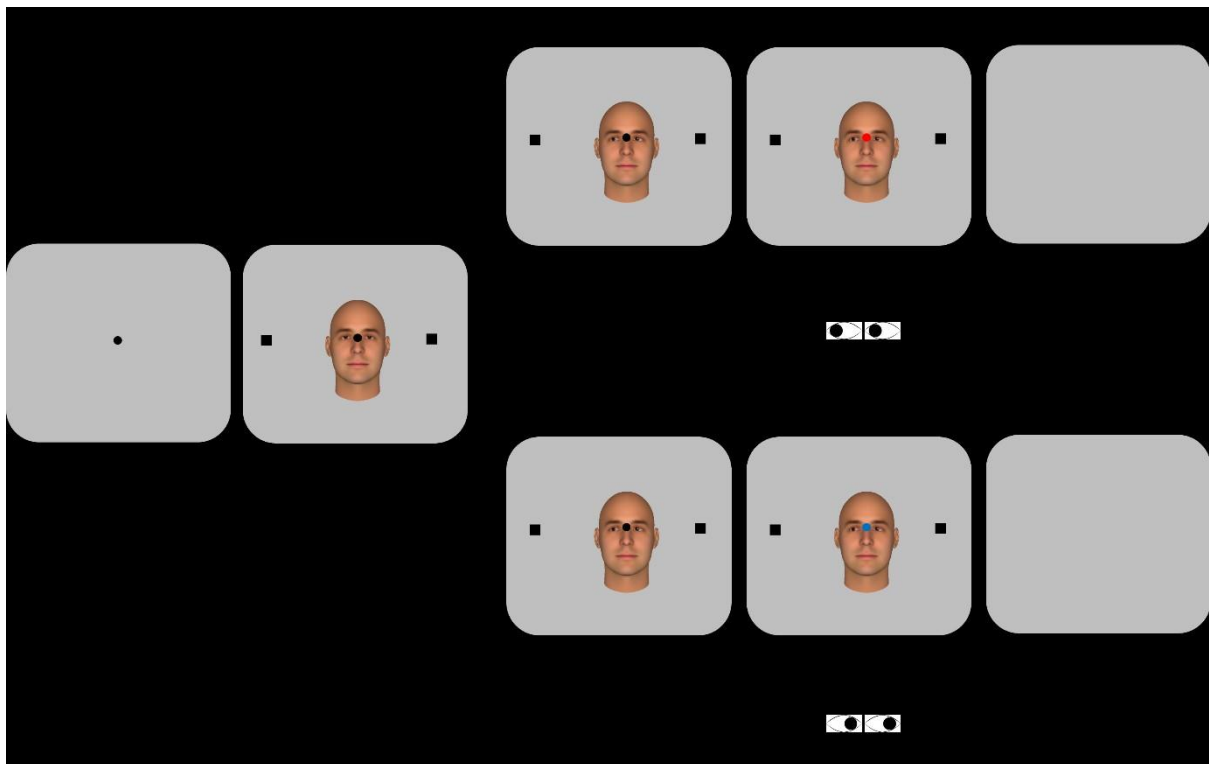

Figure 2. Schematic representation and timeline of the **gaze-following task**, with an intermediate dominance face stimulus. The upper row depicts a **congruent trial**, with the red dot signaling to perform a leftward saccade and the face gazing left. The lower row depicts an **incongruent trial**, with the blue dot signaling to perform a rightward saccade and the face gazing left. Participant (P)'s saccade depicts the correct direction toward which an eye movement should be directed. Please note that stimuli are not drawn to scale.

On half of the trials, the direction of the instructed saccade matched the direction of the gaze made by the face stimulus (i.e., congruent trials), on the other half there was no matching (i.e., incongruent trials). Participants performed 4 blocks each consisting of 75 trials (total = 300 experimental trials). A break was allowed every 75 trials. Before the beginning of a new block and after each break, the experimenters performed drift checking procedures. After completing the task, participants were then asked to fill in the Questionnaire of Cognitive and Affective Empathy (QCAE; Di Girolamo M. et al., 2019; Reniers R. L. E. P. et al., 2011), the Big Five Questionnaire (BFQ; Alessandri G. et al., 2020; Caprara G. V. et al., 1993)), and their demographic information. Additionally, for each high rank participant, the members of their team were asked to fill in the Multifactor Leadership Questionnaire (MLQ Rater Form; Avolio & Bass, 2004), aimed at measuring transformational and transactional leadership types. The experimental procedure took approximately 45 minutes. It was approved by the independent Ethics Committee of the Sapienza University of Rome and was in accordance with the 1964 Declaration of Helsinki. Participants did not receive any compensation for their participation.

2.3 Results

Data handling

Before extracting saccadic latency, we created Areas of Interest (AOIs) to check participants' accuracy in following the instructions during the task. We drew three AOIs: the i) *central AOI* (200x200 pixels) that included the cue placed in the center of the screen, the ii) *left AOI* (350x350 pixels) that included the target placed in the left side of the screen, and the iii) *right AOI* (350x350 pixels) that included the target placed in the right side.

Then, for each participant we cleaned and prepared the data according to the following pipeline: first, we removed the practice trials ($n = 24$), leaving only the experimental trials ($n = 300$). For each experimental trial, in case of multiple saccades, we only selected the first one. Since saccadic latency

faster than 100 ms could indicate saccadic motor preparation not dependent on the instruction (Crouzet et al., 2010), we checked the presence of saccades with latencies < 100 ms and found none. Also, we retained only saccades starting from the *central AOI* and ending in the *left* or *right AOIs*. For statistical analyses, we only kept correct saccades, i.e., congruent with the instructions given by the cue (n_{total} = 13582), and excluded the incorrect ones (n_{total} = 694, 5.1%). No differences emerged between Manager and Professional participants with respect to correct and incorrect saccades (χ^2 (df = 1, n = 14276) = 0.35, p = 0.55).

Saccadic reaction time

Given the small number of incorrect responses, the analysis on the saccadic accuracy was not informative. Thus, to test whether the gaze-following effect could be modulated by participants' rank in the organizational hierarchy and by the level of dominance expressed by the distractor stimulus, we used the statistical software JASP (version 0.16.3; JASP Team, 2023) to run a 2 X 3 X 2 mixed analysis of variance on the continuous dependent variable *Saccadic reaction time*. As for the independent variables, *Spatial congruency* between the instruction given by the cue and the distractors' gaze direction (2 levels: congruent vs. incongruent) and distractors' *Dominance* (3 levels: low, intermediate, high) were the within-subjects factors, and participants' *Rank* in the organizational hierarchy (2 levels: Professional, Manager) was the between-subjects factor. Moreover, to rule out any possible confounding effects due to the presence of only masculine distractor stimuli, we included participants' *Gender* as control variable. Similarly, since age-related differences in the reflexive components of overt gaze following have been found (Kuhn G. et al., 2015), we included *Age* as a control too. Descriptive analyses revealed that the data were normally distributed (all Shapiro-Wilk p-values >.46) and their variances were equal (all Levene's p-values >.05). Results of the ANOVA revealed a marginally significant main effect of *Spatial congruency* (F(1,51) = 3.38, p = 0.072, η^2 = 0.002), which is however qualified by a significant *Spatial congruency* X *Rank* interaction (F(1,51) = 6.63, p = 0.013, η^2 = 0.004). Bonferroni tests for multiple comparison showed that saccadic latency

was slower for incongruent vs. congruent trials both for Manager (mean difference = -24.62, *SE* = 3.05, *t* = -8.07, *p* <.001, 95% CI [-33.00, -16.24]) and Professional (mean difference = -13.24, *SE* = 2.87, *t* = -4.62, *p* <.001, 95% CI [-21.11, -5.37]) participants, confirming the presence of the gaze-following effect in both groups (see Figure 3). However, no differences emerged between the two groups in the magnitude of this effect neither in the congruent (mean difference = -3.66, *SE* = 13.05, *t* = 0.28, *p* = 1, 95%CI [-39.40, 32.08]) nor in the incongruent trials (mean difference = 7.71, *SE* = 13.05, *t* = 0.28, *p* = 1, 95%CI [-28.03, 43.46]) (Table 2 for descriptive statistics). We found no other significant main effects or interactions (all *Fs* <2.76, *ps* >.07).
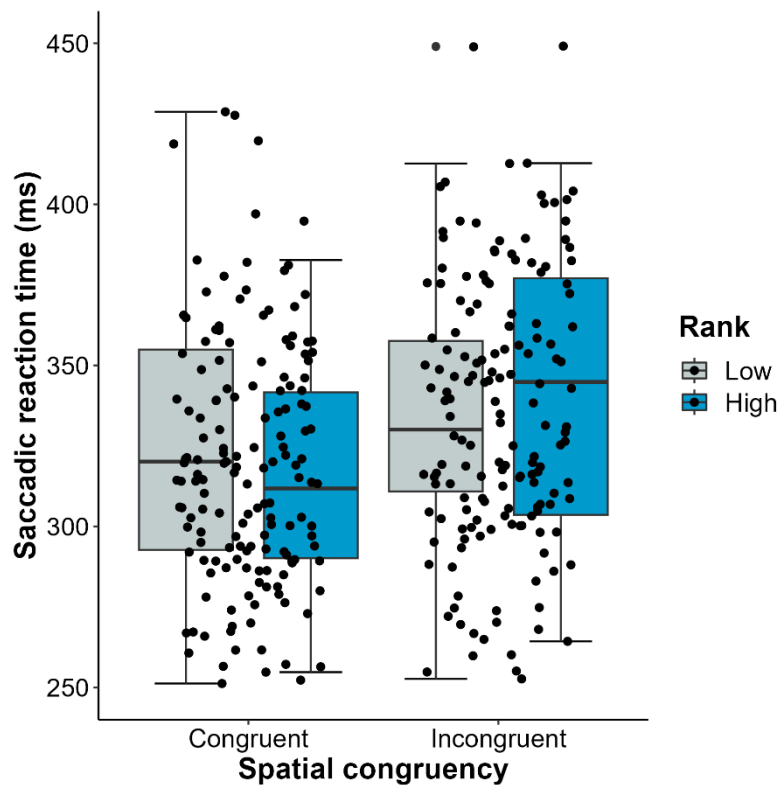

Figure 3. Boxplots show the mean saccadic RTs (ms) collapsed across conditions for spatially congruent and incongruent trials as a function of the rank of the observer (Spatial congruency x Rank interaction (F(1,51) = 6.63, *p* = .01, η^2 = 0.004)). The lower and upper hinges correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends from the hinge to the largest value no further than 1.5 * IQR from the hinge (where IQR is the inter-quartile range, or distance between the first and third quartiles). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Data beyond the end of the whiskers are called "outlying" points and are plotted individually.

Spatial congruency	Dominance	Rank	Mean	SD	Minimum	Maximum
Congruent	High	Professional	318.016	48.701	236.939	419.727
Congruent	High	Manager	315.430	32.180	261.643	381.111
Congruent	Low	Professional	315.247	48.166	230.581	428.727
Congruent	Low	Manager	314.296	30.773	256.561	370.605
Congruent	Intermediate	Professional	313.467	47.161	236.256	427.649
Congruent	Intermediate	Manager	315.748	34.923	254.750	382.698
Incongruent	High	Professional	328.900	47.849	252.649	448.906
Incongruent	High	Manager	337.540	40.074	272.095	412.778
Incongruent	Low	Professional	331.407	48.108	243.333	449.107
Incongruent	Low	Manager	338.014	41.728	264.317	404.111
Incongruent	Intermediate	Professional	328.372	48.070	248.929	469.548
Incongruent	Intermediate	Manager	341.257	41.151	273.818	402.905

Table 2. Descriptive statistics with mean, standard deviation, minimum and maximum of Saccadic reaction times in milliseconds at different levels of spatial congruency and distractor's facial dominance, for Professional and Manager participants.

