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# Emotional Intelligence

Understanding, Influencing,  
and Utilizing Emotions

*Edited by Éric Laurent*





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Published in London, United Kingdom

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<http://dx.doi.org/10.5772/intechopen.1000448>

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First published in London, United Kingdom, 2024 by IntechOpen

IntechOpen is the global imprint of INTECHOPEN LIMITED, registered in England and Wales, registration number: 11086078, 167-169 Great Portland Street, London, W1W 5PF, United Kingdom

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

Additional hard and PDF copies can be obtained from [orders@intechopen.com](mailto:orders@intechopen.com)

Emotional Intelligence - Understanding, Influencing, and Utilizing Emotions

Edited by Éric Laurent

p. cm.

Print ISBN 978-1-83769-856-1

Online ISBN 978-1-83769-855-4

eBook (PDF) ISBN 978-1-83769-857-8

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# Meet the editor



Dr. Éric Laurent is an associate professor of cognitive psychology at the University of Franche-Comté (UFC), Besançon, France. He works in the fields of affective cognition, affordance perception, eye movements, and enactive psychology. He held various roles in his university such as head of psychology undergraduate studies and deputy director of the Laboratory of Psychology. He is currently a member of the Laboratory for Integrative Research in Neurosciences and Cognitive Psychology (affiliated with both UFC and INSERM, National Institute of Health and Medical Research). He is the author of nearly 80 publications in international scientific journals.



# Contents

<b>Preface</b>	<b>XI</b>
<b>Section 1</b>	
Foundations of Emotional Intelligence: Development, Brain and Cognition	1
<b>Chapter 1</b>	<b>3</b>
Emotional Foundations and Educational Development <i>by Carolina Puertas Flores</i>	
<b>Chapter 2</b>	<b>29</b>
Emotional Intelligence and Attachment Orientations <i>by Erez Yaakobi</i>	
<b>Chapter 3</b>	<b>43</b>
Emotion Regulation and Cognitive and Social Functioning in Early Development: The Interface between Neurophysiological and Behavioural Perspectives <i>by Sara Cruz, Mariana Sousa and Vera Mateus</i>	
<b>Chapter 4</b>	<b>63</b>
Perspective Chapter: Enacting Emotional Intelligence from the Bidirectional Link between Mood and Reasoning <i>by Kévin Bague, Jean Baratgin and Éric Laurent</i>	
<b>Section 2</b>	
Emotional Intelligence in Applied Settings	81
<b>Chapter 5</b>	<b>83</b>
Could Emotional Intelligence and Period of Year Influence Clothing Color Selection? <i>by Terumi Konno, Koichiro Kakiyama and Yasuhiro Kawabata</i>	

<b>Chapter 6</b>	<b>107</b>
Perspective Chapter: Emotion and Economic Decision Making <i>by Huanren Zhang</i>	
<b>Chapter 7</b>	<b>129</b>
Perspective Chapter: Emotional Intelligence from a Neuropsychological Perspective <i>by Rubén Miranda Marcos, Lindsay Brénugat, Kévin Bague and Éric Laurent</i>	

# Preface

Cognition and emotion have often been studied in separate fields. Over the past three decades, increasing efforts have been made to consider emotions within the cognitive science field. The study of emotional regulation (ER), mood and cognitive performance, and cognitive psychopathology has contributed to organizing affective cognition as a research field.

In 1990, Salovey and Mayer [1] (p. 189) defined emotional intelligence (EI) as “the subset of social intelligence that involves the ability to monitor one’s own and other’s feelings and emotions, to discriminate among them and to use this information to guide one’s thinking and actions.” Their work has drawn attention to the related skills useful for perceiving, understanding, and managing emotions effectively.

Emotional intelligence basically encompasses processes of understanding, influencing, and utilizing emotions.

The book aims to (1) gather contributions from various disciplines that participate in improving our conception of affective cognition and (2) provide an assessment of recent works on emotional intelligence.

Two sections respectively present developmental, brain-related, and cognitive foundations of EI (Section 1), and both the insights gained through, and recommendations for, the evaluation of EI-related processes in applied settings (Section 2).

Section 1 consists of four chapters. Puertas Flores introduces EI, presents the most influential models developed to account for the concept, as well as a few key cognitive processes generally involved in ER and their relationships with underlying neural structures. She also mentions the general fields of application of EI (Chapter 1). Yaakobi reports how attachment developed during childhood can contribute to explaining ER strategies. Secure versus avoidant/anxious attachments are contrasted with each other and related to EI-related abilities. This text offers a framework for conceiving how learning and development could gradually shape EI and related styles of ER (Chapter 2). Cruz and colleagues’ contribution delves into the literature concerning the development of ER. The authors highlight the early stages of ER development and some differences in ER between children and adults; they also discuss the status of ER as a potential marker of various mental disorders; finally, they present brain activity associated with ER strategies during childhood (Chapter 3). Bague and colleagues propose an enactive approach to emotional intelligence in which EI is seen as a dynamic capacity, emerging in any specific context from complex coordinations. As an example, they analyze the case of mood, potentially contributing to the emergence of EI. In this framework, EI is not a stable ability but is variously expressed depending on the context (Chapter 4).

Section 2 comprises three chapters. Konno and colleagues report an empirical study in which students’ clothing color choices are analyzed throughout an academic year.

They present data suggesting that clothing color fluctuates with the study period (i.e., regular or exam). They propose that color choice could be related to ER strategies resonating with the demands of the tasks at hand, and hence be an adaptive strategy under the influence of EI (Chapter 5). Zhang reviews the literature related to economic decision-making. Building on Prospect theory, he notably reviews the evidence for a dissociation between the decisional processes when people are deciding for themselves and when they are deciding for others. Practical solutions for avoiding pitfalls in decision-making associated with emotional load are considered, such as spatial and temporal distancing and perspective shifting (Chapter 6). Finally, Miranda Marcos and colleagues discuss how EI can be evaluated in the field of neuropsychology, which is usually structured by the assessment of “cognitive functions” with poor consideration for emotion-related abilities. They gather the literature that can offer a basis for both a better consideration of those skills and the development of EI as a domain of evaluation in neuropsychology (Chapter 7).

The field of emotional intelligence is still “under construction,” with various approaches that characterize its study. We hope this book contributes to informing the reader about both theoretical approaches and potential fields of application of EI.

The future of EI as a research field will be dependent on the ability of researchers to further develop a rigorous scientific approach and not to let the concept only flourish outside the laboratory. The study of embodiment modalities of EI [2] could be one interesting pillar in this perspective, including the dissociation between trait EI and ability EI [3].

Much is still to do. Even researchers working on emotions sometimes consider the “interactions between cognition and emotion,” implicitly conceiving “emotion” and “cognition” as two separate entities. Therefore, in these conceptions, emotion, and intelligence are *de facto* two distinct domains. EI represents the opportunity to renew epistemological frameworks in cognitive science. The concept could prove to be useful in the process of updating our views on cognitive-affective processes and on what “cognition” is made of.

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Section 1

Foundations of Emotional  
Intelligence: Development,  
Brain and Cognition

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## Chapter 1

# Emotional Foundations and Educational Development

*Carolina Puertas Flores*

### Abstract

The following chapter seeks to provide an understanding and comprehensive definition of the concept of emotional intelligence (hereinafter, EI) and of the various perspectives from which it has been approached over the years. EI is a key personal factor in everybody's lives. Its importance can already be seen at an early age, as it favors an understanding of the world around and helps to take the right decisions when faced with everyday conflictive situations. Ultimately, it has an impact on individuals' mental and social well-being throughout their lifetime. All of this highlights the importance of supporting the continuous development of EI from childhood. Yet mastering EI is not merely confined to an early age. Prevention and protection when faced with health problems underline the need to develop emotional skills throughout the whole life cycle.

**Keywords:** emotional intelligence, regulation of feelings, well-being, psychological stress, education

### 1. Introduction

Emotion is a concept that has aroused considerable curiosity since ancient times. It has long been the subject of concern and analysis and—over the last few decades—has reached beyond the bounds of psychology to become a part of our everyday lives. Emotions play a key role in our life and are involved in all stages of our development, helping us to take decisions, forge emotional and social links, and solve problems. The ability to recognize, understand, manage, and use emotions effectively is crucial for individuals with emotional intelligence, who will be better equipped to make decisions, solve problems, and communicate more effectively compared to those without such said intelligence.

The road that has led to the definition of emotional intelligence (EI) as we know it today has by no means been easy. Throughout history, numerous definitions of the concept have been put forward, and all of them have been influenced by the theoretical model on which they are grounded.

The origin of the term EI dates back to the theory of the law of affect, proposed by Edward Thorndike during his research on social intelligence. Thorndike is considered one of the precursors of EI [1–4]. Years later, Sternberg [5] presented a construct closely related to Thorndike's social intelligence—"practical intelligence"—taken from triarchic theory. This construct assumes three types of intelligences: analytical,

creative, and practical. The author maintained that success could be achieved through a balance between the three intelligences [5, 6]. Both—Thorndike’s social intelligence and Sternberg’s practical intelligence—are related to the EI that had been studied up until then from a personality-centered approach.

Drawing on these theories, Salovey and Mayer [7] took Gardner’s contributions on intrapersonal intelligence and interpersonal intelligence to develop the concept of EI. Based on this, EI is defined as the ability to handle feelings and emotions, to discriminate between them, and to use this knowledge to shape one’s own thoughts and actions [7].

Although the concept of EI appeared in 1990, only in 1995 with the publication of Daniel Goleman’s bestseller “Emotional Intelligence” did the concept fully emerge and become widely known.

Below is a free adaptation of the evolution of the concept of EI across five stages based on Mayer’s research (**Table 1**) [11].

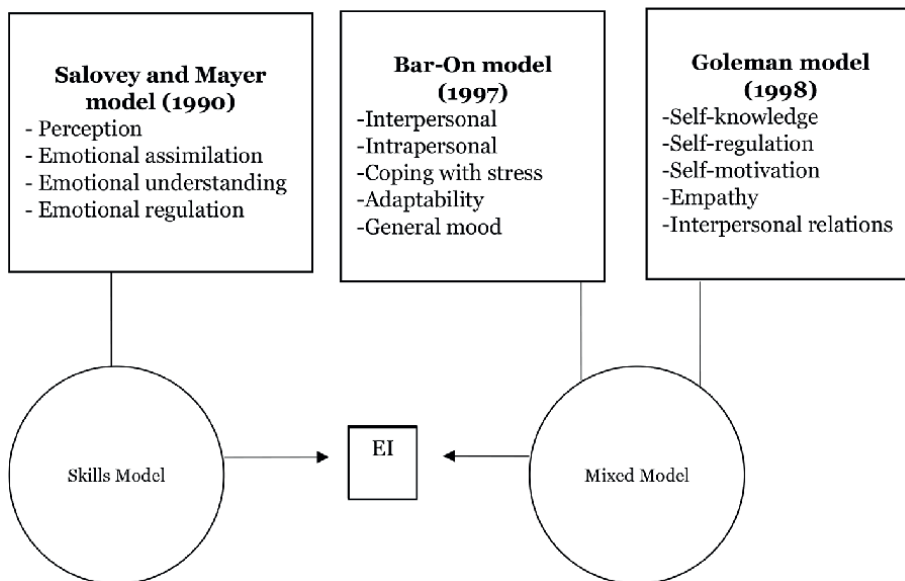
	<b>Stage</b>	<b>Characteristics</b>
First stage	1900–1970	Discriminating between the concepts of emotion and intelligence. Appearance of the psychometric approach to human intelligence
Second stage	1970–1990	Appearance of the precursors of EI—Howard Gardner and Robert Stenberg. Influence of the cognitive paradigm and of information processing.
Third stage	1990–1993	Mayer and Salovey—together with other collaborators—publish several articles that deal with emotional intelligence. They posit a model based on its components that subsequently served as a guide for them to set out the final version of their theory.
Fourth stage	1996–1997	Dissemination and expansion of the concept in academic and popular circles thanks to Daniel Goleman’s [8] book “Emotional Intelligence” Appearance of the first version of the Emotional Quotient Inventory of the Bar-On model [9].
Fifth stage	1998–2020	The basic three-branch model of Salovey and Mayer [7] gives way to a four-branch model [10]: perception and emotional evaluation, emotional facilitation, emotional understanding, and reflexive regulation of emotions. New measurement instruments were applied.

**Table 1.**  
*Evolution of the concept of EI across five stages.*

## **2. Models of EI**

As is the case with many of the constructs used in psychology, there is some discrepancy when defining the notion of EI. The difficulties involved in defining what it is, how it can be conceived, and how we can work with it have revolved around what are the fundamental components of the concept itself and which factors might account for inter-individual differences. The different theoretical currents reflect the plurality of skills that are part of the construct. This variability has been analyzed and reinforced by Fragoso [12] and Pérez et al. [13] who classified them into two large groups: theoretical models of emotional intelligence as an ability and mixed or trait models [14–16].

The first model conceives EI as the ability that takes into account the processing of emotional information and the abilities related to said processing [17, 18].