Gaze-following effect

To give further insights on the gaze-following effect, we calculated an index by subtracting the saccadic reaction time of congruent trials from the saccadic reaction time of incongruent trials (Gaze-following Index as in Jones, Debruine, et al., 2010; Shepherd et al., 2006). Thus, more positive scores

indicated stronger gaze following effect - or stronger interfering power exerted by the distractors - while more negative scores indicated weaker gaze following effect - or weaker interfering power exerted by the distractors. We ran a 3 X 2 mixed ANOVA on the continuous dependent variable *Gaze Following Index*. As for the independent variables, distractors' *Dominance* (3 levels: low, neutral, high) was the within-subjects factor, and participants' *Rank* in the organizational hierarchy (2 levels: low, high) was the between-subjects factor. Coherently with the previous analysis, we included participants' *Age* and *Gender* as control variables. Results revealed a main effect of *Rank* (F(1,51) = 6.63, p = 0.013, η^2 = 0.067), indicating that high-ranked participants presented a stronger gaze following effect with respect to low-ranked participants (mean difference = 11.38, *SE* = 4.42, t = 2.58, p = 0.013, 95% CI [2.51, 20.25], Cohen's d = 0.59, see Figure 4) (see Table 3 for descriptive statistics). We found no other significant main effects or interactions (all *Fs* <0.65, *ps* >.48).
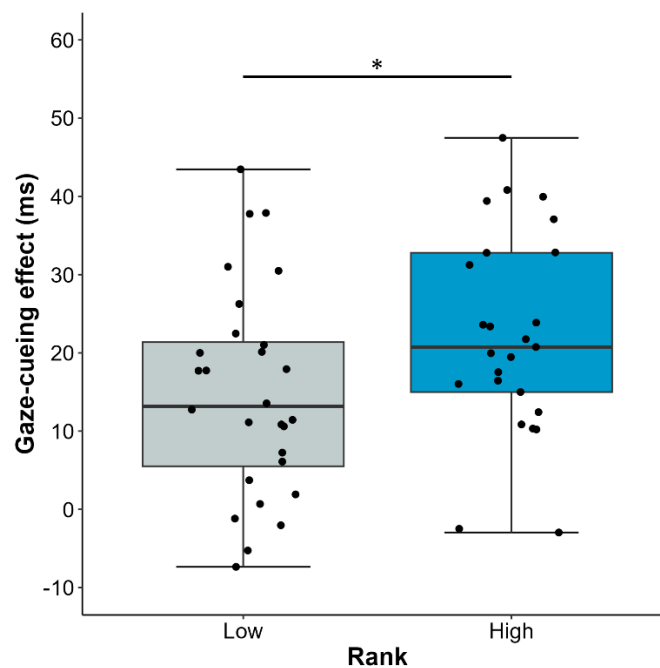

Figure 4. Boxplots show the gaze-following effect (ms) collapsed across conditions as a function of the rank of the observer (main effect of Rank (F(1,51) = 6.63, p = 0.013, η^2 = 0.067). The lower and upper hinges correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends from the hinge to the largest value no further than 1.5 * IQR from the hinge (where IQR is the inter-quartile range, or distance between the first and third quartiles). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Data beyond the end of the whiskers are called "outlying" points and are plotted individually.

Dominance	Rank	Mean	SD	Minimum	Maximum
High	Professional	10.884	22.770	-36.883	70.595
High	Manager	22.110	14.760	-1.794	50.521
Low	Professional	16.160	17.146	-11.108	56.507
Low	Manager	23.718	21.512	-10.052	78.426
Intermediate	Professional	14.905	15.979	-10.023	53.705
Intermediate	Manager	25.510	21.633	-10.951	84.524

Table 3. Descriptive statistics with mean, standard deviation, minimum and maximum of gaze-following effect at different levels of distractor's facial dominance for Manager and Professional participants.

Correlation between gaze-following effect and self-report measures

Please see Table 1 for descriptive information regarding self-report measures and Table 4 for the independent samples t-tests. The latters revealed that the two groups differed in Affective Empathy (a person's emotional reaction to other people's experiences, that does not necessarily require cognitive understanding; Leiberg & Anders, 2006) and in Peripheral responsivity (a subcomponent of Affective Empathy indexing the emotional responsiveness to the feelings of others who are detached from responder's social context, such as protagonists in a novel or in a movie; Di Girolamo M. et al., 2019), with Professionals participants reporting higher scores in both measures.

To explore whether the gaze following effect was modulated by participants' self-reported information (QCAE and BFQ, indexing cognitive and affective empathy, and personality traits, respectively), we run Pearson's correlations with the scores of the two groups and an index, i.e., *Mean Gaze Following Index*, in which we averaged the low, high, and neutral dominance levels of the *Gaze Following Index* used in the previous analysis to obtain a single numerical variable. Results showed

that for low-ranked participants' *Mean Gaze Following Index* was positively related to the Cognitive Empathy subscale of the QCAE ($r = 0.42$, $p = 0.023$, see Figure 5, Panel a), indicating a stronger gaze following effect for the low-ranked participants who were more inclined to understand and recognize others' emotional experiences and feelings, using visual, auditory, and situational cues (Di Girolamo et al., 2019). In addition, we observed the same positive association with the BFQ's Agreeableness (r = 0.46, p = 0.012, see Figure 5, Panel b) and Neuroticism ($r = 0.47$, $p = 0.011$, see Figure 5, Panel c) traits, indicating that those more inclined to friendliness and emotional stability were also more interfered by human faces during the task.

Conversely, we found no significant correlations for high-ranked participants, indicating that their stronger gaze following effect (compared to low-ranked participants, as observed in the previous analysis) was not modulated by individual differences captured by the employed self-report measures. For the high rank group only, we also tested whether the gaze following effect was modulated by participants' leadership type, so we run Pearson's correlations with the MLQ subscale scores and the *Mean Gaze Following Index*. No significant correlation emerged, no matter the leadership styles (transformational: $r = 0.12$, $p = 0.63$; transactional: $r = -0.02$, $p = 0.92$).
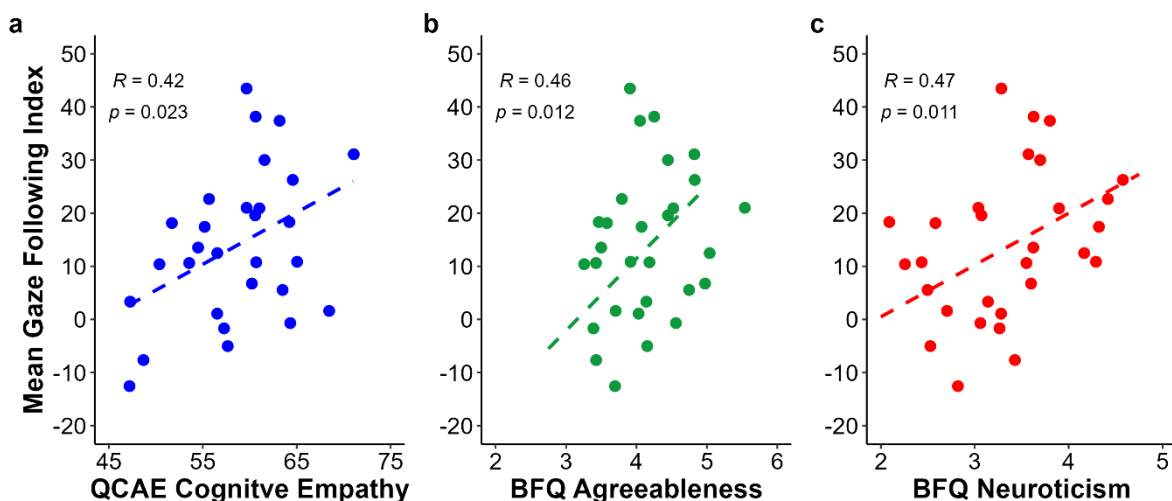

Figure 5. Correlation plots depicting the linear relationship between the Mean Gaze Following Index and (i) QCAE Cognitive Empathy (**Panel a**), (ii) BFQ Agreeableness (**Panel b**), (iii) BFQ Neuroticism (**Panel c**), in low rank participants (n = 29). For each plot, statistical information (R = correlation coefficient, p = statistical significance) relative to the relationship between the two variables and a best-fit regression line are also depicted. Type of correlation test: Pearson.

Self-report scores	t ($df = 52$)	p	Cohen's d
QCAE Cognitive empathy	-0.087	0.931	-0.024
QCAE Affective empathy	-2.475	0.017*	-0.675
QCAE Perspective taking	0.771	0.444	0.210
QCAE Online simulation	-0.989	0.327	-0.270
QCAE Emotion contagion	-1.688	0.097	-0.461
QCAE Proximal responsivity	-1.534	0.131	-0.419
QCAE Peripheral responsivity	-2.028	0.048*	-0.553
BFQ Extraversion	1.526	0.133	0.417
BFQ Agreeableness	-0.930	0.357	-0.254
BFQ Conscientiousness	0.776	0.441	0.212
BFQ Neuroticism	0.738	0.464	0.201
BFQ Openness	-1.559	0.125	-0.425

Table 4. Independent samples Student's t-tests between Professional and Manager participants for QCAE (Questionnaire of Cognitive and Affective Empathy) and BFQ (Big Five Questionnaire) scores. *p<.05.

2.4 Discussion

In this study we investigated the conjugate effects of the observer's rank and of the stimuli's facial dominance on saccadic reaction times during a gaze-following task. Contrary to previous research (Jones, DeBruine, et al., 2010; Ohlsen et al., 2013), we found no effects of facial dominance on gaze following behavior. A similar result has been recently reported by Mattavelli and colleagues (2021) who found that the gaze-cueing effects was not modulated by perceived social traits (dominance and

trustworthiness) of human-like faces (Mattavelli et al., 2021). These negative results could be ascribed to the employment of computer-generated faces that could capture attention less efficiently with respect to real human faces because they are rated as less familiar (Di Natale et al., 2023) and human-like (Miller et al., 2023) or could be less salient compared with face identities with high individual relevance (e.g., the conspecifics' faces employed with non-human primates; Shepherd et al., 2006). Moreover, previous studies, in which significant effects of facial dominance emerged, were gaze cueing tasks requiring participants to perform hand motor responses (Jones, DeBruine, et al., 2010; Ohlsen et al., 2013) and not gaze following tasks requiring participants to perform saccadic eye movements. Since motor responses require more time to be executed with respect to saccadic eye movements, it is possible that dominance facial cues may exert stronger interference effects with the formers. In line with this explanation, recent research found that saccadic responses were not affected by facial expression and identity cues, while manual response latencies were sensitive to facial emotional expressions (Kveraga et al., 2020).

Crucially, we found that Managers showed a stronger gaze-following effect with respect to Professionals ones. In other words, Manager individuals were more interfered by the gaze displayed by face distractors when performing saccadic eye movements during the task.

To the best of our knowledge, no previous study employed Professionals and Manager members of a social hierarchy as participants in a gaze-following tasks (but see the results of Shepherd and colleagues (Sheperd S. V., 2006) for findings involving non-human primates). Previous studies found that more dominant individuals were more reluctant to avert gaze from stimuli that depict dominance, including angry faces (Terburg D. et al., 2011) and body postures (Hortensius R. et al., 2014). In addition, Maran and colleagues (Maran T. et al., 2019) employed eye tracking to monitor gaze during simulated leadership scenarios in which individuals tried to influence followers toward reaching a common goal. They found that participants' self-reported charisma predicted frequency and duration of gaze directed at their followers and that longer and more frequent gazing induced leaders to be

perceived as more prototypical of their position (Maran T. et al., 2019) (for a review on eye gaze and social attention in leadership and followership see Cheng J. T. et al., 2022).

Our result also suggests that high rank individuals' attention may be more permeable to social information with respect to low rank ones. In line with this idea, previous research found that leaders seem hypervigilant to social signs displayed on others' faces. In particular, Case and colleagues (Case C. R. et al., 2021) showed that prestige-oriented (but not dominance-oriented) leaders overperceived facial expressions of social discontent and disapproval (Experiments 1 and 2). Also, manipulations of prestige induced similar behavioural patterns, suggesting that an orientation toward prestige causes leaders to have social perception biases (Experiments 3, 4, and 5) (Case C. R. et al., 2021). These attention/perception biases may be consistent with the idea that since the costs of false positive and false negative are often asymmetric, biases toward making the least costly error should have been favored under uncertainty (Error management theory; Haselton M. J. & Buss D. M., 2000; Haselton M. J. & Nettle D., 2006). In the context of leadership, erroneously perceiving group members as expressing social approval may increase the probability of losing support from them. Being hypervigilant to (negative) social signals may allow leaders to quickly identify social disapproval and to take actions aimed at managing and enhancing social relationships within a group, decreasing the probability to lose others' endorsement (Case C. R. et al., 2021).

Furthermore, a study employing electroencephalography (EEG) and event-related potential (ERP) analysis found that social class affected the neural correlates of spontaneous trait inference. In particular, in high socio-economic status (SES) individuals N400 was observed in response to incongruent face/traits pairings during a lexical decision task, while in low SES individuals N400 was not present (Varnum M. E. W., 2016; Varnum M. E. W. et al., 2012). These findings suggest that Manager individuals may be more inclined to spontaneously infer traits when presented with social information. Furthermore, a study investigating 800 senior managers showed that "high flyers" (i.e., the individuals that rose faster to the top of their organizations) presented elevated scores in several indicators, including social functioning (Jensen T. M., 2007).

The findings of our study may also suggest that Manager individuals may be more prone or prepared to social interaction with respect to Professional ones. Crucially, high power individuals (i.e., individuals who scored higher in dominance or were assigned control over resources in decision-making dyads) showed enhanced behavioural approach system activation (e.g., enhanced social perception, expression of attitudes and more positive emotional experience) compared to low power participants (Anderson C. & Berdahl J. L., 2002). Similarly, another study focusing on the neuroendocrine and cardiovascular correlates of social standing (Hamilton L. D. et al., 2015) found that higher social status (both measured and manipulated) was associated with approach-oriented physiological reactivity (e.g., higher testosterone, greater cardiac output and heart rate, lower pre-ejection period, and lower respiratory sinus arrhythmia) during a stress task (Akinola M. & Mendes W. B., 2014). These findings are in line with the approach/inhibition theory of power according to which power leads to a more active approach system and a less active inhibition system (Keltner D. et al., 2003).

We suggest that the enhanced gaze-following effect observed in Manager individuals may be linked with enhanced attentional orientation towards social stimuli. Importantly, to assess whether joint attention (i.e., following the direction of another's gaze) reflects social processing ability, Bayliss and colleagues (Bayliss A. P., 2005) measured the effects of gender and autism spectrum quotient on gaze-cueing. The authors showed that male participants pay less attention to social stimuli compared to female ones, as demonstrated by the lesser influence played by face distractors in affecting the performance of the formers. Additionally, a negative correlation between autism spectrum quotient and gaze-cueing was observed; in particular, individuals scoring higher on the autism quotient (i.e., poorer social and communication skills) tended to produce less joint attention when viewing gaze shifts (Bayliss A. P. et al., 2005). This suggests that a stronger gaze-cueing effect may index more advanced social skills.

Importantly, previous studies investigated the effects of traits that may characterize distinct leadership style on gaze following behavior. For example, Ciardo and colleagues found that the type of

relationship (e.g., cooperative or competitive) established during a previous interaction with a cueing face modulated gaze following behavior. In particular, female participants with low and average levels of competition (as measured with the Competitiveness Index questionnaire; Houston et al., 2000) displayed enhanced gaze-cueing effect for competitive with respect to cooperative contenders (Ciardo et al., 2015). Furthermore, facial identities associated with low social status elicited larger gaze following behavior (Experiment 2) and triggered higher prosocial attitudes (Ciardo et al., 2021). Our data also showed that Professional individuals performed saccadic eye movements quicker than Manager ones in the gaze-following task, suggesting that they were less interfered form face distractors. This result is in agreement with an EEG study which showed that low status participants monitor their performance more actively (as signaled by an enhanced medial frontal negativity), and adjust their behaviour more effectively when they receive a negative performance feedback (Boksem M. A. S. et al., 2012). Interestingly, Professional participants who were more inclined to understand and recognize others' emotions (QCAE Cognitive Empathy), more friendly (BFQ Agreeableness), and were more emotionally stable (BFQ Neuroticism), presented an oculomotor performance which was more like that of Managers (i.e., they were more interfered from face distractors).

To conclude, this study provided new insights about the effect of social standing in social attention orientation. In particular, we showed that Managers presented a stronger gaze-following effect, in line with previous evidence suggesting that leaders direct others' attention by means of a greater ability to gaze-lead and to maintain rather than break eye contact when stared by others (Cheng J. T. et al., 2022). We interpret our findings in terms of enhanced reactivity to social cues by high vs low rank participants, but future research should focus on the measurement of actual social skills (e.g., by employing the Social Skills subscale of the autism-spectrum quotient (AQ; Baron-Cohen et al., 2001), to assess whether social attention and social competence may be linked (as in Laidlaw et al., 2011). Our finding also confirms that gaze-following may be conceived as a conditionally automatic process, modulated by contextually relevant social information (Dalmaso M., Castelli L., et al., 2020; Zhang X. et al., 2023), including the observer's position within a social hierarchy.

Crucial for future studies, oculomotor parameters recorded in eye tracking studies may represent general indicators of real-world social interaction (for a review see Rahal R. M. & Fiedler S., 2019), including social standing in a real-world social hierarchy.

Chapter 3: The contagious leader: behavioural and physiological measures of emotional contagion in organizational settings

Abstract

The conscious or unconscious transmission of positive and negative moods and emotions within dyads, social groups, and organizations is referred to as emotional contagion, a process that may modulate a variety of social and organizational phenomena. Previous studies indicate that leaders' emotions can propagate to their followers, with important consequences on well-being and work performance. However, the biological mechanisms underlying this phenomenon in organizational settings are underexplored. In this chapter, I will discuss an experimental study investigating emotional and physiological contagion in managers and non-managers working at EY Rome Headquarter.

3.1 Introduction

Emotions impact working life at the individual, group and organization level (Ashkanasy N. M., 2003) and have important consequences on employees' productivity and well-being (Barsade S. G. et al., 2018). Emotions and moods, far from being exclusively private experiences, are shared and spread among individuals during social interactions, giving rise to "collective emotions" (Barsade S. G. et al., 2018; Goldenberg a. et al., 2020). The mechanisms underlying the spread of emotions and moods in organizations have received increasing attention in recent years, with a particular emphasis on the leader-to-follower dynamics. The expression of positive emotions by a leader may improve the followers' mood (Bono J. E. & Ilies R., 2006; Sy T. et al., 2005; Sy T. & Choi J. N., 2013), and positively affect group's performance (Barsade S. G., 2002; Visser V. A. et al., 2013). In addition,

positive emotional contagion is one of the defining features of charismatic (Antonakis J. et al., 2016) and transformational (Bass B. M. & Riggio R. E., 2006) leadership and a leader's positive mood can increase the follower's perception of his or her charisma (Cheng J. T. et al., 2012; Cherulnik P. D. et al., 2001; Erez A. et al., 2008).

Emotional contagion is defined as the transfer of emotional states from one person to another, from one person to an entire group, or within the group itself. The most accredited neuroscientific model for explaining the mechanisms of emotional contagion is that of sensorimotor simulation. According to this model, mimicry, the automatic tendency to imitate and align one's expressions, vocalizations, postures, and movements with those of another person (Hatfield E. et al., 1993; Hess U. & Blairy S., 2001) leads, through simulative processes, to experiencing the same emotion observed in the other person and converging with them emotionally and physiologically (Prochazkova E. & Kret M., 2017). Emotional contagion can spread within more or less structured groups, causing the emergence of "collective emotions" (Barsade S. G., 2002). In some cases, such as in crowds, where there is no role differentiation among individuals, the spread of contagion occurs horizontally (Raafat R. M. et al., 2009). However, recent studies suggest that in complex contexts characterized by hierarchical relationships, the spread of emotions follows asymmetric paths and can be directed by an individual or a group. A particular example is organizational contexts, where the spread of emotions and moods seems to follow a vertical trajectory, from the leader to the followers, and appears to have an impact on work effectiveness. Laboratory studies have indeed shown that the expression of positive emotions by a leader not only can influence the mood of the followers (Bono J. E. & Ilies R., 2006; Sy T., Côté S., and Saavedra R., 2005; Sy T. & Choi J. N., 2013) but also may have a beneficial effect on the performance of the work group (Barsade S. G., 2002; Visser V. A. et al., 2013).

Affective states are characterized by changes in the physiological state of the body, specifically by variations in the activity of the autonomic and endocrine systems (Cacioppo J. T. et al., 2000). The autonomic nervous system is a division of the peripheral nervous system that controls involuntary bodily functions, such as heart rate, digestion, respiratory rate, perspiration and pupillary response. It

consists of two main branches, the sympathetic and parasympathetic nervous systems, working together to maintain homeostasis and respond to different physiological demands. The sympathetic nervous system generally prepares the body for "fight or flight" responses, increasing heart rate, dilating pupils, increasing sweat, and redirecting blood flow to muscles. In contrast, the parasympathetic nervous system promotes a "rest and digest" state, slowing heart rate, constricting pupils, and facilitating activities like digestion and relaxation. Recording heart rate and electrodermal activity (EDA) can provide valuable insights into the processing of emotional stimuli. Changes in heart rate reflect the autonomic nervous system's response to emotional arousal. For example, increased heart rate is often associated with heightened emotional states such as fear or excitement (Lench H. C. et al., 2011). Electrodermal activity (EDA) measures changes in skin conductance, reflecting sweat gland activity influenced by the sympathetic nervous system. This can indicate emotional arousal, with increased skin conductance typically linked to emotional stimuli (Critchley H. D., 2002). Another technique for measuring the activity of the autonomic nervous system, that has recently gained popularity, is thermal infrared imaging (tIRI), a contact-free method for estimating cutaneous temperature and monitoring subtle changes associated with autonomic nervous system responses. Studies have shown that distinct facial temperature patterns, such as warming in periorbital regions, can reveal different sympathetic activities linked to various psychological or physical states, including flight-or-fight responses (Kosogonov V. et al., 2017). Additionally, nasal skin temperature changes indicate increased sympathetic activity, characterized by vasoconstriction and a drop in skin temperature, observed in both monkeys (Nakayama K. et al., 2005) and humans (Engert V. et al., 2014; Kosogonov V. et al., 2017). Therefore, by analyzing physiological responses in conjunction with emotional stimuli presentation, researchers can infer the intensity and nature of emotional experiences, helping to understand how individuals react to different emotional stimuli and providing insights into the mechanisms of emotional contagion.

Another important aspect to consider regarding the spread of emotions in organizational contexts is the interindividual variability in susceptibility to emotional contagion. Susceptibility to emotional

contagion, i.e., the ease with which one's emotional state is influenced by the emotional state of others or external events, varies based on personal and situational characteristics. For example, individuals with high levels of Extraversion and Neuroticism appear to be more susceptible to emotional contagion (Tee E. Y. J., 2015). The position held within society, or a group can also modulate sensitivity to emotional contagion. Recent studies report that individuals with high socioeconomic status have a reduced ability to perceive and discriminate emotions expressed by others (Dietze P. & Knowles E. D., 2021), and a reduced neural response when observing others' actions (Varnum M. E. W. et al., 2016). For this reason, it is logical to hypothesize that people occupying a high-status position within an organization (leaders) are less susceptible to emotional contagion compared to "followers". However, it is possible that the adopted leadership style plays a role in both susceptibility to emotional contagion and the tendency to transmit one's emotional state to others. The classic model of leadership styles proposes a distinction between "transformational" and "transactional" leaders (Bass B. M. & Riggio R. E., 2006). While the transactional leader focuses on specific work goals, the transformational leader "inspires" their collaborators to continuously improve for their own well-being and for the good of the organization to which they belong. The transformational leader is also focused on the well-being of their workers and generally characterized by high levels of emotional intelligence (Barbuto Jr, J. E. & Burbach M. E., 2006; Megerian L. E. & Sosik J. J., 1996), empathy (Bass B. M., 1990), and emotion recognition skills (Rubin R. S. et al., 2005). It is therefore possible that leaders adopting a transformational strategy are more susceptible to emotional contagion than transactional leaders. Furthermore, transformational leaders, being more accustomed to using emotions as a communicative tool (Ashkanasy N. M. & Tse B., 2000), might more easily transmit their emotional states to followers).

The aim of the study described in the present chapter is to explore the extent to which in hierarchical organizations emotional contagion spreads from leader to follower more than in opposite direction and whether transformational vs transactional leadership style differentially influences the viral spreading of negative vs positive moods. The study is organized in two experiments: Experiment 1,

for which data collection has been already completed, aims at recording a set of naturalistic videos to be used as stimuli in Experiment 2. Specifically, we recorded video images of participants engaged in different tasks (a resting-state Baseline, a public speech and the presentation of emotional stimuli. Along with the videos, we also collected physiological and behavioral data from each task. Through the analysis of behavioural and physiological data, we explored the hypothesis that emotional responses to stimuli may vary as a function of fig working role (Leader or Follower) and, that, in Leaders, is further modulated by their preferred leadership style. Moreover, we investigated whether working role and experience modulated physiological change during a public speaking task.

3.2 Experiment 1

In Experiment 1, we collected behavioural and physiological responses from participants engaged in different tasks. Behavioural variables were self-report evaluations of participants' current emotional state during various tasks in terms of emotional valence, intensity, and arousal. Moreover, we collected continuous ratings of emotional valence using a Response Meter. Physiological data were the electrocardiograph (ECG) activity, indexed by heart rate (HR) and electrodermal activity (EDA) in its phasic (skin conductance response, SCR) and tonic (skin conductance level, SCL) components. In addition, we measured participants' face temperature with infrared thermal imaging. Experiment 1 is divided in two experiments. In Experiment 1a, participants first completed a Baseline task, in which they were asked to stand still and report any change in their emotional state (either positive or negative changes) with the Response Meter. This task was designed to obtain each participant's baseline levels of physiological and emotional state. Participants were then asked to give a brief speech while being video recorded. This task was meant to explore whether leaders and followers differ in their physiological responses to public speaking. In Experiment 1b, participants were engaged in the emotional contagion task, where they watched positive, negative, and neutral video

stimuli. With this experiment, we tested the hypothesis that leaders may be less responsive to emotional stimuli compared to followers.

3.3 Methods

3.3.1 Common methods in Experiment 1a and Experiment 1b

Participants

The experimental sample was recruited among EY (Ernst & Young) employees working at the EY Headquarter in Rome. We recruited 60 men (mean age = 31, sd = 5.8) and 60 women (mean age = 29, sd = 4.1). Participants had the following roles in the organization: Staff 1 (N = 24), Staff 2 (N = 14), Senior 1 (N = 17), Senior 2 (N = 17), Senior 3 (N = 20), Manager 1 (N = 5), Manager 2 (N = 10), Manager 3 (N = 4), Senior Manager 1 (N = 4), Senior Manager 2 (N = 2), Senior Manager 3 (N = 3). The "Leaders" group (including Managers and Senior Managers) comprised 28 participants (9 female), while the "Followers" (Professional, including Staff and Seniors) group consisted of 92 participants (51 female). Testing took place from June to October 2023. The sample size was decided based on the availability of participants.