**Figure 1.** Emotional intelligence models. Note. Source extracted from Bar-On [9], Palmero and Martínez-Sánchez [28].

Mixed models focus on a set of personality traits, socio-emotional dispositions, and aspects linked to motivation and cognitive skills [19–21]. While many authors focus on developing theoretical models, others have sought to operationalize a more exact definition of EI [22, 23]. Some authors such as Mayer et al., —perhaps adopting a more restrictive approach—consider that the construct should be specifically defined from a scientific point of view so as to distance itself from nonscientific disclosures.

In contrast, we find Goleman [8] and Bar-On [19] whose concept of EI is broader and includes everything outside academic intelligence, such as impulse control, self-motivation, or social relationships. When defining EI, these discrepancies emerged throughout the twentieth century [24], with some researchers describing EI models as complementary [25]. However, the empirical bases on which they are grounded, their integrative elements, and the measurement instruments used for each model differ substantially, which has led to the appearance of different conceptions of EI. Today, we can speak of some substantial differences between skill models and mixed models [26, 27]. Following Bar-On [9] and Palmero and Martínez-Sánchez [28], here is a scheme of our own elaboration of the main EI models (**Figure 1**).

### 3. Psychosocial aspects of EI

#### 3.1 Perception, appraisal, and emotional expression

Based on the first branch identified in the Mayer and Salovey [10] skills model, perception and emotional expression are evident from the moment individuals are born [29]. People tend to project and perceive their emotions through the facial channel better than through any other—including verbal communication. One psychosocial aspect to be considered in emotional perception is culture. When recognizing

facial expressions, the face of the person being appraised is of great importance. The link between the person who is expressing themselves and the person who is receiving a facial expression has significant consequences vis-à-vis how accurately the two will perceive said link, due to implicit cultural factors. Certain classical studies [30] discovered that emotional facial communication tends to be more precise among those who share similar cultural environments. Therefore—and despite the universality of emotional communication—there seem to be subtle differences between subjects who belong to the same cultural community, such that we understand better those who express themselves using an emotional “sub-modality” that is similar to our own.

As regards emotional expression, there is a difference depending on evolutionary stages; at school age, the peer group is fundamental for socialization. As a result, emotional expression is used as a mechanism for becoming included in group processes. As we learn to control the emotional “sub-modality” of our cultural group, socialization improves. Social development cannot therefore be detached from cognitive-emotional development, since some of the most complex cognitive skills can be included in the social domain.

From a socioeconomic standpoint, significant differences have been found depending on income [31]. Those who belong to higher economic levels score higher in facial expression tasks than those from lower socioeconomic levels. This means there is facilitation in emotional decoding through facial expression of emotions when subjects belong to higher-income social groups.

As regards personality—and following studies into the Big Five Personality Traits [32]—factors such as mental openness and, to a lesser degree, extraversion and awareness enable facial expressions to be interpreted accurately. This may be because individuals who are high in openness tend to be more receptive to new ideas and experiences, which may make them more attuned to subtle social cues—including facial expressions. Additionally, individuals who are high in extraversion may be more socially confident and skilled at interpreting social cues, including facial expressions. Conscientious individuals, on the other hand, tend to be more detail-oriented and attentive to their surroundings, which may help them to pick up on subtle facial expressions.

In contrast, neuroticism, which is characterized by negative emotions such as anxiety and fear, has been found to predict lower accuracy in recognizing facial expressions. This may be because individuals who are high in neuroticism may be more focused on their own internal experiences and less attuned to external social cues.

Overall, personality traits can play a role in how accurately individuals perceive and interpret facial expressions, with openness, extraversion, and awareness predicting greater accuracy and neuroticism predicting lower accuracy. In sum, it would appear that individuals who are most willing to pay attention to social and situational cues are those most able to recognize the facial expressions of others.

### **3.2 Facilitation or emotional assimilation**

One of the most interesting aspects of EI involves understanding how it ties in with social competence. Determining what emotional processes help with decision-making in situations of social interaction will enable us to gain an insight into the mechanisms underlying why certain individuals enjoy social success.

A relation has been found to exist between high scores in EI—through measuring skills—and satisfactory social functioning, although only in men. This evidence does

not hold true for women. Some authors have suggested that emotions play a different role in the social interactions of men and women to the point that they form emotionally different worlds [33]. Following on from these authors, emotions facilitate social interactions differently in men and women. Nevertheless, it is not yet clear what the mediating element is that leads to this distinction in terms of gender. In addition to possessing a good level of EI, it has been suggested [34] that emotional self-efficacy may act as a mediator for successful social interaction. This concept might account for why there are those with high EI who, nevertheless, do not see themselves as being emotionally intelligent and who do not engage well socially. Although we do not know exactly the processes through which EI impacts interpersonal relations, the gender variable should be taken into account and addressed separately.

### **3.3 Emotional understanding**

This involves the ability to break down emotional signals and to substantiate and categorize these emotions. It implies a retrospective capacity for causes and an anticipatory capacity for the consequences of said emotion [35]. Emotional understanding thus has a socializing function from the first years of life. The family offers the first context of socialization for children, and it is here where the help we provide to make sense of and to understand what children feel then helps them to grasp and master their own emotions. We need to foster emotional communication in which we send out messages of understanding, where we help children to comprehend how they feel, where we validate their emotions, and where we encourage them to choose how they wish to react [36]. Communication between children and their principal caregivers plays a key role in the development of social functions.

Within the communication process, the emotional expressions of the sender and the understanding and interpretative capacity of the receiver have an enormous influence on the type of interpersonal relationship that occurs in a group [37]. Socialization of emotions thus takes place in interactions between children and their parents and, subsequently, with peers when experiencing emotions [38].

### **3.4 Emotional regulation**

In the fourth branch of the EI skills model, the family also plays a key role. Thus far, we have mentioned the latter's influence through conversations on emotional experiences and the expressivity of emotions in the family. Emotional regulation is also acquired and refined in the family context. How parents' emotions are handled may—directly or indirectly—impact how their children's emotional skills develop. Conversations between parents and children are linked to a better use of emotional language in preschool children [38] and to a better overall understanding of the causes and consequences of emotion [39]. Children who are more skilled in the use of emotional language and at understanding emotional experiences may be better at regulating their emotional states and at coping with stressing situations [40]. Indirectly, family conversations teach children ways of understanding and how to deal with emotional experiences.

In sum, how parents act with their children is key to correctly developing emotional regulation through conversations on emotions and family emotional expressivity. Patterns of anxiety have been described in children that have been linked to aversive interactions on the part of their parents, as well as control and negative behavior by mothers when interacting with their children [41].

## 4. Neuroscience

The central task of neuroscience is to explain how our individual neurons in the brain act to produce specific behavior and how these cells, in turn, are influenced by the environment, including the behavior of other individuals [42]. Thanks to neuroscience, we know now which brain regions are activated during specific emotional states, which neurotransmitters are more active when we feel good, and how we manage our emotions based on brain maturation [43]. Scientific literature has shown us how emotions can promote certain behaviors, learning processes, emotional states, or cognitive processes as neural networks and synaptic connections intensify [42]. Therefore, the emotional mind and the cognitive mind are very closely linked, and both operate in different circuits but neurally interconnected with each other.

Neuroscience is working tirelessly to ascertain what are the structures and cognitive processes involved in the different emotional states [44]. Describing how our neural system works is key to understanding and disseminating strategies that improve the mental health linked to the feeling of personal well-being through intervention based on empirical evidence. Unfortunately, much of the research carried out has focused on the neurobiological study of negative emotions. Only now are we beginning to set out on the road toward exploring the effects and functioning of our nervous system in terms of emotions such as happiness, satisfaction, or joy [45]. Although scientific literature has failed to provide any universally accepted definition of the concept of well-being, most studies point to three components: positive affect, negative affect, and life satisfaction [46].

Affects—both positive and negative—are independent dimensions concerned with emotions and moods triggered by the external stimulus that the subject is faced with [47]. Life satisfaction refers to a value judgment the person makes of their life in accordance with their own criteria concerning what is an ideal life. As a result, there is no external standardized concept of what is the “ideal life”. Rather, it is a construct that is developed internally [48].

The definition of subjective well-being would involve experiencing a high positive affect, a low negative affect, and a high life satisfaction [49]. The neuroscience of emotion and the understanding of neurophysiological correlates linked to positive emotions to generate well-being presents a new framework for the neuroscientific study of emotion across species. This is the reason underlying the shift in focus of the studies being carried out recently into neurotransmitters, neuropeptides, and hormone function. Neurochemical studies have focused on the role played by positive emotional experiences. Specifically, dopamine has become the neurotransmitter *par excellence* linked to the feeling of well-being associated to reward [50]. The mesolimbic dopamine system is key in the dynamic of reward and points to active participation of the ventral tegmental area to the accumbens nucleus, which implements responses to positive stimuli and which involves the motivational aspect [51]. This activity also extends to regions of the amygdala, the hippocampus, and the prefrontal medial cortex [52].

Personal mood and traits are linked to cognitive processes through a two-way relationship. The general cognitive process is understood to be the executive functioning that allows us to shape our behavior and regulate our actions, such as inhibitory control, working memory, or mental flexibility. When speaking of a two-way influence, we are referring to the influence that this cognitive control exerts on our own emotions or on those of others [53]. Nevertheless, little is known of the inverse

process, in other words, how mood or positive stimuli impact the cognitive processes that affect the functioning of higher areas such as attention, motivation, or memory.

#### **4.1 Inhibitory control**

Inhibitory control is the ability to suppress an automatic response generated in the presence of a stimulus [54]. This function is performed in areas of the dorsomedial prefrontal cortex and lateral cortex, in the right prefrontal lower cortex and in the dorsal anterior cingulate cortex [55]. Numerous studies have highlighted that inhibitory control helps to create more satisfactory social relations, a greater feeling of well-being, and positive effects. This promotes healthier lifestyles [56] and is compatible with having greater cognitive flexibility.

#### **4.2 Working memory**

Working memory is a critical element that enables us to retain information in the memory for its immediate processing in order to respond to complex learning tasks such as reasoning linked to decision-making and the use thereof to fulfill our objectives [57]. This function allows us to move toward our goals and improve our emotional regulation [58]. Some studies report that people who exhibit better levels of working memory show greater willingness to respond to stimuli with positive valence. As a result, they tend to report higher levels of well-being and greater life satisfaction. Neuroanatomically speaking, these functions may be found at the prefrontal cortex; specifically, the right side has been identified as the area responsible for codifying the valence of stimuli [59, 60] and prefrontal lateral cortex.

#### **4.3 Mental flexibility**

Mental flexibility allows us to modify our goal-oriented behavior, depending on motivation, interest, or the extent to which said goals may be achieved. Having the right mental flexibility substantially improves our mood as it avoids phenomena such as perseverance, reduces the risk of frustration, and enhances the ability to solve problems, since it enables attentional control to be tempered [61]. This cognitive flexibility allows us to realize that what we are doing is not working or has ceased to work and that we must therefore readjust our behavior, how we think, or our opinions in order to adapt to the environment and to new situations. The prefrontal medial cortex, the cerebrum parietal, and premotor of the cingulum have generally been highlighted as the areas involved in the change in tasks depending on the goal pursued [62].

In sum, neuroscience has developed theories as to how cognitive control influences mood, emotions, and positive stimuli and vice-versa. Gaining an insight into how emotions and positive moods impact cognitive control has enormous potential in the treatment of psychological disorders where there is cognitive deficiency, such as in depression [63].

### **5. Predictive effectiveness of EI**

EI has been defined as a critical construct for psychological well-being that “can promote emotional intellectual growth” [10]. Nevertheless, most studies have focused

on evaluating the more conceptual or psychometric aspects. This is due to the desire to demonstrate that EI might emerge as an adaptive indicator in everyday life, irrespective of other classical constructs. EI can have a significant impact on a person's daily life, and some of the areas where this may be evident are described below.

EI can help individuals to communicate more effectively with others. When we understand our own emotions and those of others, we are more likely to respond appropriately and empathetically. People with high EI have been defined as better communicators because they can better understand the emotions and needs of others and, consequently, adapt their communication style [9].

There are numerous areas where effective communication has been linked to EI: from the realm of interpersonal relationships generated in the work context, improving relationships between employees and supervisors [64], to positive relationships established in the educational context among people and in the teacher–student relationship [33].

In line with maintaining better interpersonal relationships, EI has also proved useful for conflict resolution. Emotionally intelligent individuals can understand the emotions of others and work to find solutions that satisfy all parties. Several studies have shown that having high EI promotes conflict management in work teams, reduces levels of aggression and hostility in confrontational situations [65], and predisposes individuals to active listening of the conflicting parties [66].

EI can be useful in making important decisions. Emotionally intelligent individuals can weigh up different options more carefully and make informed decisions without letting emotions cloud their judgment [67]. This is because during decision-making, they are better able to regulate their emotions, which leads to more objective decisions [68].

In another line of research, EI has been shown to be a factor that significantly improves decision-making. This is because emotionally intelligent individuals are capable of regulating their emotions during this process, allowing them to make more objective decisions [68], especially in ambiguous and highly uncertain situations [61].