ECG and EDA recording - Cardiac (ECG) activity was continuously recorded during the tasks through Ag/AgCl disposable electrodes placed in a Lead II configuration and sent to a PowerLab C amplifier (ADInstruments) connected to a BioAmp ECG module. From ECG data, we extracted a mean value of beat-per-minutes (BPM), indicating the heart rate frequency. Electrodermal activity (EDA) was continuously recorded through a pair of steel GSR Finger Electrodes placed on the middle and index finger of the left hand. The EDA signal was then amplified with the PowerLab C amplifier and a ML116 Galvanic Skin Response (GSR) module. ECG and EDA signals were acquired at a sampling frequency of 1 kHz and monitored online through the software LabChart 8

(ADInstruments). EDA data pre-processing was carried out using Matlab (The MathWorks, Natick, MA, version R2019) and the Matlab-based toolbox Ledalab (Leipzig, Germany; www.ledalab.de, version 3.4.9). Continuous decomposition analysis (CDA) was performed to separate phasic components from tonic activity based on standard deconvolution. Skin Conductance Response (CDA.SCR) was analyzed using the mean amplitude of the phasic SCR with a minimum response of 0.01 µS, whereas the Tonic activity (CDA.Tonic) was analyzed using the mean tonic activity of decomposed tonic component. To overcome computational limits, data were down sampled to 10 Hz.

Infrared thermal imaging and video recording - Participants' facial temperature was recorded at a sampling rate of 50 Hz with a FLIR A655sc infrared thermal camera, placed on a tripod and located 3 meters away from their face. The thermal camera was associated with a Logitech C920 webcam that was placed above the computer screen used to deliver the video stimuli. Both the thermal camera and the webcam were connected to a computer running the IRI Image PRO 4.0 software, developed by Next2U s.r.l (Pescara, Italy) for thermal imaging acquisition and analysis. The software records at the same time the thermal imaging data and a digital video through the webcam, which is later used to identify facial landmarks and regions of interest (ROIs). We stored the digital videos for the analysis of emotional expressions and to use them as stimuli in Experiment 2. During the extraction phase, we selected as ROI the following face regions: corrugator, perioral, periorbital (left and right, averaged) and periorbital (left and right average).

Emotional expression coding with AI-based software FaceReader - Digital videos were analyzed to quantify the amount of facial emotional expressions using the software FaceReader (Noldus Information Technology inc., Wageningen, the Netherlands). FaceReader is an artificial intelligence automated system for the recognition of specific properties in facial images and expressions. The software quantifies the intensity of specific facial expressions for basic emotions (Neutral, Sad,

Happy, Angry, Surprised, Scared and Disgusted) on a scale from 0 to 1 based on facial action units (AU) configurations (Ekman & Friesen, 1978).

Questionnaires - We assessed individual differences in affect, sensitivity to emotional contagion and personality traits through the following questionnaires in their Italian versions. The Positive and Negative Affect Schedule (PANAS, Terracciano et al., 2003) is a commonly used tool to measure Positive Affect (PA) and Negative Affect (NA). The Positive Affect scale reflects pleasant engagement, capturing enthusiasm, excitement, activity, and determination. The Negative Affect scale assesses unpleasant engagement and distress, encompassing feelings like fear, nervousness, guilt, and shame. We asked participants to rate how often they experienced each feeling in the past week. The Emotional Contagion Scale (ECS, Lo Coco et al., 2013) comprises 15 items designed to assess individual variations in susceptibility to adopting the emotions of others. It explores the inclination to mimic five fundamental emotions: love, happiness, fear, anger, and sadness. Furthermore, we administered the short version of the Big Factor Inventory 10 (BFI-10, Guido et al., 2015), a widely used personality assessment tool that measures individuals on five major personality traits: Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism, and (only to the Leader group) the self-administered version of the Multifactor Leadership Questionnaire (MLQ, Avolio & Bass B. M., 2004), which measures the frequency of behaviours associated with Transformational (e.g. "I help others find meaning in their work") and Transactional (e.g. "I tell others what to do if they want to be rewarded for their work.") leadership.

3.3.2 Experiment 1a

Procedure

Upon their arrival at the lab, participants read and signed the informed consent forms and filled the personality questionnaires. The experimenter then proceeded to place the ECG electrodes and the EDA sensors, and the participant completed the Baseline task. After that, participants underwent the

Speech task. During all the tasks, participants were comfortably seated on an office chair placed in front of a computer screen. In each task, we recorded participants' ECG, EDA and face temperature. In addition, we videotaped them with a web camera, framing their face and torso.

Baseline task

After ECG and EDA sensors placement, participants were first asked to rate their emotional state in terms of valence (0 = completely negative, 100 = completely positive), intensity (0 = not at all intense, 100 = extremely intense) and arousal (0 = extremely low arousal, 100 = extremely high arousal) using a visual analogue scale (VAS) presented on a computer screen through the software E-Prime (version). After answering the questions, they were informed that their physiological activity would be recorded for 6 minutes. This time window was selected because previous studies indicate that HRV can be reliably calculated from a 5-minute ECG recording (e.g. Sinnreich et al., 1998). During this time, a fixation cross was presented on the computer screen and participants were suggested to use the cross as a reference point for orienting their eye gaze. In addition, participants were asked to report, in real time, any change perceived in their emotional state using a Response Meter connected to a PowerLab (ADInstruments) amplifier. The Response Meter has a slide control with a 10-point Likert scale that provides the subject with the ability to quantify their response to a range of different stimuli continuously over the duration of each stimulus. Participants were informed that the scale represented the valence of possible emotional states ranging from 0 (completely negative emotional state) to 10 (completely positive emotional state) and were instructed to move the slide control whenever they perceived a change (either positive or negative) in their emotional state.

Speech task

During the Speech task, participants were asked to give a 2-minutes speech while being video-recorded. They received the following instructions: "*Imagine that you are talking with a person, named Francesco, who has the intention of joining your company but is not completely convinced, he*

has doubts. Your task is to try and convince Francesco to give EY a chance, possibly describing your personal experience". The experimenter informed the participants that they could take all the time they needed to prepare the speech and told them that, when they felt ready, they could start the recording by pressing the spacebar on a keyboard. Participants were asked to minimize as much as possible their body movements to avoid the contamination of physiological data.

3.3.3 Experiment 1b

Procedure

Participants were seated in front of a computer screen and presented with neutral, positive and negative video stimuli (see Emotional Induction task) After the end of the Emotion Induction task, participants received a full debriefing concerning the experimental hypotheses and were given the opportunity to ask questions.

Emotional induction task

Stimuli - Stimuli were short emotional and neutral videos selected from existing databases and previously validated (Behnke et al., 2022). Neutral video clips were four 40-second snippets of Disney's Earth documentaries depicting an arctic landscape (video code: ARTI), a forest (TREE), a waterfall (WATR) and snowy mountain tops (SNOW). Clips were selected from the EMDB database (Branco, 2018), and were presented to participants without audio. For the induction of emotional states, we selected four 90-second clips from famous movies, dubbed in Italian language. As positive stimuli, we used a scene from "The Visitors" (Visitors damage the letter carrier's car) and from "When Harry Met Sally" (Sally pretends to have an orgasm in a restaurant), previously validated in (Behnke et al., 2022), while for the negative emotional induction we used "Dangerous Minds" (The teacher informs the class about the death of their classmate) and "The Champ" (the boy cries after his father dies), previously validated in (Behnke et al., 2022). At the end of the task, participants watched

a clip from "Benny and Joone" (Benny plays dumb in the café) as a wash-out for the negative emotion induction.

Task - We used the software E-Prime 2.0 Professional (Psychology Software Tools, Pittsburgh, PA) to deliver the video stimuli and collect participants' responses. Stimuli were presented on a computer screen placed in front of the participants at a distance of 30 cm, see Fig 1. Participants were instructed to watch the video stimuli and use the Response Meter to report any change they observed in their emotional state (as in the Baseline procedure). It was made clear to participants that they were not supposed to respond to the emotional content of the stimulus but, rather, to their own reaction to it. At the end of each video, participants were asked to rate their emotional state on a 0-100 VAS in terms of valence (0 = completely negative, 100 = completely positive), intensity (0 = not at all intense, 100 = extremely intense) and arousal (0 = extremely low arousal, 100 = extremely high arousal). We also asked them to select the discrete emotion that they thought best represented their current emotional state from the following list: happiness, amusement, tenderness, surprise, anger, sadness, fear, anger, disgust and embarrassment); and to indicate whether they had already seen the movie (only for emotional videos).
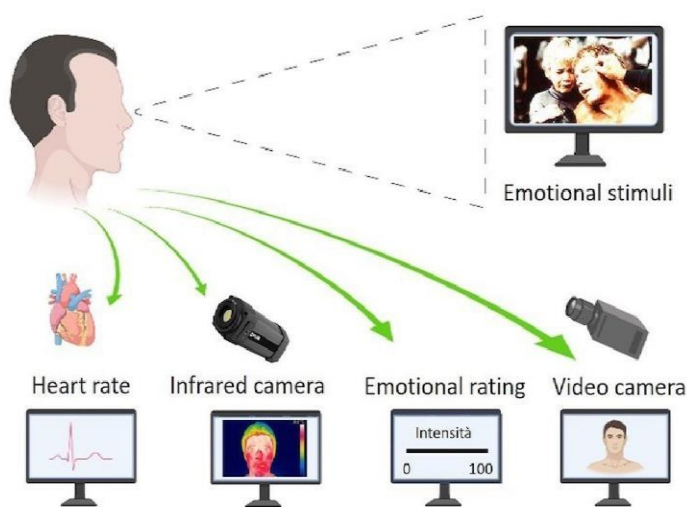

Figure 1 – Schematic depiction of the Emotional Contagion task setup.

3.4 Results

3.4.1 Experiment 1a and Experiment 1b

Demographic data

We compared the Leader and Follower groups for Age and Gender with the F-test and chi-squared test, respectively. Significant differences were observed for Age, with participants in the Leader group being significantly older than in the Follower one. Although there were more females in the Follower than in the Leader group, the chi-squared test did not reach significance (see Table 1). Considering that the two groups were unbalanced for Gender and Age, we decided to control for these two variables in all statistical analysis including the factor Group.

LF Variable	N	Follower Mean	SD	N	Leader Mean	SD	Test
Age	92	29	3.5	28	35	6.6	F=36.715[***]
Gender	92			28			X2=3.773[*]
... Female	51	55%		9	32%		
... Male	41	45%		19	68%		

Statistical significance markers: * p<0.1; ** p<0.05; *** p<0.01

Table 1 - Descriptive statistics and group comparisons on Age and Gender between Leaders and Followers.

Personality traits

Differences in personality traits between levels of Group (Leader-Follower) and Gender were first explored using linear models including Group, Gender and their interaction as categorical predictors. The models revealed a significant effect of Gender in multiple variables, indicating that female participants scored higher on the negative subscales of the ECS (Fear, Anger and Sad), on the total score (EC_TOT) and on the Neuroticism subscale of the Big Five inventory (see Table 2). A

significant Group x Gender interaction ($F(1,116) = 5.02$, $p < 0.05$) was found for the Negative subscale of the PANAS questionnaire. Post-hoc tests revealed that Male Leaders experienced less negative affect than Female Leaders ($p < 0.01$) and Female Followers ($p < 0.01$), see Fig. 2.

Group	FollowerFemale			FollowerMale			LeaderFemale			LeaderMale			
Variable	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	Test
Pos_PANAS	51	29	4.7	41	28	4.2	9	31	4.7	19	27	3.8	F=1.84
Neg_PANAS	51	28	4.1	41	28	4.1	9	28	3.4	19	26	3.7	F=0.84
EC_Happy	51	12	2.2	41	11	1.8	9	12	2.3	19	12	1.5	F=1.516
EC_Love	51	12	2.3	41	11	2.3	9	13	1.7	19	12	1.6	F=0.877
EC_Fear	51	11	2	41	8.7	2.3	9	10	1.6	19	8.6	2.4	F=9.614***
EC_Anger	51	9.8	2.2	41	8.2	2.9	9	9.3	2.5	19	7.8	2.2	F=4.574***
EC_Sad	51	11	2.4	41	7.6	2.5	9	10	2.5	19	8.2	2.2	F=17.12***
EC_TOT	51	56	7.1	41	47	8.7	9	54	7.5	19	48	7.1	F=10.957***
Extraversion	51	6.2	2.1	41	6.5	1.8	9	5.7	1.7	19	6.9	1.6	F=1.218
Agreebleness	51	6.1	2	41	6.3	1.5	9	6.6	1.2	19	6.9	1.2	F=1.004
Coscentiousness	51	7.7	1.4	41	7.8	1.7	9	7.7	1.5	19	7.8	1.5	F=0.042
Neuroticism	51	6.3	1.7	41	4.8	1.8	9	6.6	1.3	19	4.5	1.8	F=8.564***
Openness	51	7.6	1.8	41	7	2.2	9	6.2	2	19	6.9	1.4	F=1.664
Statistical significance markers: * p<0.1; ** p<0.05; *** p<0.01													

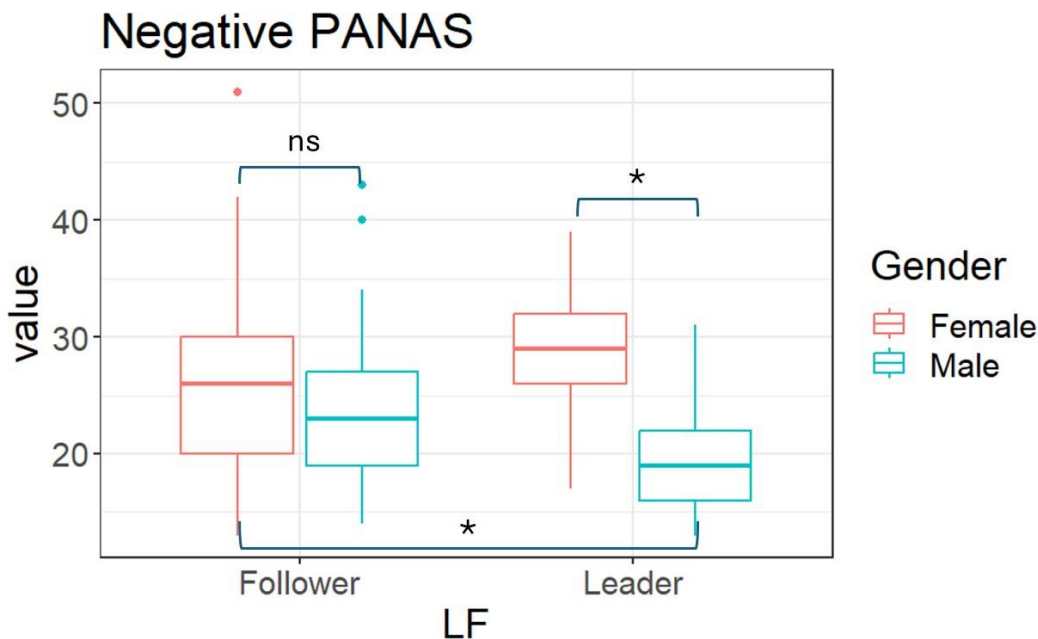**Table 2** - Questionnaire scores for Female and Male Leader and Follower participants.

Figure 2 – Visualization of the Group x Gender interaction for the Neg_PANAS questionnaire scores. Horizontal lines inside the boxes indicate the median, while upper and lower borders indicate 1st and 3rd quartile, respectively. "Whiskers" extend to the farthest points that are not outliers.

3.4.2 Experiment 1a (Baseline and Speech Tasks)

Affect rating before and during the Baseline Task

First, we analyzed participants' ratings of their affective state before (i.e., VAS ratings of Emotion, Intensity and Arousal) and during the Baseline recording (i.e., continuous affective rating with the Response Meter, averaged over the 6 minutes Baseline duration) with linear models including Group and Gender as categorical predictors and Age as a covariate. Linear models for VAS Emotion, Intensity and Arousal scores failed to show any significant effect. The Response Meter model revealed a significant effect of Group ($F(1,115) = 2.72$, $p = 0.042$), indicating that participants in the Leader group reported on average a more positive affective state during the Baseline (i.e., higher values indicate positive affect, see Fig 3).
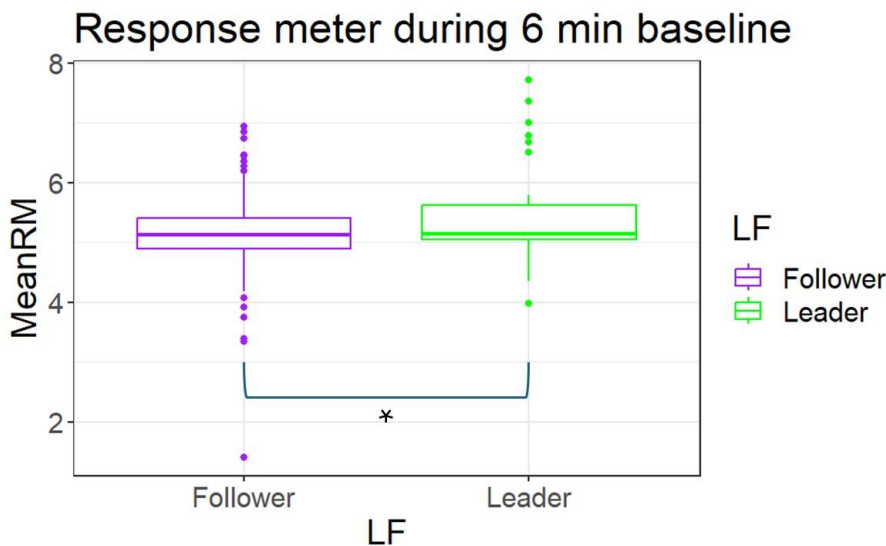
Figure 3 – Visualization of Response Meter data during the Baseline task. Values above 5 (set as neutral state) indicate a shift toward a more positive affective state, values below 5 indicate a shift toward a more negative state. Leaders reported an overall more positive affective state during the baseline compared to Followers. The boxplots display the distribution of a continuous variable. Horizontal lines inside the boxes indicate the median, while upper and lower borders indicate 1st and 3rd quartile, respectively. "Whiskers" extend to the farthest points that are not outliers.

Physiological activity during Baseline and Speech task

We first analyzed participants' levels of physiological activity (mean HR, SCR, SCL and face temperature) across two different moments: the Baseline task and the 2-minutes Speech. For each physiological measure and in each task, we ran a linear model including Group, Gender and their interaction as categorical predictors and Age as a covariate. For the Baseline task, we observed no significant effect of Group or Gender. Instead, during the Speech task, the HR model revealed significant main effects of Gender $(F(1,115) = 6.01, p < 0.05)$ and Group $(F(1,115) = 4.12, p < 0.05)$, indicating an overall higher cardiac frequency in females compared to males and in Followers compared to Leaders, see Fig. 4. The SCR models for both tasks did not reveal any significant effect.
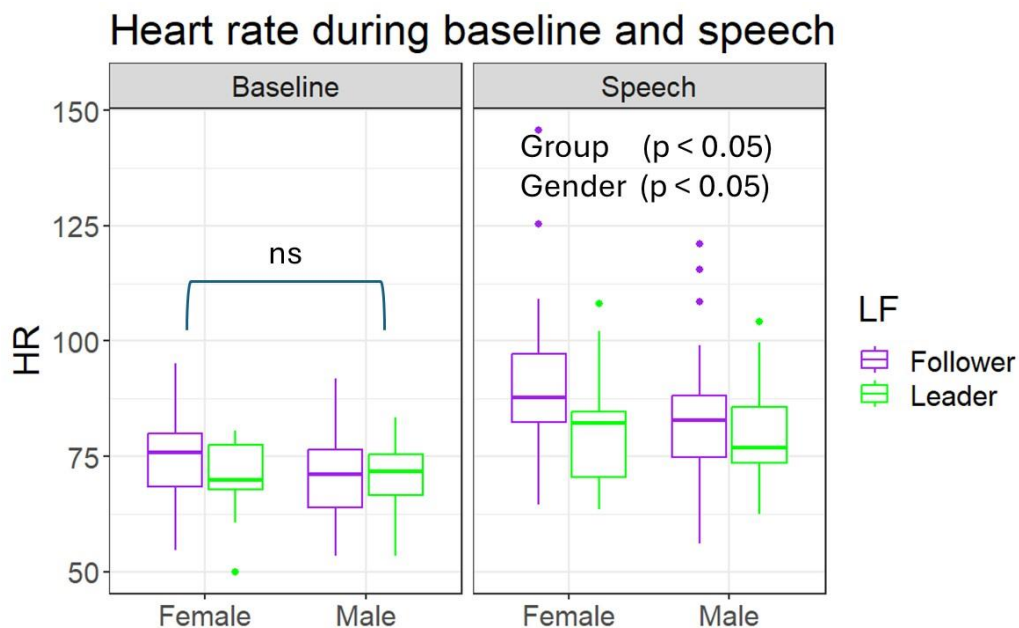
Figure 4 – Visualization of Group and Gender effect on HR data. Leaders and Females show increased HR during the Speech task. The boxplots display the distribution of a continuous variable. Horizontal lines inside the boxes indicate the median, while upper and lower borders indicate 1st and 3rd quartile, respectively. "Whiskers" extend to the farthest points that are not outliers.

We explored the relationship between task-related physiological activity and personality traits through correlational analysis (see Fig 5). Results revealed that Extraversion was negatively correlated with HR values during the Baseline ($r = -0.21$, $p < 0.05$) and with HR values during the Speech ($r = -0.26$, $p < 0.05$), see Fig 5. People with higher levels of Extraversion thus displayed reduced cardiac frequency at rest, in accordance with previous studies (Brouwer et al., 2014) and during the Speech. Since cardiac acceleration reflects an activation of the sympathetic nervous system and is usually associated with stress and anxiety, our results are consistent with previous behavioural studies reporting that public speaking anxiety is negatively predicted by Extraversion and positively predicted by Neuroticism (Kelsen, 2019). Overall, the link between Extraversion and HR (both at rest and during the Speech task) highlight the protective effect of certain personality traits on traits on stress.
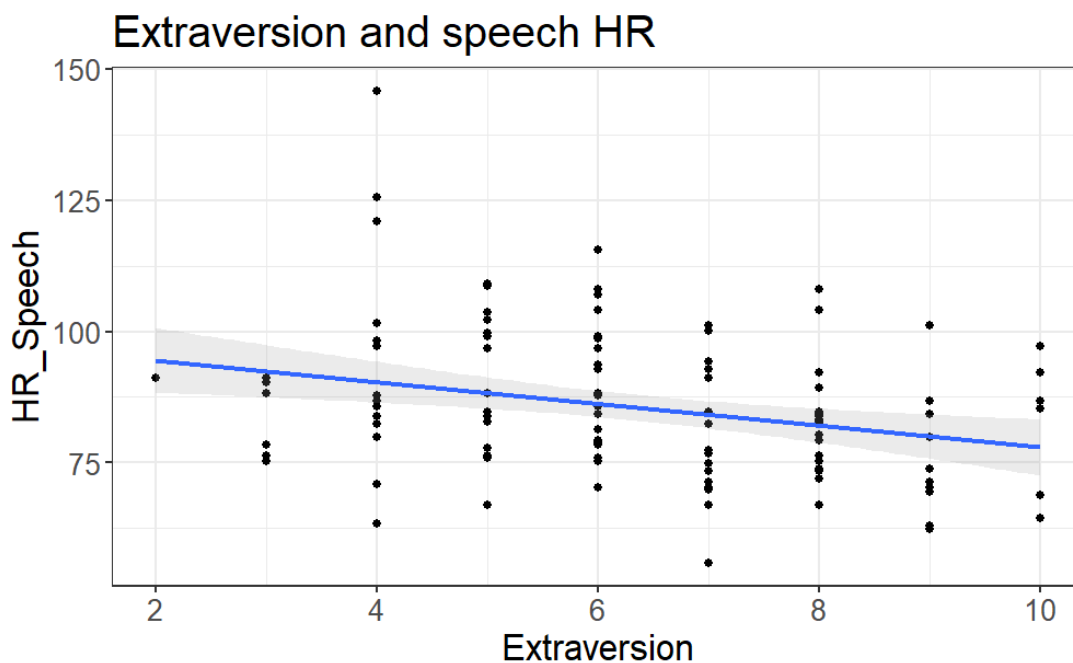

Figure 5 – Scatterplot of the significant correlation between Extraversion and HR during the Speech Task.