Current lines of research [69–71] have shown that those with high levels of EI obtain more positive results in their life at the psychological well-being level, in terms of academic performance and in professional career success:

- Improved quality of life and subjective well-being.
- Improved quality of social relations.
- Better academic performance and school adaptation.
- Ability to develop their personal strengths.

EI therefore emerges as a construct linked to the current definition of health, perceived as a state of biopsychosocial balance and not solely seen as the lack of illness [72].

Although the mechanisms through which EI exerts its positive effects are not known, there are two perspectives that are compatible with each other concerning the benefits of having a high EI. From the individual perspective, it has been suggested that this may function as a buffer against stress, fostering more adaptive responses when faced with difficulties while also favoring better recovery from stressing events [70]. From the social perspective, it highlights the benefits of both real as well as perceived social support relations in terms of enhancing well-being [73].

## 6. EI and health

Since the emergence of the concept of EI in 1990 with Peter Salovey and John Mayer, the linkage between physical and mental health as well as the clinical aspects involved has—as was to be expected—opened up a field of inquiry. Nevertheless, research into EI and health has not been confined to the concept of illness, but has also been adapted to the WHO's concept of health as a state of physical, mental, and social well-being and not merely as the absence of illness [74].

The first studies carried out in an attempt to ascertain what impact EI has on health focused on assessing self-perceived EI through the Trait Meta-Mood Scale (TMMS). These findings determined that high levels of EI acted as a protective factor against situations of stress, anxiety, eating disorders, and depression. However, since the scale evaluates meta-knowledge of emotional states, the results were called into question. A few years later—with the expansion of the skills model of Salovey and Mayer [10] and thanks to improved measurement instruments—the Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT) was developed. This test enables EI to be measured through performance and ability tests. On this occasion, the results obtained on the role played by EI in health supported the initial findings and provided greater support for the initial idea of the protective role that an adequate level of EI plays when faced with emotional problems, stress, and eating disorders.

Studies conducted in an effort to evaluate what role EI plays in terms of protection against drug use have shown that a low EI is a risk factor vis-à-vis the consumption of tobacco and alcohol among adolescents. People who are emotionally more intelligent understand better the pressure put on them by their colleagues to take drugs and are better able to reconcile the discrepancies between their own personal motivations and those of the group. In behavioral terms, this enables them to handle peer pressure better and—as a result—can help them to reduce their consumption of alcohol and tobacco [75]. EI acts as protective barrier because it is linked to an enhanced perception of the negative social consequences associated with smoking and it proves more effective when rejecting the offer of tobacco from colleagues. These results are significant in that they show the importance of including the EI variable in substance use prevention programs among adolescents. Abilities that predict, understand, and regulate emotions—coupled with interpersonal skills that can help withstand the pressure from friends around us—have been seen as protective elements against substance use.

This information is consistent with the high prevalence of alexithymia often displayed by patients who suffer from psychosomatic disorders. Alexithymia is an emotional dysregulation trait that is linked to operational thought, high impulsiveness, and numerous bodily sensations; it includes features such as verbal difficulty to express feelings, scant emotional awareness, and specific thought that is focused highly on external details. Certain studies have highlighted that the suppression of thought or a reduced ability for emotional repair is a predictor of increased levels of anxiety during pregnancy. Likewise, low affective expression and low inter- and intrapersonal processing are linked to increased levels of stress during medical tests [76].

Along the same lines, Fernández-Berrocal and Extremera [26] found that EI enables us to reduce the intensity and frequency of negative states of mind caused by everyday adverse occurrences. As a result, EI protects us—or at least makes us less vulnerable—when faced with negative affect and depression. Even though the results relating depression and EI remain limited, Irina Goldenberg and her team [77] did

find that the depressive symptomatology evaluated using BDI correlated negatively with EI levels.

People with schizophrenia are characterized by displaying a number of cognitive deficits such as attention, memory, speed of processing, learning, or verbal memory. These deficits are also reflected in the emotional aspect where they exhibit limitations that seriously affect their social involvement. Eack [78] conducted an experiment with a control group in which subject were given training that included improvements in the experimental group's socio-emotional skills. The results evidenced an increase in the MSCEIT scores in a pre-post comparison, thereby indicating that significant improvements can be achieved in emotional skills. These data reflect that it is possible to enhance the emotional processing of schizophrenia patients.

In sum, it has been found that both perceived EI—evaluated through the TMMS self-report—and ability-based EI evaluated through MSCEIT are related to people's health and well-being. Aspects such as substance use and suffering from symptoms of depression or schizophrenia can be treated by providing the right training in EI.

## **7. EI and education**

The countless social changes we have undergone in recent years due to phenomena such as increased life expectancy, technological developments, globalization, or the scourge of a global pandemic have altered the way we interact with one another [79, 80]. This contextual dynamism requires us to endow individuals with the necessary resources and personal skills to adequately deal with these changes [81, 82]. Emotional skills enable us to face up to the complexity of an ever-shifting context, allowing us to adapt to our surroundings [83, 84], strengthen our social ties, and promote positive self-assessment, far removed from the quest for approval or social prestige [85, 86].

Education has not remained indifferent to this new scenario, which undoubtedly poses new demands and challenges in the educational work of our teachers [87, 88]. However, there is certain agreement that the traditional education system as we know it has become obsolete and that it needs to be remodeled in order to adapt to new social demands [89–91]. In particular, it has been highlighted that traditional practice is more focused on teaching than on the students' learning process, with conventional wisdom deeming that content has been learned merely because it has been taught [92].

### **7.1 New perspectives**

In this sense, the field of neuroscience is making constant progress when seeking to shed light on what are the cognitive, affective, and motivational processes that take place when we learn and how these processes work [45, 50, 93]. On the one hand, work is being done to explore direct routes, aiming to improve brain health through physical fitness, diet, sleep, and stress reduction using relaxation techniques or meditation [94, 95]. On the other hand, possible indirect routes are being explored, based on developmental theories from cognitive neuroscience [96]. These study brain changes throughout the life cycle in order to propose and evaluate new learning activities and how they can be transferred to academic achievement [50].

Existing research has evidenced a set of cognitive skills that are key to specific academic domains such as concept formation, spatial skills, or the manipulation of

quantities [97, 98]. These abilities are essential for acquiring literacy and arithmetic skills. However, educational neuroscience is also focusing on the skills of executive function and emotional regulation as important elements to address the more general domains that involve cognitive control and flexibility [99]. In this sense, emotional regulation plays a major part in the social environment of the classroom and in the relationships between students as well as between students and their teachers [100–102]. Indeed, emotional regulation can be considered a skill that develops in early childhood [103–106].

In view of the recent developments and advances in cognitive neuroscience, we can affirm that there is growing interest in its application to current educational theories and teaching methods [107]. These data provide valuable information about how attention, memory, decision-making, and, above all, the impact of emotion and language intentionality all work in developing emotionally stable and healthy people [108–110].

In line with this—and as stated by Busso and Pollack [111]—neuroeducation is positing a series of reforms aimed at promoting a change in educational traditions. Interdisciplinary bridges must be built to articulate the knowledge of education, cognitive psychology, and neuroscience. The goal is to pursue a change in educational trends, which has traditionally focused on developing purely cognitive skills to the detriment of affective skills [50, 96].

## **7.2 Emotional skills in students and teachers**

Emotional skills provide students with the capacity required to make appropriate decisions under stress and to help them regulate and manage emotions effectively in order to prevent psychological problems [112–114]. Current research focusing on emotional literacy has supported improvements in levels of inter- and intrapersonal skills with enhanced emotional understanding and increased respect for others [115, 116]. From the field of education, emotional intelligence has gained great importance in recent years due to the multiple benefits it can offer, not only for students but also for all those involved in the education system. Moreover, different approaches have pointed to EI skills as a protective factor for subjects against stress, poor mental health, and dysfunctional social relationships [112, 113, 116, 117].

Students' emotional education largely depends on the role played by their teachers. However, teachers have traditionally been valued for their ability to manage the theoretical content of classes and for their teaching and instructional skills [118, 119]. Yet we now know that other characteristics such as empathy, communication skills, motivation, or reflection are key to creating positive and enriching learning environments [120–122]. More and more scientific literature agrees in pointing out the importance of developing good emotional intelligence in teachers in order to achieve greater physical and mental stability as well as improve their students' academic performance [85, 123–125].

At a personal level, the psychosocial risks involved in teaching put teachers in danger of suffering emotional disorders such as stress or depression due to work overload, lack of organizational support, difficulties in class management, or the pressures of the role [99, 126, 127]. While several studies point to the link between low EI and burnout syndrome [128–130], other studies highlight the positive relationship between EI and psychological adjustment [26, 131, 132], social functioning [82, 130], the quality of interpersonal relationships [85, 133], well-being [134, 135], or health [95].

In this sense, emotional education might explain which individual factors help to understand why those who are most resistant to stress are those most capable of perceiving, understanding, and managing both their own emotions as well as those of others [120, 136, 137]. Such people possess a series of coping strategies and socio-emotional support networks that act not only as an explanatory factor but also as a protective factor against situations that put their biopsychosocial well-being at risk. Endowing our teachers with good emotional skills will therefore allow them to face stressful work situations by implementing active strategies within the school framework. This will have a positive impact by enabling better professional performance [138, 139] and greater personal fulfillment and by reducing stress [140, 141].

At this point, the concept of emotional education—understood as the ongoing educational process that an individual must undergo throughout their life [142]—takes on special meaning. Emotional education is a form of nonspecific primary prevention wherein skills applicable to several key areas (personal, social, family, work, ...) are developed.

Many studies maintain that the best way to develop adequate emotional intelligence is through emotional education [143–146]. Given the pressures suffered by both students and teachers alike, the education system offers the ideal context in which to carry out emotional education so as to improve the general well-being of the various stakeholders involved in the education system [147, 148].

### **7.3 Objectives of emotional education**

The main objective of emotional education is to develop basic emotional skills for life and to improve individuals' all-round development [142]. In this sense, it is essential to work comprehensively on the emotional skills that generically affect the learning processes [148]:

- Individuals' relations with their surroundings, where the affective climate created as a result of the relations between students, their families, and teachers impacts the educational environment and, ultimately, the learning process.
- Perception and recognition of one's own emotions as well as those of others.
- Understanding both basic as well as social emotions that are acquired throughout a learning and teaching process.
- Emotional regulation that is highlighted through the socialization process, wherein the desire to please others, to comply with norms, to achieve good academic performance, and to avoid disruptive behavior or when negotiating with teaching staff and classmates are situations that involve handling emotions correctly.

Specifically, emotional education pursues the following concrete objectives, according to Álvarez et al. [149]:

- To acquire knowledge of one's own emotions.
- To identify emotions in others.
- To name emotions correctly.

- To regulate emotions.
- To increase tolerance of frustration.
- To prevent the negative effects of negative emotions.
- To generate positive emotions.
- Self-motivation.
- To adopt a positive attitude toward life.
- To learn to flow.

#### **7.4 Effectiveness of EI programs**

EI programs in the field of education are principally aimed at boosting positive emotions, since these are an indicator of well-being and can foster learning, in the sense that learning linked to an emotion is consolidated better and that emotion shapes and guides information processing [35, 92]. The aim is also to ensure appropriate handling of negative emotions, given that increased EI correlates negatively with disruptive behaviors.

Mayer and Salovey's mixed EI model is the one to have aroused the greatest interest in the scientific community. This model offers a theoretical framework which, on the one hand, provides a knowledge of the emotional processes that are key to developing adequate psychological well-being, while, on the other hand, it helps to understand the mediating role played by certain emotional variables in students and their influence on psychological adjustment.

Recent research findings have pointed to the existence of a link between emotional factors and academic performance. This posits the need to foster research into which emotional factors enhance academic and professional performance together with well-being and personal adjustment vis-à-vis achieving people's full and holistic development [150].

Although many of the studies carried out into emotional intelligence in the field of education have been conducted with university student samples, an increasing number of studies performed with children and adolescents [151] have shown that a low EI is linked to certain negative indicators—both inside and outside the school environment. Some of the conclusions to emerge may be summed up in the following points [152]:

- Deficit in students' levels of well-being and psychological adjustment.
- Fewer and poorer quality interpersonal relations.
- Poorer academic performance.
- Appearance of disruptive behavior and use of addictive substances.

For this reason, certain authors [153, 154] have focused on evidencing the importance of working with emotional competencies from very early ages and

throughout children's schooling. Implementing emotional education boosts resilience and emotional well-being and reduces levels of stress, anxiety, and conflictive behavior [152, 155–159].

In this regard—and as pointed out previously—when looking at the early stages of education, primary school emerges as the optimal time at which to implement and develop such programs [160]. Although it is important to begin emotional identification at an early age, it is the period between when they are six and 12 years old that children—in addition to identifying their emotions—develop skills such as empathy and acquire language that affords them greater understanding and emotional expression.