Preliminary thermal imaging results – Due to time constraints, thermal imaging data was extracted and analyzed on a subsample of 40 participants (27 Follower, 7 Leader; 19 Female, 15 Male). Here, I present the preliminary results from an analysis investigating how face temperature is modulated by task demands and by the emotional content of observed stimuli. The temperature (in Celsius degrees) was extracted from each ROI at a sampling frequency of 50 Hz and subsequently averaged over the duration of each experimental block. Data were analyzed with linear models including the categorical predictors of Task (Baseline, Speech) and ROI (corrugator, nose tip, perioral and periorbital), (face temperature across the different movies was averaged by emotional valence). The model revealed a significant main effect of effect of ROI ($F_{(3,312)} = 35.32$, $p < 0.0001$), with Corrugator temperature values significantly higher compared to Nose tip and Perioral (Ps < 0.0001) but lower compared to Periorbital ($p = 0.035$). Interestingly, there was a tendency toward significance for the Task effect, with overall colder temperatures during the Speech compared to Baseline ($F_{(1,312)} = 3.08$, $p = 0.08$), see Fig. 6. Although these results should be considered as preliminary, it interesting to note that decreases in nose tip temperature have been linked to a decrease in parasympathetic autonomic activity (Kosogonov V. et al., 2017) and are thus a plausible correlate of a stress response. Indeed, a temperature decrease in the same region has been observed during stressful conditions in humans (Engert et al., 2014; Kosogonov V. et al., 2017) and in monkeys (Nakayama K. et al., 2005).
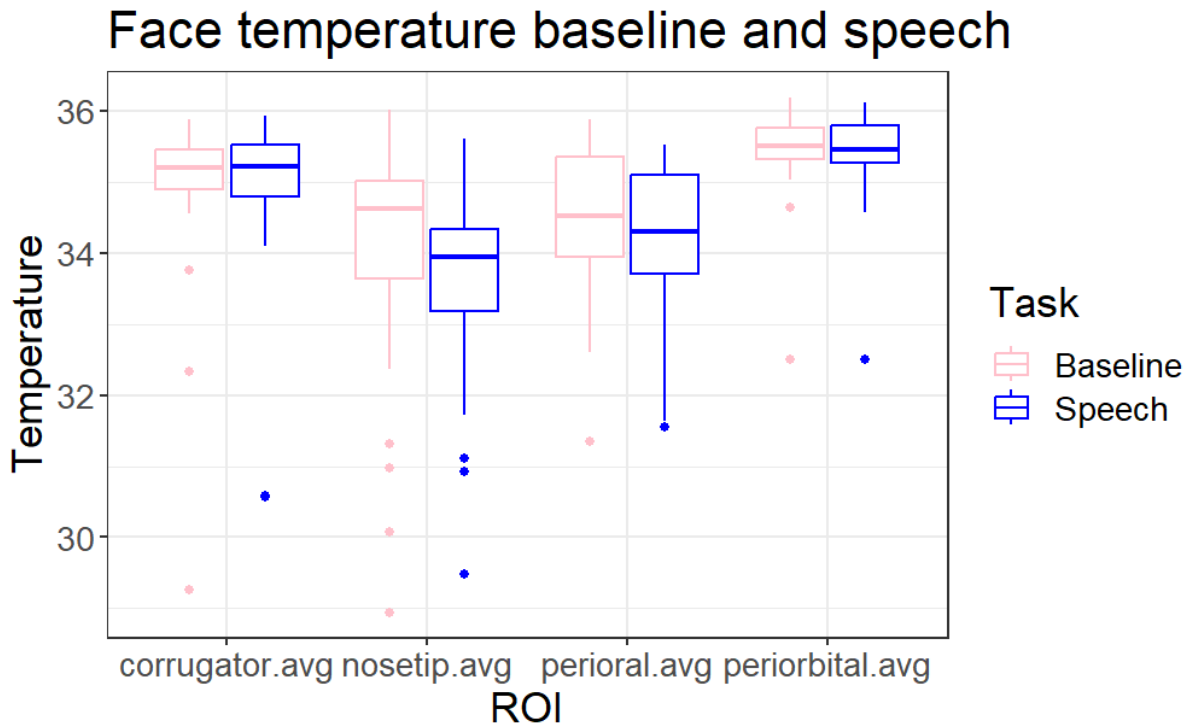
Figure 6 – Visualization of average temperatures (in Celsius degrees) in different ROIs during the Baseline and Speech tasks. The boxplots display the distribution of a continuous variable. Horizontal lines inside the boxes indicate the median, while upper and lower borders indicate 1st and 3rd quartile, respectively. "Whiskers" extend to the farthest points that are not outliers.

Facial emotional expression during the Speech task - Through the software FaceReader, we quantified the amount of emotional expression while participants were performing the speech. The analysis focused on two expressions: Happy and Neutral. For each expression, the average intensity was analyzed with linear models including Group, Gender, their interaction, and Age. Intensity values for Happy emotional expressions revealed significant effects of Group ($F(1,112) = 4.09$, $p = 0.045$) and Gender ($F(1,112) = 11.36$, $p < 0.01$), indicating that followers and female participants displayed more "happy" facial expressions (see Fig 7). The model for Neutral expression revealed significant effects of Group ($F(1,112) = 14.07$, $p < 0.001$) and Gender ($F(1,112) = 31.62$, $p < 0.0001$), with larger display of neutral expressions in leaders and male participants (see Fig 7).
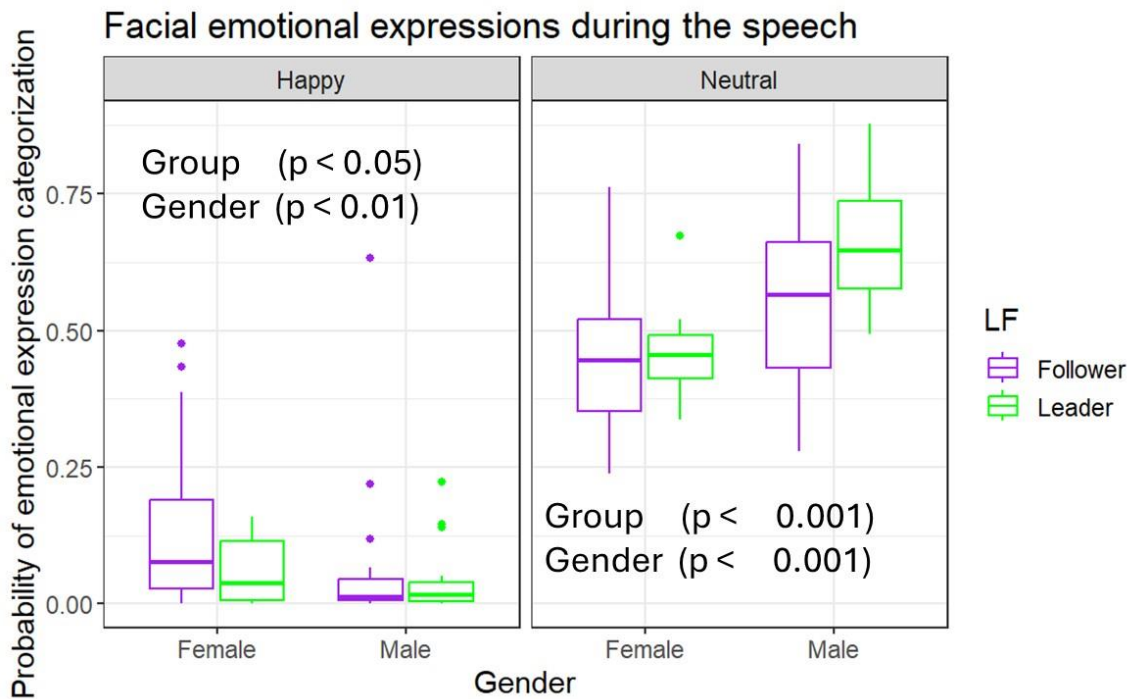
Figure 7 – Visualization of intensity value for the expression of Happy and Neutral emotions measured with FaceReader in male and female leaders and followers. The boxplots display the distribution of a continuous variable. Horizontal lines inside the boxes indicate the median, while upper and lower borders indicate 1st and 3rd quartile, respectively. "Whiskers" extend to the farthest points that are not outliers.

Relationship between leadership style, facial emotional expressions during the Speech task and personality traits – Another set of analysis was conducted only on the Leader group (N = 28), with the intention of examining the role of leadership style (Transformational vs Transactional) on participants' psychophysiological responses to the different tasks. To this end, we took the leaders' scores on the two subscales of the MLQ questionnaire (Bass B. M. and Avolio, 2004) and looked at correlations with task-related behavioural and physiological responses, see Fig. 8. Results showed that, as expected (see Bass B. M. & Avolio, 2004), Transformational_MLQ was positively correlated with Transactional_MLQ (r = 0.57, p = 0.010). Moreover, Transformational_MLQ correlated positively with FaceReader_Happy (r = 0.51, p = 0.007) and negatively with Neuroticism (r = -0.42,

p = 0.043) and EC_Anger (r = -0.44, p = 0.031). Transactional_MLQ was instead negatively correlated with Mean_RM_Baseline (r = - 0.46, p = 0.024). These results indicate that leaders who report adopting a more transformational leadership style are more likely to display facial expressions of happiness when communicating to others, are less neurotic and less permeable to anger contagion. Conversely, leaders who adopt a more transactional style experienced a more negative emotional state at baseline.
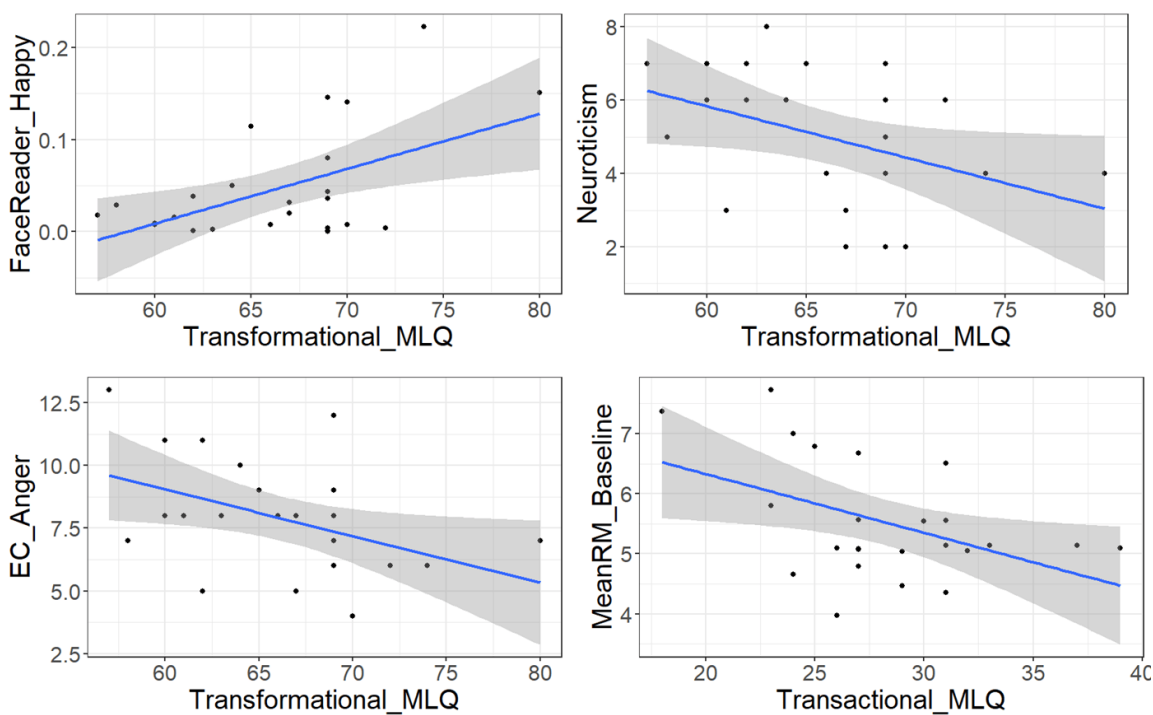

Figure 8 – Scatterplots of significant correlations between Transformational and Transactional MLQ scores and other variables.

3.4.3 Experiment 1b (Emotional Induction Task)

Validation of video stimuli - After watching each video, participants were asked to identify the emotion that best matched their current feeling among happiness, amusement, tenderness, surprise,

anger, sadness, fear, anger, disgust and embarrassment. Emotional categorization responses for each video are reported in figure 9. For "The Champ" and "Dangerous Minds, the most frequent emotion was Sadness (0.65% and 0.44%, respectively), in line with the original validation (Behnke et al., 2022). Also, in line with previous studies, "When Harry met Sally" and "The Visitors" were mostly (0.72% and 0.48%, respectively) categorized as eliciting Amusement. For neutral videos, the most frequent emotion was Neutral (from 0.44% to 0.55%), with the exception of the "Waterfall" video, for which the most frequently reported emotion was Happiness (0.33%).
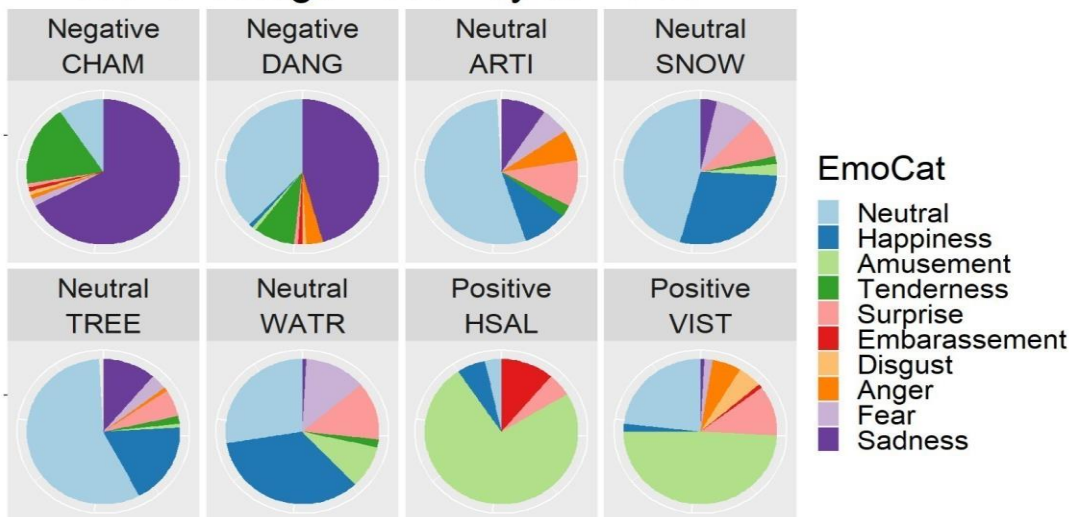

Figure 9 – Pie charts depicting the proportion of emotional labels selected by participants for describing their emotional state after each video. CHAM = "The Champ", DANG = "Dangerous minds", ARTI = "Arctic", SNOW = "Snow", TREE = "Forest", WATR = "Waterfall", HSAL = "When Harry met Sally", VIST = "The Visitors".