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## Chapter 2

# Emotional Intelligence and Attachment Orientations

*Erez Yaakobi*

### Abstract

Attachment orientations reflect the inner representations of the self and others that are formed in early childhood. Emotional intelligence is seen as a set of skills involved in the expression of emotion, its effective regulation of emotion, and the use of feelings. Attachment orientations are thought to derive from infants' experiences with their primary caregivers and are associated with a range of cognitions, emotions and behaviors, including the interpretation of emotional experiences, the use of coping mechanisms, and affect regulation strategies to deal with stressful events and as such are closely related to emotional experiences and the broader concept of emotional intelligence. This chapter presents the foundational studies and recent empirical findings on attachment theory and emotional intelligence and then discusses ways to integrate these two concepts from a dual psychodynamic-cognitive perspective.

**Keywords:** attachment, affect regulation, anxiety, avoidance, emotional intelligence, emotions

### 1. Introduction

This chapter delves into foundational studies and recent empirical findings in attachment theory and emotional intelligence to illustrate how these two constructs are interrelated from a dual psychodynamic-cognitive perspective. Attachment orientations, which are rooted in early childhood experiences with primary caregivers, play a pivotal role in shaping individuals' internal representations of the self and others. These orientations are tightly linked to various cognitive, emotional, and behavioral factors, and influence how individuals interpret emotional experiences, employ coping mechanisms, and regulate affect in response to stressors. Emotional intelligence is characterized by the repertoire of skills encompassing the expression and effective regulation of emotions, as well as the astute utilization of feelings. The exploration of the intricate interplay between early attachment experiences and the development of emotional intelligence presented here is aimed at providing a more fine-grained, comprehensive understanding of human emotional functioning.

## **2. Emotional intelligence**

Emotional intelligence (EI) has been shown to be a key dimension of individuals' core characteristics, and is related to a wide range of psychological indices of adjustment and functioning, including greater positive well-being, happiness, flourishing, career-related outcomes, life satisfaction, and mental and physical health [1–8]. Salovey and Mayer [9] were the first to discuss the concept of emotional intelligence. Since then, numerous models of emotional intelligence have been proposed. The differences in theoretical conceptualizations of EI mainly hinge on the methods used to measure emotional intelligence [10]. The two main streams of research on EI are known as ability-based emotional intelligence and trait-based emotional intelligence. Ability-based emotional intelligence scales use performance measures [11], and define emotional intelligence as the ability to understand, perceive, use and manage emotions [11, 12]. These scales typically administer test items that can include asking participants to rate the effectiveness of an action in managing an emotional situation or to identify the emotion manifested in a facial expression [7]. Trait-based emotional intelligence is assessed on self-report rating scales designed to capture EI as a personality construct [7]. On this type of rating scales, participants typically self-rate their skills on four core abilities (perception, understanding, use, and management) or self-rate various dispositions such as their self-esteem, social competence, empathy, emotionality, impulsiveness, and trait happiness [7, 13]. A meta-analysis by Joseph and Newman [14] found that ability- and trait-based emotional intelligence scales were only moderately correlated with each other (.12 to .26).

Both ability-based EI and trait-based EI have also been found to be related to highly valued outcomes such as academic performance [12], job satisfaction [15, 16] and job performance [16] and positively related to relational facets of life such as satisfaction with one's romantic relationship [17].

The association between EI and relationship quality [18] suggests it may also be accounted for by attachment theory, which is also linked to relationship quality. Both EI and attachment theory share many interrelated aspects in terms of factors that affect human cognitions, emotions and behaviors. Both were found to be associated with key interpersonal qualities such as attitudes, expectations, modes of communication, and individual traits that people bring to a relationship (for a review see [17, 19]). Yaakobi and Goldenberg [20] reported that attachment internal working models were also associated with the way different individuals disseminate information in virtual social networks, such as Facebook. Higher scores on emotional regulation were found to be positively associated with perceived quality of social interactions among friends [21]. Attachment theory is described in greater depth in Section 3. This is followed by a presentation of its associations with emotional intelligence and related findings. Suggestions for future research are put forward in the conclusion.

## **3. Attachment theory**

Attachment theory, originally developed by Bowlby [22–25] is a psychological theory derived from the psychodynamic evolutionary approach in psychology which describes the way in which enduring beliefs and tendencies regarding the development of interpersonal relationships between infants and their main caregiver in early childhood are transferred to other interpersonal relationships [19, 26, 27].

Attachment Theory posits a relational framework capturing the ways individuals relate to others both socially and interpersonally [19, 22, 28, 29]. The core notion of Attachment theory is the cognitive-affective process of “attachment,” which is defined as the human propensity to seek out and develop affectional bonds to others [22]. Attachment theory posits that individuals can be categorized along a spectrum anchored by two different orientations, known as avoidance and anxiety. The anxiety dimension reflects the extent to which individuals fear that partners will fail to be available or responsive in time of need. The avoidance dimension reflects the extent to which individuals mistrust their partner’s goodwill and opt to maintain behavioral independence and emotional distance (for a review see [19]).

The constructs of avoidance and anxiety can account for the ways individuals perceive themselves and others, which includes their and others’ emotions, the ways people perceive the underpinnings and outcomes of their and others’ emotions, and the ways individuals choose to respond to these emotions in interpersonal circumstances [7].

Numerous empirical studies have confirmed Bowlby’s intuition that early internal attachment models are predictive of behavior and interpersonal relationships in adulthood [19, 30–33]. One of the most frequently employed measures of attachment orientation is known as The Experiences in Close Relationships Scale (ECR; developed by Brennan et al. [34]) that rates individuals on the two independent, roughly orthogonal dimensions of anxiety and avoidance.

For example, attachment orientations were shown to moderate the way people respond to social exclusion or ostracism immediately after they experience social rejection and after a delay [32, 33, 35, 36]. More avoidant individuals were less distressed after being ostracized whereas more anxious individuals exhibited more distress. Findings have also revealed the ways differences in attachment orientation can moderate the use of social coping mechanisms to deal with stressful events. Parenthood for example, was only a successful terror management strategy in coping with impending death among less avoidant individuals [37].

More secure individuals tend to score low on both these dimensions and employ constructive and effective affect-regulation strategies. Individuals scoring high on anxiety or avoidance are considered insecurely attached and draw on hyper-activation or deactivation, respectively, to deal with perceived threats [38]. These aspects of affect regulation strategies can thus be seen as closely related to core effects of EI and their relations to cognitive, affective and behavioral outcomes. EI was originally defined as including emotional regulation, appraisal, and expression of emotion, and the use of feelings to motivate, plan, and achieve ([9, p. 185]). The hyperactivation affect regulation strategies of more anxious individuals and the deactivation strategies used by more avoidant individuals are maladaptive, and hence are less effective emotional regulation mechanisms.

A recent empirical study [39] indicated that attachment anxiety, but not avoidance, was correlated with problems in impulse control and repairing negative moods. Avoidance, but not anxiety, was associated with the devaluation of attending to feelings. Two crucial mediating variables were also identified: a lack of clarity regarding emotions and a lack of strategies for emotion regulation. Other works have found that people characterized by avoidant attachment exhibit diminished awareness of their emotional state and demonstrate lower reactivity to their emotions. In contrast, individuals with anxious attachment display heightened emotional awareness but encounter difficulties in both recognizing their feelings and managing impulses [40]. Other studies have reported that in response to negative affect induction, individuals

with high attachment anxiety responded with an affect-congruent pattern that was characterized by poorer recall of positive information and more stable/global attributions of negative events, thus corresponding to their hyperactivation affect regulation strategies. In contrast, individuals with high attachment avoidance showed no significant cognitive effect of negative affect, thus reflecting deactivation affect regulation strategies [41].

The ways insecure anxious and/or avoidant individuals construct reality and social relationships as well as their personal motivations can be linked to the other components of EI, and specifically to the way people appraise and express their emotions and use their feelings to achieve their goals. For example, the anxious fear of being abandoned or tendencies to flee social situations characterizing more avoidant individuals may lead to biased and maladaptive appraisals and inappropriate expressions of emotions by these individuals.

Six studies revealed that anxious-ambivalent individuals tend to overestimate self-other similarities whereas avoidant individuals underestimate this, unlike secure individuals who provide more accurate similarity scores [42]. The findings showed that these distinctions were heightened by negative emotions but alleviated by positive emotions. Further, the distortions in insecure individuals were a consequence of alterations in their representations of both themselves and others. In 5 other studies investigating the associations between adult attachment styles and the perception of trust in close relationships, individuals with secure attachment expressed greater trust in their partners. They also presented increased accessibility to positive trust-related memories, reported more positive trust-related experiences over a 3-week period, and employed more constructive coping strategies when faced with trust violations compared to participants with insecure attachment styles. Although intimacy attainment emerged as the primary trust-related goal for all attachment groups, anxious-ambivalent individuals pursued the additional goal of security attainment, whereas avoidant individuals pursued the additional goal of control attainment [43]. Four other studies exploring the relationships between attachment style and strategic variations in self-appraisals found that secure individuals maintained a consistently positive self-perception. Avoidant individuals exhibited a positive self-view, while anxious-ambivalent individuals displayed a negative self-view. These self-views were heightened by distress arousal and diminished by factors inhibiting the activation of regulatory mechanisms. The results indicated that the self-perceptions of insecure individuals fluctuated as a function of specific attachment-related concerns and needs. The positive self-view of avoidant individuals was linked to their efforts to validate their sense of self-reliance, whereas the negative self-view of anxious-ambivalent individuals was associated with their endeavors to elicit compassion and affection from others [44].

Recent social-psychological approaches to attachment theory have addressed other key psychodynamic issues beyond close personal relationships, including key organizational processes and outcomes [19, 29, 45]. Attachment styles were shown to play a significant role in the workplace, because they can capture employees' perceptions of themselves and their colleagues in close and supportive interactions as well as their willingness to engage in these relationships [46]. In the workplace, attachment orientations affect the associations between employees'/managers' beliefs about employees' abilities as well as their beliefs in the abilities of their work group, and employee performance in organizational settings. Other studies have indicated that attachment orientations impact the ways managers perceive the availability of employees' internal and external resources, including their social resources, which

in turn influence managers' general beliefs as to the relative importance of these resources when predicting employee performance.

Thus, overall, attachment orientations in adults are related to both intrapersonal as well as interpersonal factors and can be seen as complementing the concept of emotional intelligence. In particular, these include affect regulation strategies, emotional competencies, as well as one's expectations and beliefs about and attitudes toward others [19, 27, 47]. Attachment theory is rooted in the interpersonal origins of adult emotionality through its fundamental premise that emotional defenses linked to insecure attachment impede the processing of emotional messages. This inhibition also obstructs the awareness of feelings and intentions within the self and others [22, 25]. Adult attachment orientations encompass both affective and cognitive regulations and strategies, which influence individuals' emotional responses and their relationships. Individuals categorized as secure, anxious/ambivalent, and avoidant adopt fundamentally distinct strategies for regulating affect and processing emotional information [48]. The convergence of cognitive and emotional processes plays a pivotal role in adult attachment and is a core component of EI [49]. Emotional regulation is thought to function as a trait-like stylistic process in adult attachment [49, 50]. Studies on the cognitive and affective dimensions of attachment orientations have shed light on the ways in which individual differences influence the perception, facilitation, understanding, and management of emotions, all of which have parallels with EI [19, 49]. Empirical findings have consistently confirmed the positive correlations between secure attachment and the facilitation, understanding and management of emotions [49] and negative correlations with EI abilities in the case of attachment anxiety.

Supporting this line of reasoning, in the organizational literature, studies have shown that EI is closely associated with job satisfaction and performance in both managers and employees [16]. Thus, the underlying mechanisms associated with attachment orientations (e.g., fear of abandonment and social avoidance) are also likely to be linked to the key aspects of EI related to work settings, such as affect regulation strategies and social appraisals, as well as with the ways employees and managers communicate with each other. This is applicable to numerous organizational and medical settings. Studies have also found associations between attachment orientations, emotional intelligence, and medical communication [51, 52]. For example, findings revealed that doctors' attachment orientations and emotional intelligence are associated with their patients' emotional expressions in primary care consultations [51]. Specifically, the findings revealed that doctors' attachment anxiety was negatively associated, and attachment avoidance was positively associated, with patients' cues (indications of unpleasant emotion and that lacked clarity) and concerns (a clear unambiguous expression of an unpleasant current or recent emotion where the emotion is explicitly verbalized). Avoidance scores were found to be positively associated in that EI was negatively related to patients' cues and concerns. In another article, Marks et al. [53] found that EI mediated the relationship between adults' insecure attachment and subjective health outcomes. Anxious and avoidant attachment orientations were both associated with lower EI, which in turn was associated with more detrimental subjective health outcomes (somatic, anxiety/insomnia, severe depression and social dysfunction). Further, EI was shown to mediate the relationship between adult attachment anxiety and avoidance orientations and subjective well-being [54]. Specifically, the results indicated that both attachment anxiety and avoidance were negatively associated with EI as well as with subjective well-being. EI was found to be positively associated with subjective well-being.

Organizational researchers have demonstrated that employees' attachment orientations can influence a variety of work-related attitudes and behaviors, including relationships with leaders, coworkers, mentors, and the organization, which function as sources of social support and membership [55, 56]. For example, secure attachment was found to be negatively related to career indecision (lack of readiness, lack of information, and inconsistent information) and emotional intelligence mediated the link between attachment security and career indecision [57]. Specifically, attachment security was found to be positively associated with EI and EI was found to be negatively associated with both a lack of information and inconsistent information), but not with a lack of readiness. Attachment orientations were also found to be associated with entrepreneurship [58]. The findings showed that attachment orientations not only predicted the tendency to become an entrepreneur but also the type of entrepreneur they would become. Specifically, attachment anxiety accounted for the largest share of the variability in becoming an entrepreneur. Both anxiety and avoidant dimensions predicted entrepreneur characteristics and attitudes.

Similarly, attachment orientations may also moderate responses to negative organizational circumstances such as organizational closure [59]. Dispositional avoidance (but not anxiety) moderated the effects of an organizational priming condition (closure vs. control) on employees' work priorities. By contrast, recall of an attachment event interacted with dispositional avoidance (but not anxiety) on work priorities after organizational closure priming. The saliency of organizational closure (the cessation of the activity of the organization) mitigated the moderating role of individual differences on the effects of both dispositional orientation and priming of an attachment event on work priorities.

One possible advantage of attachment theory in accounting for interpersonal behavior is that attachment styles simultaneously reflect two separate working models: one related to the self and one related to others. Since attachment styles reflect individuals' self-image and other-image, they can be used to predict intrapersonal characteristics (based on self-perceptions) and interpersonal characteristics (based on perceptions of others; [60]). Together, these models have been found to predict individuals' feelings and behaviors toward work and employment relationships [61], as well as the extent to which people can cope with stressors in the work environment [61, 62]. These factors are also tightly related to abilities subsumed under EI. For example, strategies for coping with stressful situations and interpersonal communication have both been associated with attachment orientations as well as with EI components such as affect regulation and emotion evaluation, suggesting that the two may have interdependent effects on cognitions, emotions and behaviors.

The early Hazan and Shaver [63] study showed that secure employees reported higher work success whereas anxious employees reported that they were unable to meet work deadlines and complete work tasks, which implies lower performance. Avoidant employees reported that they persisted at work-related tasks, refrained from obtaining help, tended to work alone, and gave themselves lower self-ratings on job performance. An EI perspective suggests that more avoidant individuals may have lesser emotional intelligence capabilities. This claim was found empirically, as described above [51, 54, 57]. More recent studies have found that higher secure attachment is positively correlated with team performance [64, 65]. Ronen and Zuroff [45] argued that greater attachment security tended to predict more dominant leadership and coalition-building behaviors, which in turn led to higher job performance and job promotion. Hence these more secure individuals may have greater EI capabilities, in terms of emotional expressions and appraisals.

Studies have also found a direct correlation between secure attachment and organizational citizenship behaviors [66], as well as negative correlations with insecure attachment [67]. Other studies have shown that secure attachment is negatively related to counterproductive work behaviors and that securely attached individuals showed greater vigor at work and extra-role performance known as organizational citizenship behavior [66]. Mikulincer and Shaver [19] suggested that secure attachment promotes job performance because it makes people feel capable of taking on challenges and confident that they will get others' support when needed. Secure individuals' confidence and tendency to trust others and avoid becoming easily distracted by worries about their relationships may make them more effective and efficient at their jobs [19].

Bartholomew and Horowitz [68] put forward a taxonomy of four prototypical attachment patterns that combine individuals' concepts or images of the self (positive or negative) and their views of others (positive or negative) which can also account parsimoniously for group and team behavior in organizations. For example, negative perceptions of others, which is a characteristic of attachment avoidance, is likely to cause both employees and managers to evaluate collective efficacy as a less effective resource for enhancing performance. High avoidant individuals, as compared to low avoidant individuals, tend to perceive social connections with their colleagues as neither necessary nor desirable [29]. These individuals favor detachment and emotional distance, prefer to work alone, are likely to focus on non-relational aspects of work, do not attend social gatherings [29, 55, 63, 69], do not acknowledge the value of interacting with others, and tend to be more suspicious of others' intentions [70]. Groups that involve greater levels of interdependence threaten high avoidant individuals, who have a strong need for self-reliance [19, 69]. Individuals high on attachment anxiety have little belief that others will contribute to their performance, and may also worry about being unappreciated by team members [29].

In contrast, less anxious or avoidant individuals (that is, individuals with higher attachment security), are likely to manifest a greater positive association between self/collective efficacies and performance. Individuals high on attachment anxiety tend to view tasks requiring teamwork as threatening, whereas avoidant individuals see them as unchallenging [65]. It was argued and empirically found that leaders' secure attachment was positively associated with behaviors that conveyed dominance and support, which contribute to effective functioning and performance in both task- and relationship-focused situations [71–73]. These findings also hint that leaders characterized by insecure attachment fail to provide their followers with support, show poor leadership performance in task-related and emotional focused situations, and exhibit more self-serving and less prosocial motivations to lead [71, 74].

Theoretical and empirical evidence also shows that secure attachment reflects an individual's belief that other people will be responsive and supportive when needed, and is associated with greater levels of optimism, positive views of the self and others, and emotional stability [19]. Confirming the links between EI and attachment orientations, a recent meta-analysis of 26 studies [7] found that both attachment security and insecurity were both significantly associated with EI. A meta-analysis showed that attachment security was positively correlated with trait EI but that there were only small to medium correlations or no correlations with ability EI, whereas both attachment anxiety as well as attachment avoidance were found to be negatively correlated with both ability and trait EI [7, 75]. The findings also revealed that attachment anxiety was more strongly and negatively associated with both ability and trait EI than attachment avoidance [75]. Attachment avoidance was also significantly and

negatively related to EI. Finally, the magnitude of the association between attachment orientations and EI was stronger when EI was measured as a trait than when measured as an ability [7]. Thus, attachment orientations that form early in life as a result of infants' interactions with their primary caregivers may lead to the later development of the traits and abilities of EI. The differences between the results for trait vs. ability EI may result from changes in the affective deficits presented in preschool-aged children who were included in some studies or avoidant adults' insights into their own emotional competencies [7, 40, 76]. However, these possibilities should be further examined in future work to elucidate the reasons for this finding.

#### **4. Conclusion**

This chapter explored the associations between two dominant theories of human behavior today: emotional intelligence and attachment orientation. Empirical findings have revealed that EI is positively associated with various outcomes such as academic and job performance, satisfaction with one's job and with one's romantic relationships as well as with well-being, and happiness. Two main streams of research have incorporated examinations of ability-based EI and trait-based EI. The different attachment orientations, which develop in infancy, are related to different cognitive, affective and behavioral abilities, which were also found to be empirically associated with different affective tendencies such as affect regulation strategies. Whereas more secure attachment was positively correlated with various types of EI capabilities, more anxious and avoidant attachment patterns were more negatively associated with EI capabilities. The better resources developed by more secure individuals may thus facilitate and provide the resources associated with EI, and hence lead to more positive outcomes. In contrast, the cognitive and affective deficits and processes found in more insecure (anxious and/or avoidant) individuals may inhibit the EI resources needed to achieve these outcomes. It thus contributes to the growing body of research on the importance of interdisciplinary explanations of human cognition, emotion and behavior through different theoretical lenses and suggests new integrative directions for further investigation of these two theoretical perspectives in explaining human behavior.


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## Chapter 3

# Emotion Regulation and Cognitive and Social Functioning in Early Development: The Interface between Neurophysiological and Behavioural Perspectives

*Sara Cruz, Mariana Sousa and Vera Mateus*

### Abstract

Research on the development of emotions and their function as indicators of psychological adjustment has increased dramatically in recent years. The importance of emotion recognition and regulation for understanding normal development and the development of psychopathology is now undeniable. From an early age, the ability to recognise and modulate emotional responses to cope appropriately with environmental demands is associated with cognitive, behavioural and social development. This chapter aims to critically review the research field of emotion regulation, its relationship to emotional intelligence and its contribution to cognitive and social functioning in young children (up to the age of six), placing a dual emphasis on the role of physiological systems in emotion regulation and on the interface between neurophysiological and behavioural perspectives. Challenges and future directions in emotion regulation research will be discussed.

**Keywords:** emotional intelligence, emotion regulation, early development, childhood, neurophysiological correlates

### 1. Introduction

Over the past decades, there has been a surge of research interest in early childhood emotions. The first years of life appear to be the most optimal period for emotional development because of the brain processes that occur during this time. The brain's structure, functions and connections are being established in response to environmental stimulation, so emotional experiences that happen early in life will have a profound impact on the development and ability to recognise and manage emotions appropriately [1].

Emotion regulation (ER) is a key element in children's developmental outcomes, influencing cognition, behaviour and social interactions, and is closely related to emotional intelligence (EI). During childhood, appropriate ER strategies enable

children to successfully communicate and cooperate with peers, adults and the environment [2]. These strategies are associated with cognitive functioning, behaviour and empathy processes [3, 4]. In view of the significant importance of emotions, alterations in emotional processing have been proposed as a transdiagnostic mechanism in child psychopathology (see [5] for a review).

The purpose of this chapter is to provide an overview of ER in early childhood (up to the age of six). In what follows, we will define ER and its relationship to EI, as well as explore ER strategies used by young children, discussing their adaptive value and their association with cognitive and behavioural outcomes. We will also examine the role of ER in childhood psychopathology. We will then present a narrative review of the evidence for the neurophysiological mechanisms underlying ER and its relationship to cognition and behaviour. For this purpose, the following terms were used in the literature search: (infant OR infancy OR child\*) AND (“emotion\* regulation”) AND (mri OR fmri OR fnirs OR nirs OR eeg OR erp OR vagal OR rsa). In addition, a manual search of the reference lists of the selected studies was conducted to identify additional studies that may have been of interest for this review. Finally, we will discuss future challenges and directions for ER research.

## **2. Emotional intelligence and emotion regulation**

Emotional development begins early in life, as infants are already born with the ability to process and express different emotions (e.g. crying) [6]. In the first six years, emotional development is a fundamental aspect that influences cognition, behaviour and social functioning, as it allows children to adapt to different environments (e.g. school) and successfully establish interpersonal relationships throughout their life [7]. Early childhood is an extremely important period for children to learn and manage emotions, with research demonstrating that this period represents a critical window for the development of emotional competencies and self-regulation, with long-term consequences for academic, personal and social outcomes [8].

EI and ER are two research traditions that address emotion management across development. Although relatively independent, their relationship is well-established in the literature. High EI individuals manage their emotions at the earliest point in the emotion trajectory, have a larger repertoire of regulation strategies and are more flexible and successful in regulating their emotions [9]. Understanding emotions will allow their recognition and, consequently, the employment of adequate strategies to deal with different emotional states [10]. Research in early development also corroborates these findings and has shown that children with higher EI are better able to pay attention, are more engaged in school, have more positive relationships and are more empathic [11, 12]. In parallel, children who score higher in EI are also better at regulating aggressive behaviour [13].

EI refers to a set of skills (e.g. perception or regulation of emotions) that allow the recognition and understanding of emotions in oneself and others [14, 15]. These skills are consistent with the term ‘emotional competence’ (EC) employed in the developmental psychology literature [16]. Young children’s EC entails (i) the expression of emotions, (ii) knowledge of emotions in oneself and others and (iii) the ability to regulate their own and others’ emotional expressiveness and experience [17]. The ability to effectively regulate one’s emotional expressions (i.e. emotion regulation) is of great importance, especially in the preschool years, as it plays an important role in development due to its long-term impact on future adjustment [18].

## 2.1 Emotion regulation in early childhood

ER refers to the child's ability to modulate emotional responses consciously or unconsciously [19]. It encompasses the intrinsic and extrinsic processes of monitoring, assessing and modifying emotional reactions, particularly concerning their timing and intensity, to achieve personal goals [20, 21]. By modifying the magnitude and/or type of their emotional experience or the emotion-evoking event [22], children can influence their emotions, depending on their valence (positive or negative), along with the situations and time when they are expressed [23]. This ability enables them to effectively navigate and adapt to different environments [24, 25]. According to Gross [22], ER strategies are organised around four temporal stages: (i) an internal or external event triggers an emotional response, (ii) attention is allocated to that event, (iii) an assessment of that event is made and (iv) a response is produced following the emotional experience of that event.

ER abilities grow rapidly in the early years and continue to grow throughout development [26]. In children aged between 1 and 3 years, ER abilities rely heavily on external social support, particularly from their parents and caregivers [27–31]. Alongside, various processes, such as language or executive functions (e.g. cognitive control), influence the development of ER, enabling children to recognise and label their emotional states, communicate their needs, seek support from others and appropriately respond to environmental demands [21, 27, 32–35]. The increased awareness of others, supported by the development of the Theory of Mind abilities [36], adds a social dimension to emotions [37].