Continuous and post-video ratings of emotional state - We analyzed the Response Meter data collected during the videos and the VAS scores given by participants after each video along the dimensions of Valence, Intensity and Arousal. VAS and Response Meter values were analyzed with linear models including Condition (Negative, Neutral, Positive), Group and Gender as categorical predictors. To control for the effect of Age, we included it as a covariate. The Valence model showed

an effect of Condition (F(2,344) = 188.47 p < 0.0001) indicating that, on average, participants reported a more negative affective state while watching negative compared to neutral (p < 0.0001) and positive (p < 0.0001) stimuli, and a more positive state after positive compared to neutral stimuli (p = 0.003). A significant effect of Gender (F(1,344) = 15.66, p < 0.01) revealed that male participants reported an overall more positive affective state compared to females. Furthermore, a significant Group effect (F(1,344) = 7.49, p = 0.006) revealed that, independently of the affective content of the stimulus, Leaders reported a more positive affect compared to Followers. Similarly, the Response Meter model revealed a tendency towards significance in the same direction (i.e., more positive affect reported by Leaders (F(1,344) = 3.31, p = 0.069), see Fig 10. The Arousal model showed that Leaders reported higher levels of arousal – independently of the stimulus content – compared to Followers (F(1,344) = 4.53, p = 0.033). Overall, these results indicate the presence of a "positivity bias" in the Leaders group, with a tendency to report a more positive (and aroused) affective state irrespective of the emotional content of the stimulus they were presented with. Along with the similar results observed at baseline (i.e., more positive Response Meter scores), this pattern suggests that Managers and Senior Managers may be happier than Staff and Seniors.
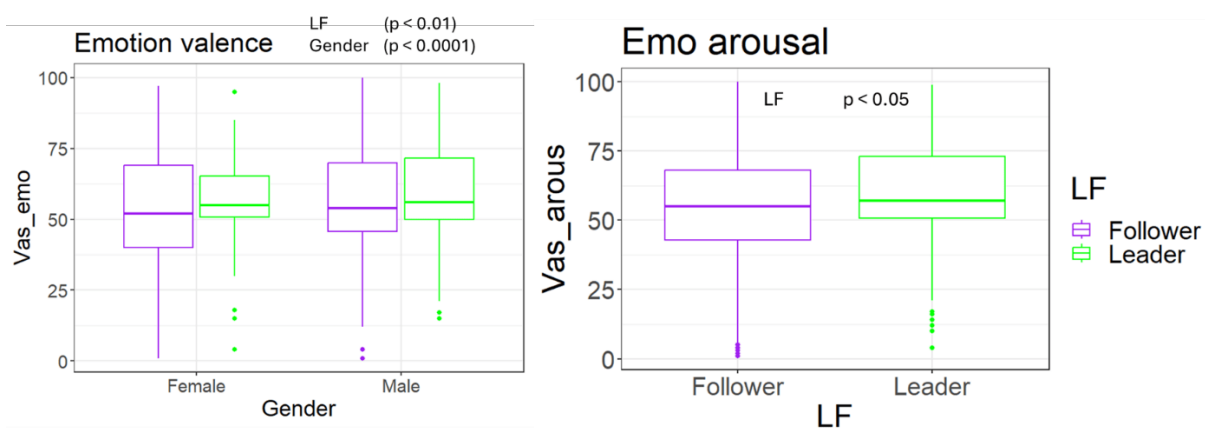

Figure 10 – Visualization of Valence and Arousal VAS scores values across stimulus valence. The boxplots display the distribution of a continuous variable. Horizontal lines inside the boxes indicate the median, while upper and lower borders indicate 1st and 3rd quartile, respectively. "Whiskers" extend to the farthest points that are not outliers.

Physiological responses during video watching - Each physiological variable (HR, SCR and SCL) was analyzed with linear models including Condition, Group and Gender as categorical predictors and Age as a covariate. The HR and SCL models did not reveal any significant effect, while an effect of Condition was observed for SCR values ($F_{(2,220)} = 5.19$, $p < 0.01$), with higher SCR values during positive stimuli compared to negative ($p = 0.02$) and neutral ($p = 0.009$) stimuli, see Fig 11. Visual inspection of SCR values for each stimulus (see Fig 10) suggests that this effect may be driven by the stimulus "When Harry met Sally", which was categorized as eliciting Embarrassment by 13% of participants. Previous studies indicated that embarrassment does elicit an increase in autonomic activation (Müller-Pinzler et al., 2012).
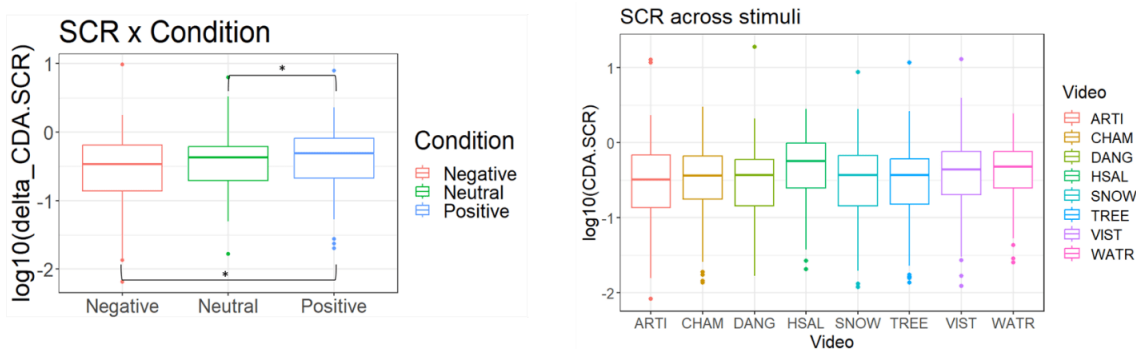

Figure 11 – Visualization of SCR values averaged across Condition (Negative, Neutral, Positive – **left side**) and in each stimulus (**right side**). The boxplots display the distribution of a continuous variable. Horizontal lines inside the boxes indicate the median, while upper and lower borders indicate 1st and 3rd quartile, respectively. "Whiskers" extend to the farthest points that are not outliers.

3.5 Experiment 2

In Experiment 2 we will use the video recordings collected in Experiments 1a (Speech video) and 1b (Stimulus watching videos) to measure leader-to-follower and follower-to-leader emotional and physiological contagion. "Physiological contagion", the phenomenon in which the neural or autonomic state of one individual at time tX can be predicted by another individual's state at time tX-1 has been observed in multiple studies (Thorson & West, 2018) and is linked to the social transmission of affective states. In particular, differences in social status seem to determine the direction of physiological contagion, with high-status individuals influencing the state of low-status ones. For example, in a study by Kraus and Mendes (2014), it was observed that interacting with a person wearing attire signaling high-status produces a physiological contagion effect where the participant's nervous system activation "follows" that of the high-status companion. Similar results were observed in another study where the followers' cardiac activity changed based on the leader's during an emotional imitation task (Park et al., 2019). Thus, measuring the physiological activity of two individuals can open a window into the processes of emotional contagion occurring between the two and can shed light on how leader-follower dynamics in organizations may influence this exchange. Participants in Experiment 2 will observe the videos depicting their co-workers (of equal, inferior or superior rank) while watching the emotional stimuli and while giving the speech, see Fig. 12. We expect to find evidence for emotional and physiological contagion from leaders to followers but not vice-versa. More specifically, we expect to find a delayed synchronization between the physiological time series of participants ("actors") collected in Experiment 1 and the time series of participants in Experiment 2 who are watching their videos ("observers"). However, we expect this synchronization to be stronger when followers watch their leaders compared to when leaders watch their followers.
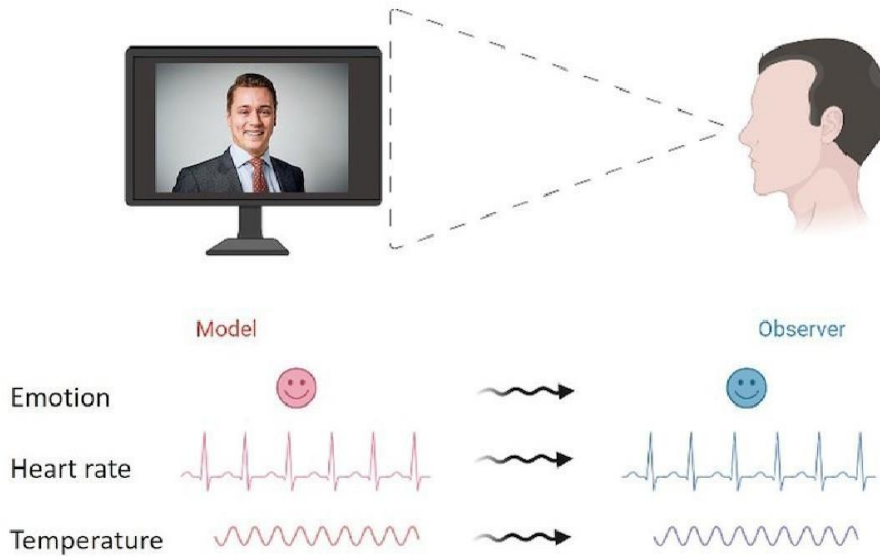
Figure 12 – Schematic depiction of the setup for Experiment 2.

3.6 Discussion

In Experiment 1, we collected behavioural and physiological data to investigate whether Manager and Professional (i.e., leaders and non-leaders) employees from a financial consulting company differ in their sensitivity to emotional contagion for positive and negative emotions. In addition, we investigated whether leaders' and non-leaders' physiological activity is differentially modulated by a public speech task.

Looking at individual differences in personality traits, we observed that female participants, independently of their rank, scored higher in emotional contagion dispositions, particularly for contagion of negative emotions (i.e., Sad, Fear and Anger) and in Neuroticism. These findings are consistent with previous research (Vecchione et al., 2012; Costa et al., 2001) and highlight the importance of taking into account gender differences when conducting research in organizations. Moreover, be observed that male leaders reported significantly lower negative affect (measured with

the PANAS scale) compared to both female leaders and male followers. This suggests that achieving a high rank within an organization may represent a more stressful experience for women compared to men.

3.6.1 Experiment 1a: Baseline and public speech-related differences in experienced and expressed emotional affect.

While no group differences were observed in baseline-level physiological activity, participants in the Leaders group rated their emotional state during the Baseline as more positive. This suggests that people in these working positions may be happier than those in the professional roles. Interestingly, a 2014 survey (https://www.pewresearch.org/social-trends/2014/01/09/why-its-great-to-be-the-boss/) from the Pew research center found that 83% of managers, but only 74% of workers, describe themselves as "very satisfied" with their family situation, while 69% of managers but 48% of workers report they are very satisfied with their current working position. Furthermore, there is evidence that being in a position of leadership is associated with lower levels of the hormone cortisol (Sherman et al., 2012).

During the Speech task, participants were asked to imagine talking to someone who was considering starting a job at EY and to try to convince them to join the company. This task gave us the opportunity to investigate how Manager and Professional employees perform in impromptu public speaking and how their physiology is modulated by the task. Our results revealed that, during the Speech task (but not during the Baseline session), female participants and followers showed an increased cardiac frequency compared to males and followers. Since cardiac acceleration reflects the activation of the sympathetic nervous system, and this patter is consistent with speech anxiety (see Kirschbaum et al., 1993; Liu et al., 2020), these results indicate that these two categories experienced higher levels of stress when asked to give a speech. Thus, our Speech task, although performed by participants without an interacting audience, was effective in inducing public speaking anxiety. Interestingly, we observed a negative correlation between the cardiac frequency during the speech and Extraversion levels, in

line with previous research linking high Extraversion to reduced public speaking anxiety (Kelsen, 2019) and to reduced cardiac response to social stress (Lü et al., 2018). Overall, these findings have implications for organizational research and practice, suggesting that women, lower-ranking and less extraverted employees may experience more stress when engaging in public speaking.

Using an AI-based software for the recognition of emotional expressions (FaceReader), we were able to quantify the emotional expressivity in leaders and followers during the speech task. We focused on the expression of Happy and Neutral emotions and observed that female participants showed more happy and less neutral emotional expressions compared to males. Research consistently shows that women smile more than men (Morse, 1982; Krys, 2015; Halberstadt, 1988; Briton, 1995). This gender difference is particularly pronounced when discussing positive topics (Halberstadt, 1988). Furthermore, women are perceived as more honest when they smile, a perception that is consistent across different cultures (Krys, 2015). These findings suggest that there is a gender-based expectation for women to smile more, and that this behavior is perceived more positively. Moreover, we found that leaders showed less happy and more neutral expressions. Status differences may explain this effect, as research consistently shows that low-status individuals tend to smile more than their high-status counterparts (Ketelaar, 2012; Hecht, 1998; Deutsch, 1990). This is attributed to the social obligation for low-status individuals to smile, regardless of their actual emotional state (Hecht, 1998). Additionally, stereotypes about the emotions associated with high and low-status individuals further reinforce this pattern, with low-status individuals expected to feel more sad and guilty, emotions that are often masked by a smile (Tiedens, 2000).