By the age of 3, emotion regulation significantly improves, as children can recognise basic emotions in others and adjust their behaviours in social interactions, as observed in an experimental task in which children were asked to assign an emotion to a cartoon character [38]. Behavioural control emerges along with the peak of aggressive behaviours, and young children become able to use effective ER strategies, such as delaying gratification, maintaining focus, using a lower voice and/or reducing motor behaviour, assessed in both social role-play tasks and parent report measures [33]. Additional evidence, using story completion tasks to elicit emotion-related narratives, suggests that children begin to use antecedent-focused ER strategies (i.e. regulatory strategies that occur before or during emotion processing and are effective in modulating emotional responses, see [39]), such as *cognitive reappraisal* (e.g. the process of creating positive interpretations or perspectives of a stressful situation to reduce distress, see [40]), at age 3, and become more effective in using this strategy throughout childhood (around age 5) [41]. Between the ages of 4 and 6, children begin to grasp their internal experiences (e.g. memories, fears and wishes) and distinguish real emotional experiences from virtual ones [30, 34, 38, 42]. At the age of 6, they become increasingly able to cope with negative emotions and use distraction strategies (e.g. playing, drawing or singing) to manage them [37]. They also begin to control some maladaptive emotion regulation strategies, such as crying, wailing and shouting [42].

In terms of maladaptive strategies, two strategies have been consistently linked to adjustment problems: suppression and rumination [43–45]. *Suppression* involves the inhibition of both emotional expression and thoughts. According to Gross's model [44, 46, 47], this is a response-focused strategy that restrains emotional expression and temporarily reduces the subjective experience of emotion, but it is ineffective in regulating emotions and physiological arousal over time. In addition, the suppression of unwanted thoughts may paradoxically lead to increased access to these suppressed

thoughts [47], resulting in heightened emotional arousal, particularly in the physiological domain, which is considered maladaptive [48]. *Rumination* is the repetitive focus on the emotional experience, its causes and effects [48, 49]. This strategy is used to further understand and solve problems [50]. However, it can inhibit positive problem-solving [51] and lead to indecision and difficulty in taking action [52].

The benefits of using adaptive ER strategies at an early age are well documented. For example, a systematic review and meta-analysis examined 150 empirical studies on ER abilities (using teacher-, parent-report and task-based assessments) in early childhood and their association with various outcomes [18]. The authors reported that these abilities, assessed around the age of 4, predicted 25 developmental outcomes. Particularly, ER was positively associated with social competence, school engagement and academic performance and negatively associated with internalising problems (e.g. depressive symptoms), peer victimisation and externalising problems (e.g. aggressive behaviour) in early school years (around age 8), later school years (around age 13) and adulthood (around age 38). Other empirical research has shown that ER in pre-schoolers is positively related to social and school engagement (i.e. appropriate interactions with adults, peers and/or materials) and prosociality and negatively related to hyperactivity [53].

The consequences of using *suppression* or *rumination* strategies in early childhood are less studied, probably due to the linguistic and cognitive limitations of this age. However, some research has addressed this matter. For example, a study employing a puppet procedure investigated 3- and 4-year-old children's views about 'effective' (e.g. cognitive distraction) and 'ineffective' (e.g. rumination and venting) ways of controlling anger, sadness and fear [42]. Compared to adults, children reported that "ineffective" strategies, such as rumination, resulted in greater reductions in negative emotions. The authors suggest that this may be because they have less understanding of or experience with emotion regulation, or because they 'genuinely consider a strategy like rumination to be effective because they know that emotions sometimes improve with the passage of time' (p. 11). Other evidence supports the negative impact of maladaptive ER strategies on behaviour and cognition. A study of 193 pre-schoolers aged around 55 months, using teach-report assessments, showed that those who used more maladaptive ER strategies (e.g. anger and frustration) were more likely to engage in aggressive behaviours [54]. Another study involving 119 children aged around 69 months, and using a task-based assessment (i.e. children's directed attention and concentration to a movie clip), found that the use of suppression hinders their self-control resources [55].

In summary, evidence suggests that young children still develop their emotional awareness and regulation abilities. They often rely on strategies such as seeking comfort from caregivers. These early attempts at emotion regulation can be seen as advantageous, providing children with a sense of security and helping them to cope with overwhelming experiences. In contrast, children who use maladaptive strategies are more likely to experience difficulties in interacting with others and may be more vulnerable to developing psychopathology.

## **2.2 Emotion regulation as a transdiagnostic factor**

Clinical psychopathology has been dominated by a disorder-specific approach to diagnosis and treatment that does not always adequately address comorbidity and symptom overlap between disorders. Furthermore, many risk factors appear to lead to different rather than specific disorders, and the same intervention strategies appear to

alleviate these different conditions [56]. These limitations have been highlighted [57], and research has investigated the processes underlying different disorders. Among these, ER has received some attention, as numerous systematic reviews have demonstrated that distinct psychological disorders are related to altered ER, both in adults [43, 58, 59] and children [5]. Due to the apparent role of ER difficulties in different psychopathologies, it has been proposed that it should be considered as a transdiagnostic mechanism [56].

A transdiagnostic framework aims to conceptually understand and explain comorbidity across psychopathology [60]. In line with this, the National Institute of Mental Health (NIMH) has developed the Research Domain Criteria (RDoC) initiative, which provides a translational framework of basic domains of functioning—negative valence, positive valence, cognitive, social processes and arousal/regulatory systems—that underlie human behaviour, from typical to atypical manifestations, and reflect cognition, emotion, motivation and social behaviour processes. Accordingly, clinical conditions emerge from dysfunction in these processes, which predate diagnosis and can be measured through multiple levels of analysis—biological, physiological and behavioural [61, 62]. ER has gained notable importance in the transdiagnostic literature, which suggests that emotion regulation dysfunction not only contributes to distinct conditions (e.g. internalising disorders or conduct problems), but also is comorbid across different forms of psychopathology (see [5] for a review).

Research suggests that difficulties in ER reflect a mechanism underlying the occurrence of psychopathology in childhood. A recent meta-analysis of 60 longitudinal studies reported that maladaptive ER strategies (e.g. rumination), assessed using self-report and experimental (e.g., delay of gratification task) measures, are stable, long-term risk factors for developmental psychopathology in children and adolescents [63]. Consistent with this, another meta-analytic review of longitudinal evidence found that appropriate emotion regulation abilities, measured using parent-report questionnaires, at an early age were associated with later lower levels of psychopathology (internalising and externalising problems) [64]. Empirical evidence further supports these findings. Parent-report measures of emotion dysregulation (e.g., irritability) in children aged 3–5 years have been found to predict later mood and externalising disorders in late childhood and adolescence [65, 66].

Studies investigating experiences of childhood maltreatment also contribute to support the transdiagnostic role of ER in psychopathology. A large meta-analysis of 215 studies using report measures (i.e. questionnaires) documented that ER difficulties (e.g. rumination or suppression) in children who experienced maltreatment were positively associated with psychopathology in preschool children (i.e. internalising, and externalising problems) [67]. Consistent with this, a study using a multilevel modelling approach showed that childhood maltreatment was associated with lower positive effect and higher negative effect, as well as reduced success in ER, as assessed by report instruments [68]. A longitudinal study found that childhood maltreatment was associated with increased emotional reactivity, measured using a task-based experiment (i.e. a visual dot-probe task using affective faces), and the use of suppression and rumination strategies, measured using self-report questionnaires, which mediated the association between maltreatment and psychopathology over time [69].

Further support for the role of ER as a transdiagnostic process comes from studies of children with neurodevelopmental disorders, such as autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD) [70]. ASD and ADHD preschool children tend to show marked difficulties in ER, either in parent-report questionnaires or in observational tasks (e.g. frustration-elicited task) [71]. In ASD,

ER difficulties have been proposed as a core feature of this condition [72], as it is a strong predictor of symptom severity [73]. Autistic pre-schoolers, compared to typically developing children using observational methods (e.g. free play in an unstructured setting), often show less appropriate ER strategies (e.g. seeking social support) and more maladaptive strategies (e.g. avoidance), as well as increased difficulties in regulating impulsivity to emotional events and more negative effect [74]. Similarly, impulsivity in ADHD children may be related to ER difficulties. For example, a meta-analysis focusing on young children with ADHD has shown that these children have increased difficulties in emotion recognition and exhibit greater emotional lability (i.e. increased shifting of emotions, intense emotional responses), as evidenced by greater behavioural negative emotionality (e.g. anger, frustration) during frustration/challenging tasks [75].

Overall, the evidence points to the importance of adequate ER abilities at an early age and how ER dysfunction may act as a risk factor for the development and maintenance of psychopathology. Promoting effective ER abilities in early childhood not only contributes to enhanced cognitive, behavioural and interpersonal functioning but also serves as an important protective factor against various mental health problems later in life.

### **3. Neurophysiological correlates of emotion regulation**

Emotional functioning develops rapidly in early childhood supported by several neurophysiological mechanisms and structures that mediate the dynamic interplay between emotion, cognition and behaviour. Although less investigated than in adults, a few studies have explored the neural and physiological correlates of ER at early ages.

Neuroimaging research highlights the role of the amygdala and prefrontal cortex (PFC) in ER throughout childhood. For example, a positive association between functional connectivity of the right amygdala-medial prefrontal cortex (mPFC) and parent-reported emotion regulation scores was found in children aged 4–6 years [76]. In addition, right amygdala-mPFC connectivity was negatively correlated with right amygdala reactivity to facial emotional expressions and parental reports of child negative effect. This finding is consistent with previous research in older children, adolescent and adults, suggesting that the amygdala and mPFC are key neural substrates for emotion processing and regulation across the lifespan [77].

The amygdala has been implicated in emotional reactivity and processing of the stimuli affective arousal and salience [78–81]. Regions of the PFC, in turn, have been implicated in working memory, inhibitory control, attention and planning [82] processes that are essential for generating and maintaining adaptive ER strategies [80]. In addition, regions of the PFC are often connected to the amygdala, thus contributing to integrate information from the emotion generative and regulatory systems and promote adaptive ER abilities [83]. For example, depressed 4–6-year-old children showed increased activity in the right amygdala when viewing faces of different emotions compared to their non-depressed peers [84]. The authors also found a positive association between amygdala activity and parental reports of children's negative effect but a negative association with their perceptions of children's ability to successfully self-regulate their emotions. In another study of children aged 4–7, greater exposure to early life adversity (e.g. serious accident, parental conflict) was significantly associated with weaker amygdala-mPFC functional connectivity, which in turn was associated with more parent-report symptoms of aggressive behaviour

and attention problems [85]. Further evidence of the role of these two brain regions derives from studies linking disrupted functioning of the amygdala and related brain circuits to emotional problems in young children with neurodevelopmental disorders. Significantly reduced connectivity between the amygdala and other brain areas important for socio-communicative behaviours (e.g. mPFC, temporal lobe) has been observed in autistic preschool children (mean age of 3.5 years) compared to typically developing peers [86]. Furthermore, this work observed that altered functional connectivity between the amygdala and frontal lobe was associated with greater autistic symptom severity.

The involvement of the PFC has also been confirmed in previous works using functional near-infrared spectroscopy (fNIRS) to study frustration in childhood, which is particularly relevant to the regulation of emotions when a desired goal is not achieved. Increased bilateral PFC activation was observed in children aged 4–7 years in response to elicited frustration (i.e. receiving negative feedback) in social contexts, with those children who scored higher on parent-report measures of their negative affectivity showing less brain activation in this brain region [87]. Similar findings were reported in a study of 3- to 5-year-old children [88]. Greater activation in the middle PFC was observed in response to winning a prize in a computer game, whereas increased lateral PFC activation was registered in the frustration condition (i.e. losing a desired prize). Furthermore, changes (increases) in PFC activation to a frustration task were observed in children aged between 4- and 6-years following exposure to a conscious ER interpersonal scaffolding condition, in which children interacted with the examiner during a colouring activity designed to deliberately associate physiological sensations and cognitions with emotions [89]. Among children assigned to the interpersonal scaffolding condition, being rated by their parents as having better emotion regulation abilities was associated with greater increases in PFC activation.

Another neurophysiological marker associated with ER has emerged from studies using electroencephalography (EEG) and event-related potentials (ERPs). ERP frontal N2 and P3b responses were examined as indicators of ER in 4–6-year-old children [90]. The results showed a higher amplitude and shorter latency of the N2 component, as well as a larger P3b, when viewing pictures of angry (vs. happy) faces. Children described by their parents as temperamentally more fearful showed an earlier N2 response to angry faces. Frontal N2 (occurring approximately 200–400 ms after stimulus onset) and P3 (observed in adults approximately 300–500 ms after stimulus onset) components are thought to tap into inhibitory control and attentional regulation processes, as well as action and conflict monitoring, reflecting related activity in regions of the PFC, such as the anterior cingulate cortex (ACC) and orbito-frontal cortex (OFC) [91, 92].

Another ERP index that has been studied in relation to ER is the late positive potential (LPP). The LPP is indicative of attentional processing of negative emotions and emerges as a potentially relevant neural signature for dysregulation of behaviour and effect [91]. The LPP response typically increases to emotional rather than neutral stimuli, but in contrast, a decrease in the LPP response has been reported following the use of ER reappraisal strategies in adults and older children (see [91, 93] for a review). In accordance with this, emotional content (vs. neutral condition) elicited larger LPP amplitudes in children aged 4–6 years [94, 95], but findings on the effect of reappraisal have been inconsistent. One study found that directed instructions to reappraise unpleasant stimuli did not down-regulate LPP, suggesting that young children may still be developing their ability to use cognitive reappraisal strategies [94]. However, another study found that pre-schoolers registered lower

LPP amplitudes following simplified instructions for neutral compared to negative interpretations [96]. These inconsistencies may be related to the nature of the reappraisal task administered to the children and thus require further investigation. On the other hand, frontal EEG activation has also been implicated in emotion processing and regulation, with left frontal asymmetry (FA) (i.e. greater activation in the left hemisphere relative to the right hemisphere) being an indicator of appropriate emotional functioning and more adaptive ER abilities [97, 98]. For example, greater left FA has been found in adults during the performance of an appraisal task involving the visualisation of negative pictures [99]. In 9- to 10-year-old children, greater left FA during cognitive appraisal of a sad video clip was observed in those whose parents also used adaptive cognitive ER strategies and when the children reported greater inhibition of negative emotions [100]. Moreover, task-related FA assessed at 4½ years of age predicted later emotional functioning—greater left FA was associated with parent reports of appropriate ER abilities at 9 years of age [101]. In 4-year-old children, patterns of greater right FA were related to parent reports of more externalising and internalising problems in sociable and shy children, respectively, compared with children who showed greater left frontal activation [102]. However, a recent meta-analysis [103], examining the relationship between self-regulation (ER, effortful control and executive function) and frontal EEG activity during infancy and early childhood (up to 6 years of age), found a significant association only between frontal EEG alpha activity and executive function, but not with ER. Despite the substantial evidence suggesting that EEG frontal asymmetry is a potentially relevant marker of later maladaptive emotional functioning, future research is needed.

Finally, respiratory sinus arrhythmia (RSA)—computed by measuring the heart rate pattern taking into account the frequency of respiration—is a particularly important neurophysiological mechanism for the development of ER abilities and vulnerability to several forms of psychopathology [104]. RSA reflects the action of the vagus nerve supporting the link between the individual's physiological functioning and social behaviour [105]. Greater RSA at baseline and RSA withdrawal (i.e. a decrease in RSA during challenging conditions) have been associated with better regulatory abilities and more positive developmental outcomes [106–108]. Studies show that RSA was associated with the ability of 5- to 6-month-old infants to recover and self-soothe during a Face-to-Face Still-Face paradigm [109, 110]. In addition, 10-month-old infants' higher vagal withdrawal during an arm restraint procedure was associated with more observed maternal orienting (e.g. looking), but not distracting, regulatory behaviours [111]. RSA also discriminated physiologically between infants (6 months) classified as more or less easily frustrated, as measured by maternal reports of their temperament, and observed behaviour during a task-based experiment (i.e. frustration-elicited task), such that more easily frustrated infants displayed greater RSA and had problems with RSA withdrawal in response to an attention-demanding task [112]. Another study showed that lower RSA recovery (i.e. an index of ER) during a fear-provoking situation at 42 months of age was associated with higher parent reports of externalising problems at 48 months [113]. Children aged 2–5 years who showed higher RSA during a challenging social interaction (i.e. playing with unfamiliar peers) exhibited fewer internalising and externalising problems and better self-regulatory behaviours assessed 6–10 months later [114]. There is also evidence indicating that children's ability to physiologically regulate themselves is related to parental behaviours and psychopathology (e.g. depression) [113, 114].

In conclusion, neuropsychophysiological research seems to indicate that specific markers may underlie adaptive and maladaptive ER. However, longitudinal studies

and multi-method approaches are needed, especially when assessing young children. In this way, the developmental changes in emotion processing and regulation that occur during childhood and the acquisition of related skills (e.g. attention, inhibitory control) can be examined to gain a more comprehensive understanding of ER abilities.

#### **4. Conclusion and future directions**

The aim of this chapter was to highlight and discuss the importance of supporting appropriate ER abilities in early childhood. Appropriate emotion regulation strategies at an early age are likely to contribute to higher levels of emotional intelligence, as children can effectively manage, understand and deal with their own emotions [9]. Promoting emotion regulation abilities in early childhood may then lay an important foundation for increased emotional intelligence, fostering emotion recognition and contributing to improved interpersonal relationships and social interactions.

In this chapter, we have presented how the current literature supports the development of adjusted ER abilities in young children. Adaptive ER strategies are associated with long-term cognitive, social and mental health outcomes and have a significant impact on children's successful development. Furthermore, we have examined current evidence on the role of neuropsychophysiological markers associated with ER abilities and how specific physiological responses underlie adaptive and/or maladaptive strategies. In summary, the literature suggests that promoting and supporting the development of appropriate ER abilities, both behavioural and physiological, in early childhood will enable children to be emotionally competent, deal effectively with personal and interpersonal difficulties as well as work with others in social settings, to the benefit of children, families, educators and society.

However, it is important to recognise that the optimal development of ER abilities occurs in an interpersonal context. Although this topic was not the aim of this chapter, it is important to consider that ER emerges in the socialisation process and that the parent/caregiver-child relationship is crucial at an early age for their optimal regulation. Therefore, future studies should address the dyadic context in the emergence and development of ER. For example, examine how parenting styles (e.g. permissive, or authoritative), or the role of intergenerational transmission, affect the development of ER abilities (e.g. whether children tend to adopt similar strategies as their caregivers/parents). Similarly, future studies should investigate how peer interactions (e.g. friendships and social support networks, e.g. school setting) influence emotion management and regulation in young children. It is also important to investigate how cultural factors may influence the development and effectiveness of ER strategies from an early age, as evidence in adults suggests that culture may lead individuals to regulate their emotions differently [115]. In the same line, future neurophysiological studies should consider the contributions of interbrain synchrony (i.e. spatial and/or temporal coordination of biological and behavioural systems between individuals, [116])—particularly in the context of parent/caregiver-child interaction—to the development of appropriate ER abilities.

Finally, as we live in the digital age, it is increasingly important to examine the impact of technology on ER. At an increasingly young age, children are often exposed to and interact with others through digital devices and social media. Future research should investigate how digital communication and social media may affect the development of ER and EI and whether it differs from face-to-face interactions.

## **Acknowledgements**

This work is funded by national funds through the FCT—The Portuguese Foundation for Science and Technology, I.P., under the Project UIDB/04375/2020.

## **Conflict of interest**

The authors declare no conflict of interest.

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# Perspective Chapter: Enacting Emotional Intelligence from the Bidirectional Link between Mood and Reasoning

*Kévin Bague, Jean Baratgin and Éric Laurent*

## Abstract

During the last 20 years, the concept of emotional intelligence (EI) has gained significant attention in psychology. Traditionally, EI has been conceptualized as the ability to reason with and/or about one's own emotions and/or in the presence of emotion-related stimuli. This chapter presents an enactive framework for conceptualizing EI as a context-sensitive, dynamic, emerging and purposeful ability. We describe a bidirectional relationship between mood and reasoning processes, building on the dual-process model of reasoning. First, we report evidence showing how mood can impair reasoning capacity. Mood also interacts with task content relevance, which can suppress detrimental effects of induced mood on reasoning. The dynamic influence of mood on reasoning can be explained by the cognitive load induced by positive and negative moods that saturates System 2 involved in EI-related reasoning. Furthermore, negative mood could promote EI-related reasoning based on System 2, while positive mood could promote EI-related reasoning based on System 1. In this framework, mood regulation plays a central role in EI. Then, we discuss how the reasoning abilities of each EI subcomponent can influence mood. Overall, those proposals can be conceived within a cycle including both mood and reasoning, in the context of need regulation. The coordination between those various factors contributes to enacting EI.

**Keywords:** cognition, dual process, emotional intelligence, enactivism, mood, mood disorders, reasoning

## 1. Introduction

For a long time, affective processes were excluded from cognitive sciences [1, 2]. However, in recent years, the relationships between cognition and affects have increasingly received attention (e.g., [3]). This is especially true in the new paradigm of reasoning (e.g., [4–6]). In this framework, reasoning is no longer reduced to a neutral and objective process. Rather, it is dependent on the people's motivation, preferences, environment and subjective goals. Thus, in the study of reasoning, it seems essential to

take into account the additional implicit or subjective undertones that may result from linguistic pragmatic effects, social norms and other contextual influences specific to the individual [4–6]. The latter are highly dependent on affective processes (e.g., [7, 8]). In this context, emotional intelligence (EI) is a very good study case, because EI is commonly defined as the capacity to reason with emotions and about emotion-related stimuli [9]. The prevailing model conceptualizes EI as a set of abilities that allow individuals to perceive, use, understand and regulate emotions [9]. Below, we use the formulation “EI reasoning” or “EI-related reasoning” to refer to this set of skills. Although this is a major conceptualization of EI (e.g., [1, 9]), it is limited to studying EI within a steady [10] and disembodied framework. That is, classical models of EI do not take into account the influence of situational factors [10, 11]. They do not allow for the possibility that an individual may exhibit EI capacities in a specific context but not in another [11]. In other words, they do not help to grasp the complexity associated with *why* and *how* EI emerges [11]. We will provide support for a more balanced and complex view in which a set of cognitive and emotional processes dynamically coordinate with each other. EI would be embodied and embedded in a multiscale context and enacted from that context. Because of the complex features associated with this emerging pattern, the EI abilities would be rather dynamic, non-linear and context-dependent. In this chapter, we define context “as any other elementary (or groups of) living or non-living material or symbolic objects, which, through their connectedness with the first biological unit, may influence its activity” ([12], p. 2).

Ybarra and colleagues were among the first to propose a dynamic and context-sensitive account of EI [11]. According to this view, an individual with high capacities in EI can sometimes have poor performances (i.e., impaired EI such as ineffective or maladaptive behaviors, low score on EI assessment), because the actual manifestation of a capacity is context-dependent. They proposed that EI is embodied and influenced by needs, especially at social (e.g., social needs, social climate) and cognitive (e.g., automatic *vs.* controlled processing) levels. Pekaar and colleagues developed a more complex model of EI, in which EI is enacted during an emotional episode through an embodiment of multilevel factors such as emotion type, personality, cognitive capacities, social factors and environmental demands [10]. In this chapter, we propose to pursue the dynamic conceptualization of EI by emphasizing the significance of mood. Mood is relevant in this domain, because individuals with high EI capacities may demonstrate different performances depending on their mood. While EI is defined as the capacity to reason with emotions and emotion-related stimuli [9], this reasoning activity occurs within a particular mood state. More traditional conceptualizations of EI could lead to the representation that reasoning activity occurs in an affective vacuum, despite EI being itself a concept related to affective processes. We propose that EI is embodied and therefore influenced by mood state.

Mood and emotions are tightly related. They are currently considered as two distinct entities, though a lot of confusion between the two concepts can be found in the literature. We differentiate mood from emotion, particularly at the temporal level. Pekaar and colleagues explained that emotions occur over a discrete episode [10]. It has both clearly distinguishable start and end. Prior to an emotional event, individuals already experience a mood state that can influence their emotional reaction to stimuli. The emotional event can modify the dynamics of the mood state, the latter being due in part to a residual effect of the emotion. For example, if you wake up in a bad mood, you might react strongly if one of your colleagues makes a remark upon arriving at work. If you have an argument with your spouse in the morning, it is possible that you will remain in a similar bad mood for a part, or the rest, of the day.

At any moment, humans experience a particular mood state (e.g., [13]), meaning that there could also be a variable influence of mood state on EI.

In the remaining lines, we will discuss how mood interacts with reasoning processes to contribute to the emergence of EI. Reasoning is a core component of EI in both “static” (i.e., traditional) and “dynamic” accounts. Ybarra and colleagues have emphasized that factors inherent to reasoning can influence EI [11]. We will first expose evidence for mood influences on reasoning and then discuss how reasoning can in turn influence mood. Finally, we will share a perspective combining those influences in order to contribute to an enactive approach to EI.

## 2. How could mood and reasoning enact EI

### 2.1 Mood impairs reasoning capacity: empirical findings

Numerous studies have examined the impact of mood on logical reasoning. Most of these studies showed that both laboratory-induced negative and positive moods impair reasoning performances [7, 14, 15]. For example, using a Wason’s selection task<sup>1</sup> to assess logical reasoning, and videos to induce mood, Oaksford and colleagues showed that positive and negative moods reduced reasoning performance (experiment 1) [16]. However, in this experiment, participants reasoned with neutral content (i.e., without emotional content).

Interestingly, Jung and colleagues showed that participants in negative mood performed poorer than participants in positive mood, and participants in positive mood performed poorer than participants in “neutral” mood when they were presented with emotion-related stimuli (i.e., positive or negative material content) on the Wason’s selection task and conditional reasoning task<sup>2</sup> [2]. EI has been defined as the ability to reason with emotion-related stimuli [9]. Therefore, people could have impaired EI under positive or negative moods.

### 2.2 How mood impairs reasoning capacity and involvement for EI

Although EI has been related to reasoning ability, one could argue that this ability differs from logical reasoning. The literature assessing the influence of mood on logical reasoning has proposed interesting explanatory mechanisms. These mechanisms could also account for EI dynamics. Mood is known to influence the way we reason [17, 18]. The influence of mood on reasoning could be explained within the dual-process theory framework. Such a theory proposes that people reason from either: (a) automatic processes (System 1) that are quick, effortless, heuristic and running

<sup>1</sup> In this task, participants observe four cards. One card displays “*p*” information, one displays “*not-p*” information, one “*q*” information and one “*not-q*” information. Participants have to select the two cards that they need to turn over to demonstrate that if a card displays “*p*” on the front, then it displays “*q*” on the back.