Examining the impact of leadership behaviours on task-related variables, we observed that the tendency to adopt a more transformational style correlated with the amount of happy facial expressions displayed during the Speech. Transformational leadership has been found to be related to emotional intelligence (Barling et al., 2000; Barbuto Jr, J. E. et al., 2006), and transformational leaders are, according to Ashkanasy & Tse (Ashkanasy & Tse, 2000) more likely to use emotions for communicating with their followers. Here, we provide direct evidence for this link, showing that more

transformational leaders incorporate nonverbal displays of positive emotions when imagining communicating with a potential employee. In addition, scores of Transformational leaderships were negatively correlated with Neuroticism and sensitivity to anger contagion. Thus, managers who reportedly adopt a more "transformational" leadership style, implying that they try to inspire their teams to perform beyond expectations and to produce a meaningful change in the organization, were characterized by higher emotional stability and reduced sensitivity to negative emotional contagion. Conversely, Transactional leadership was associated with experiencing a more negative emotional state at baseline. While most of the research so far has focused on the effects of leadership style on employees, it would be interesting to study more in detail how it affects the well-being and emotional experience of the leaders themselves.

3.6.2 Experiment 1b: Evidence for a positivity bias in leaders when reporting their emotional state.

The emotional induction task was designed to measure psychological and physiological reactions to positive, negative and neutral video stimuli. First, participants' categorization of stimulus-induced emotional state was consistent with previous validation, although a high variability in the responses was observed. For example, besides Amusement, the positive stimuli "When Harry met Sally" and "The Visitors" also elicited Embarrassment and Anger, while the negative stimuli "The Champ" and "Dangerous minds" elicited Sadness but also Neutral and Anger emotions. Participants' rating of stimulus-induced emotional state on valence, intensity and arousal dimensions were consistent with our expectations. Negative stimuli induced a more negative, less intense and less aroused state compared to positive and neutral stimuli. Similarly, averaged continuous responses collected with the Response Meter during stimulus presentation reflected the expected differences between positive and negative stimuli. Thus, our stimuli were effective in inducing the expected changes in participants' emotional states. Interestingly, we observed that the Leaders group showed a "positivity bias",

meaning that – independently of the emotional content of the video stimulus – they reported experiencing a more positive and arousing emotional state. While the absence of a Group x Condition effect on self-reported emotional state speaks against our hypothesis that leaders may be less responsive to emotional stimuli compared to followers, our results, along with those observed during the baseline (i.e., more positive Response Meter scores), converge in depicting the "Leaders" group as experiencing an overall more positive emotional state.

Looking at the physiology, we did not find any significant effect of Condition, nor any Group or Gender effect for HR and SCR values. It should be noted that a meta-analysis (Lench H. C. et al., 2011) failed to find any significant differences in physiological responses between sad and happy emotions. Conversely, we observed a significant increase in SCR for positive stimuli compared to neutral and negative ones, which was probably driven by the embarrassment elicited by "When Harry met Sally".

In conclusion, Experiments 1a and 1b combined multiple neuroscientific and behavioural methods to investigate the dynamics of emotional contagion in leaders and followers. Results revealed that, although leaders and non-leaders do not differ in their sensitivity to emotional contagion, leaders report experiencing more positive affective states, and show a reduced tendency to express positive emotions while talking. Nevertheless, we observed that transformational leadership further modulates this effect, with more transformational leaders more inclined towards the nonverbal display of positive emotions. With Experiment 2, we aim at investigating emotional contagion in a more interpersonal setting, using as stimuli the naturalistic videos recorded in Experiment 1. Using advanced methods for quantifying interpersonal physiological synchrony, we aim at shedding light on the dynamics underlying the spread of emotions in organizations.

Chapter 4: The future of leadership studies

Abstract

This chapter discusses the growing interest in neuroscience research of leadership, as traditional management and work environment psychology approaches are no longer sufficient to address the complex challenges faced by organizations today. The emergence of "organizational neuroscience" and "neuroleadership" seeks to incorporate insights from cognitive and brain sciences into the study of organizational behavior and leadership styles. The chapter also explores the concept of sustainable leadership, which emphasizes the balanced development of economy, society, and environment, and is considered a "meta-competence" that combines mindset and skillset. Neuroscience can play a crucial role in shaping the future of leadership development by offering insights into social emotions, social decision-making, and other key elements of leadership, helping leaders refine their abilities and contributing to build stronger, more inclusive, and innovative organizations.

The future of leadership studies

Leadership continues to be one of the most studied and investigated constructs in organization and work psychology. For Psychology and Neurosciences Leadership is a clear growing "field of play". Two trajectories are intertwining to create a gain-momentum for a brain-inspired deep dive on Leadership: the transformation of the society/organizations and the transformation of people. The connections are evident and the challenges that open up are increasingly complex. The fields of traditional sciences, from management to work environment psychology, seem to be no longer sufficient to direct actions and initiatives able to lead to major improvements for organizational life. A growing number of visionary business leaders are starting to consider the old "toolkit" of methods and theories not enough valid to support their daily job. As a consequence, there is an increasing

interest in CEO's, managers, institutions and officers in creating new approach to the exploration of leadership.

Related to this, the recent approach to the exploration of organizational dynamics and leadership based on the integration of neuroscientific principles and techniques is burgeoning. Within this framework, the new field known as "organizational neuroscience," has gained traction both within and outside academic circles (Becker W. J., Cropanzano, R., 2010; Becker W.J. et Al., 2011). Organizational Neuroscience is an area of study that seeks to incorporate insights from cognitive and brain sciences into the examination of organizational behavior. It comes as no surprise that this field is increasingly focusing on the relationships between leaders and followers. Leadership is, after all, a core aspect of organizational science, and one of the earliest applications of Organizational Neuroscience has been the development of "Neuroleadership" (Rock D., 2010). This research domain aims to connect neural measurements with psychological constructs that can predict an individual's ability to effectively lead a group. Studies utilizing EEG have discovered associations between various neural indices and leadership traits such as "psychological capital" (Luthans A. et Al., 2007; Peterson S.J. et Al., 2008), leader "self-complexity" (Hannah S.T. et Al., 2013), and inspirational (Waldman D.A. et Al., 2011), transformational (Balthazard P.A. et Al., 2012), and ethical (Waldman D.A. et al., 2017 a,b) leadership (Zaleznik A.,1992) posits that managers maintain minimal emotional involvement with others, while leaders connect with people on an intuitive and emotional level, eliciting stronger feelings in their followers – both positive and negative (Individualized Consideration). More recently, researchers have turned their attention to understanding the neural processes occurring within team members' brains when they are working in harmony or discord, how to fine-tune message delivery to ensure effective communication, how to foster greater creativity and innovation, and how proper nutrition can contribute to better leadership (Platt M., 2020).

The traditional ideas of market rationality and equilibrium have proven insufficient in explaining actual market behavior (Taleb N. N., 2007). Thanks to development of the psycho-economic studies performed by researchers like Daniel Kahneman, we now understand that human nature is driven by

more than just greed and egoism. Fairness, cooperation, and altruism also play a significant role in our decision-making, even when it means displaying "bounded rationality" (Simon H., 1972; Kahneman D., 1979). Studies of social emotions, social decision-making, and other key elements of intersubjectivity like interpersonal dynamics, can play a crucial role in shaping the future of leadership development.

Overall, we started the studies raising questions related to potential differences between leaders and followers (and in leaders between the transformational/prestige or transactional/dominant leadership style) regarding social attention and way of feeling emotions or managing them in terms of their physiological responses to public speaking. In the first study, the gaze following results (Chapter 2) confirm that Leaders show a stronger gaze-following effect (i.e. they are more influenced by the averted gaze of distracting stimulus) which would seem to infer that they are more reactive to social cues. In the second study (Chapter 3), the results of the emotional contagion experiment indicate that leaders who adopt a more transformational leadership style were more likely to display facial expressions of happiness when communicating to others, are less neurotic and less permeable to anger contagion. Conversely, leaders who adopt a more transactional style experienced a more negative emotional state at baseline. we observed that the tendency to adopt a more transformational style correlated with the amount of happy facial expressions displayed during the Speech. Transformational leadership can activate more aware behaviors through emotional intelligence and better emotion management to modulate the communication with followers. Interestingly, we observed that the Leaders group showed a "positivity bias", meaning that – independently of the emotional content of the video stimulus – they reported experiencing a more positive and arousing emotional state.

These results could represent a first step towards future studies aimed at investigating whether transformational leadership traits have correlates of "more advanced social skills" or whether transactional leaders can inspire more followers and guarantee them a context of greater "psychological safety" that can improve their motivation, well-being and productivity. The results found so far and future research steps open important perspectives in how companies can hire, select,

train and evaluate the leaders they need. In particular, these perspectives can provide a practical key to interpreting the leadership style that companies look for when they want to interpret their business in a sustainable way, in line with recent studies on sustainable leadership. Within this framework, we find particularly useful to extend the results of the psycho-physiological studies described in chapter 2 and 3, using a neuroscientific approach.

Neuroscience finds a natural connection with recent research on "sustainable leadership" that show promising results indicating a positive impact on employees' organizational commitment, job satisfaction (Suriyankietkaew S. and Avery G., 2014), organizational trust (Dalati S. et al., 2017), and overall sustainable performance (Burawat P., 2019; Iqbal Q. et al., 2020a, b).

Based on these studies, sustainable leadership can be considered a "meta-competence," combining mindset and skillset to bridge the gap between current leadership styles and the ones needed for a sustainable future. By adopting sustainable leadership, leaders can create positive change while respecting people, environment, and society as a whole.

The concept of Sustainable Leadership goes beyond the green transformational leadership and responsible leadership, by emphasizing the need of having a balanced development of economy, society, and environment (Liao H., 2022). <Liao analyzes sustainable leadership at three different levels: Individual, Organizational and "Cross level". From this analysis, sustainable leadership appears essential at both individual and organizational levels. For individuals, it's about having leaders with sustainable traits to form sustainable organizations. At the organizational level, sustainable leadership involves activities that are integrated into the whole organization, creating a self-reinforcing system that helps achieve long-term sustainable development while balancing economic, social, and environmental aspects, supported by employees who adopt similar sustainable behaviors (Iqbal Q. et al., 2020). Sustainable leaders who promote participation, value people, and focus on productivity build a sense of psychological safety, encourage collaboration, and enhance long-term sustainable performance (Bandura A. and Walters R. H., 1977); (Frazier M. L. et al., 2017).

Psychological safety is essential for employees to express themselves without fear of negative consequences (Kahn W.A., 1990). They feel safer when there's trust and support in the work environment. Kahn (Kahn W. A., 1990) looked at this at the individual level, where Edmonson studies (Edmondson A. C., 2018) support a team-level climate that promotes interpersonal risk-free environments. Additionally, psychological safety mediates the relationship between sustainable leadership and sustainable performance (Iqbal Q. et al., 2020). Finally, at the "cross level", sustainable leadership emphasizes the integration of organizational and individual perspectives to drive sustainable business transformation and contribute to building a sustainable economic system (Armani A. B. et al., 2020). Leaders need to recognize and adapt to disruptive and transformational changes in the current business landscape and society (Tideman S. J. et al., 2013). In a nutshell, the Sustainable Leadership model evolves other leadership concepts, like transformational leadership, green transformational leadership, responsible leadership, and moral leadership (Tideman S. J. et Al. (2013); (Bass B. M. et al., 1987); (Brown M. E. et al., 2005); Maak and Pless (Maak T., Pless N. M, 2006). Indeed, the crux of sustainable leadership lies in the triple bottom line of economy, society, and environment. Its goal is to foster long-term wellbeing and lasting value for all stakeholders, going beyond just social and environmental responsibility.

In this thesis I provided experimental, psychophysiological evidence for Charisma and dominance investigation (chapter 2). An innovative paradigm for investigating how leadership styles can influence emotion control and attention to negative emotional flows (chapter 3). I plan to apply a neuroscientific approach to the same issues by capitalizing on our Wavespace Innovation Lab at the EY Rome branch (https://www.ey.com/en_gl/wavespace/rome). This space, created for helping clients with transformation processes, has demonstrated over the years the importance of integrating diverse skill sets. In specific, in the framework of the activities at the Wavespace Lab, cognitive and social neuroscientists interacted with occupational and work to explore the connection between a consistent Transformative Leadership style, Sustainable Leadership, and Psychological Safety

culture. In this vein, I conclude with a plea for integrating in the study of leadership neuroscience and ecology with organizational psychology for shaping the future of leadership development. Exploring how the activity of brain functions like emotions, decision-making, and intersubjectivity develop in situated, environmental conditions will likely provide new tool for understanding how can refine their abilities and build stronger, more inclusive, and innovative organizations. This integrated approach may help to bridge the "mismatch" between the leadership styles widely adopted today and the ones we truly need in the modern organizations. This way, we can work together to envision the future, take action, and create positive change, all while respecting our people, environment, and society as a whole.

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