<sup>2</sup> In this task, pairs of premisses were presented to the participants. A conclusion followed the two premisses. The conclusion was based on one of the following inference: Modus Ponens (i.e., if *p* then *q*, *p* is true, then *q* is true), or Modus Tollens (i.e., if *p* then *q*, *q* is false, then *p* is false), or Affirmation of the Consequence (i.e., if *p* then *q*, *q* is true, then *p* is true) or Denial of Antecedent (i.e., if *p* then *q*, *p* is false, then *q* is false). From the two premisses, participants have to indicate if the conclusion is logically valid. In this task based on the old reasoning paradigm, only Modus Ponens and Modus Tollens are considered as logically valid inferences.

in parallel, or (b) controlled processes (System 2) that are reflective, slower, analytical, effortful, constrained by working-memory capacities, systematic and running sequentially [14, 15, 19–25].

On the one hand, it has been proposed that both positive and negative moods induce cognitive load that saturates System 2 involved in logical reasoning (e.g., [14]). In several studies, the authors emphasized the general saturation of cognitive resources by mood; resources that could otherwise be allocated to the reasoning task (e.g., [2, 14, 16]). It has also been shown that participants with depressed mood have poorer reasoning performance than healthy participants: (a) because they reason like healthy participants with saturated working memory [26]; (b) only when they have limited working memory capacity and reason in a conflict context (i.e., when the responses are logically invalid but believable or logically valid but unbelievable) [27].

On the other hand, it has been suggested that different mood states promote different style of reasoning [15]. People in positive moods are more prone to recruit System 1-related processes [15]. People in negative moods would preferentially recruit System 2-related processes [15]. Such reports stem from works in social cognition [15] and are consistent with cognitive theories of mood. Mood could be used as information to interpret the current situation [18, 28, 29]. Positive mood could signal a benign and safe situation that does not require effortful and systematic processing [18]. Rather, automatic and heuristic processing would be sufficient, while the reasoning task could require a process-based System 2 [18]. Positive mood promotes dominant and default processing modes [28]. These findings explain why people could engage in reasoning based on System 1 when they are in a positive mood. Conversely, a negative mood could signal a problematic situation that requires a systematic and detailed analysis with effortful processing [15, 18]. Likewise, negative mood promotes non-dominant processing [28]. Negative mood is a signal that there is a problem in a situation. Thus non-dominant processes could take over default to both solve the encountered problem and improve mood. People could hence engage in reasoning based on System 2 when they are in a negative mood. However, negative mood induces a cognitive cost that decreases the cognitive resources allocated to reasoning-based System 2. Thus, the cognitive load associated with mood regulation plays a central role in reasoning processes and can impair performance [2, 14, 16, 18, 26, 27, 30].

Similarly, mood can influence EI-related performances. Several authors emphasized the role of dual-process in reasoning abilities of EI [11, 31]. EI reasoning based on System 1 processes can be ineffective (i.e., fails to accurately achieve the intended goal) if the default thinking style is not attuned to the current context [11]. Mood can be associated with a maladaptive thinking style. For example, this is the case in people suffering from mood disorders. They exhibit negative automatic thoughts that reflect cognitive distortions of reality and maladaptive schemas [32–34]. EI reasoning based on System 2 processes can be problematic if there is a cognitive overload [11]. We have just mentioned that mood induces a cognitive load that decreases the ability to reason from System 2. More generally, EI could depend on dual-process reasoning, which is, itself, influenced by mood.

### **2.3 The role of task content**

In specific conditions, the detrimental effect of mood on reasoning seems to disappear. Mood effect on reasoning seems to interact with material content. It has been proposed that consistency between task content and induced mood could reduce the detrimental effect of mood on reasoning [2, 7, 14]. In Jung and colleagues' research

[2], participants had to solve Wason's selection tasks with neutral, positive or negative content while being under a neutral or positive or negative induced mood [2]. A trial was considered as relevant when the valence of the task content and the valence of the induced mood were the same. They showed that valence relevance did not interact with mood on reasoning performance [2]. The authors observed the same finding when they used a conditional reasoning task easier than the Wason's selection task [2]. From two premises that had a neutral or positive or negative content, participants had to indicate if the conclusion followed necessarily from premises while being in a neutral or positive or negative induced mood [2].

When the content of the task is semantically associated with the content of mood induction, then the detrimental effect of negative mood is suppressed (see [7] experiment 4). In this experiment, the authors used a conditional reasoning task [7]. Participants had to indicate if four inferences, each based either on a Modus Ponens, Modus Tollens, Denying the Antecedent or Affirming the Consequent were valid or not [7]. Each trial was solved after seeing a video with (a) negative and semantically related content, (b) negative and semantically unrelated content and (c) neutral and semantically related content or (d) neutral and semantically unrelated content [7]. However, in this experiment, this semantic association between mood induction and the content of the reasoning task was only studied with the negative and neutral valences. That is the semantic congruence only concerned negative or neutral stimuli. But it would be interesting to extend those results with positive valence.

Such findings suggest that the relevance feature of stimuli plays a role in the mood effect on reasoning. On the one hand, when mood induction and reasoning content are semantically associated, the cognitive load of the former overlaps the cognitive load of the latter [7]. In experiments involving irrelevant conditions, the cognitive cost of mood and the cognitive cost of the task are additive, overloading the working memory and System 2 processes. In other words, when the semantic content of the task is relevant, it does not add cognitive load as it is already activated by mood induction [7], thereby not adding the burden on System 2 [14].

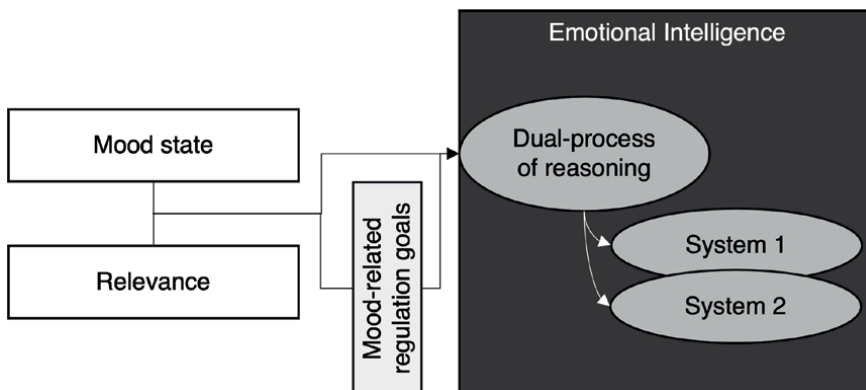
On the other hand, a complementary interpretation is possible: mood regulation could explain such results. Semantic congruency effect could be the expression of a more general goal-relevant effect. This goal is the regulation of mood [35, 36]. The semantic proximity between mood induction (i.e., one of the causes of the current mood state) and reasoning task could give participants the impression that they can regulate their mood by solving tasks. They would be more motivated to solve the task and allocate more resources to it, as they feel that they are addressing the cause of their negative mood. Such a proposition emphasizes the role of mood as information and as a function of the satisfaction level of needs [7] and the teleological synchronization of cognitive functioning (in this case, reasoning) with that level of satisfaction. This interpretation remains speculative and needs to be tested in additional experiments. Additionally, these two interpretations are not mutually exclusive.

Both interpretations could apply to EI. Processes of EI-related reasoning are based on dual-process [11, 31]. Therefore, the semantic relevance effect could occur to optimize reasoning activity. Likewise, mood regulation is a need that could influence more generally the cognitive system (e.g., perception [35]). It could be particularly salient in EI because the regulation of emotion is a core ability of EI. Thus the effect of semantic relevance could also occur in EI to provide individuals with the opportunity to regulate their previously induced mood. In other words, an individual would have more motivation and interest in investing in and succeeding at, a task that will make them feel better.

Moreover, participants are more likely to try to explain negative events that induce negative mood in comparison with positive events that induce positive mood (see [18] for a review). Such findings seem to be very interesting for the *understanding* subcomponent of EI [9]. This subcomponent notably allows determining the antecedents of emotions [9]. Regarding this dimension, there could be a difference in performance according to the valence of the events (i.e., negative *vs.* positive).

## 2.4 Concrete example and summary

Let us imagine the story of Sam, who works for an advertising agency. This morning, he presented his advertising campaign project for a well-known company to his boss. The presentation does not go well. The boss is not satisfied with Sam’s work, becomes angry, and gives him very negative feedback. However, he allows Sam the opportunity to present his work again in a few days. After this interview, Sam’s mood is negative. He appears sad and easily irritable. According to the findings presented above, Sam could demonstrate the following EI ability. It could be relevant for him to perceive his boss’s emotions in that situation, to understand them, as well as what could satisfy his boss and generate positive emotions. However, once he arrives home, he struggles more to understand what his spouse is feeling and to act accordingly. In the first situation, the deployment of Sam’s EI is semantically relevant to one of the causes of his negative mood. The mood induction and the reasoning task to be performed have the same source. This frees up space for him to understand why his boss became angry and how he could adapt his work to transform that emotion into a positive one during the next interview. Moreover, solving this problem would allow him to correct his own mood. If the boss is pleased with the next presentation, then Sam’s negative mood should fade, as it was generated by that situation. In the second situation, the deployment of Sam’s EI is challenged. Cognitive resources are mobilized to resolve the situation that caused mood disturbance, as an attempt at regulating internal and/or external affective processes. Consequently, there is a saturation of EI-related reasoning processes necessary for Sam’s situation with his spouse, especially considering that deploying EI with his spouse would not *directly* regulate the cause of his negative mood.



**Figure 1.** How could mood and reasoning enact EI. EI capacities depend on the balance in the use of reasoning processes respectively based on system 1 and system 2. Dual-process underlying reasoning abilities are attuned to needs and goals expressed through mood, which interacts with relevance of the tasks.

Taken together, these statements reflect a dynamic and nonlinear conceptualization of EI, which is dependent on mood context. Indeed, EI is the capacity to reason with emotions and emotion-related stimuli [9]. We have shown that this capacity could vary according to mood state and the relevance of emotion-related stimuli (**Figure 1**). These principles could be conceived as foundations for a dynamic approach to the EI abilities that emerge from both mood and reasoning processes. In other words, the dual process underlying reasoning abilities of EI [11, 31] is attuned to needs and goals expressed through mood (**Figure 1**). At this point, we also have to consider the reciprocal effect of reasoning on mood.

### 3. Reasoning influences mood regulation

In the previous section we have suggested that EI could be enacted from mood through the influence of mood regulation need on reasoning processes. Reasoning processes can also influence mood. Such a reciprocal relationship is relevant in the case of EI because the way of reasoning modifies mood, which, in turn, can influence EI.

#### 3.1 Reasoning and mood in cognitive psychopathology

The influence of reasoning on mood can be discussed from cognitive theories and therapies for mood disorders. Cognitive models of depression state that depressogenic reasoning schemas are cognitive vulnerability factors that could lead to a higher risk of developing depressive disorders (e.g., [37, 38]). The most famous conceptualization is Beck's model mentioned above. In this perspective, depression is associated with the occurrence of automatic thoughts and reasoning biases (e.g., selective abstraction, arbitrary inference, absolutistic thinking, magnification and minimization) [34]. These automatic thoughts are produced by the activation of maladaptive schemas that lead to negativity biases [34]. A second famous conceptualization is the hopelessness theory in which negative anticipations are core processes of depression [39, 40]. According to its proponents, depression is associated with negative inferential style that corresponds to the attribution of negative events to stable, global causes and to infer negative consequences and negative self-characteristics from a given (negative) event [39–41]. In other words, there is a bias in the use of information to draw conclusions about the causes, consequences of the event, and about self-characteristics, and as a consequence, about the future. Such reasoning biases also increase the risk of developing a depressed mood, especially because of a lack of anticipated gratification (e.g., [41]). The theoretical background of cognitive therapy states that events do not have a valence and do not elicit positive or negative emotions *per se*. Rather, it is the cognitive interpretation of the event that elicits positive or negative emotions. That is why recurrently negative inference and “maladaptive” thinking can lead to psychopathology. For example, if Bastien employs a maladaptive reasoning pattern such as “if a dog bit me, then all dogs are dangerous,” he will likely generate automatic thoughts like “it will bite me,” “it is mean” and consequently, a feeling of fear will arise each time a dog is encountered. However, if Bastien interprets the presence of a dog as comforting or amusing, the resulting emotion will be more positive. One aim of cognitive therapies is to dispute such biased thoughts to increase alternative rationality [34]. Let us revisit the example of Sam. When his boss criticizes his work, Sam may create an automatic chain of thoughts such as “he didn't like what I presented,” “my boss is never satisfied with my work,” “I'm not a good employee,” “I'm worthless”. Such a chain could lead

to the conclusion of a failed life, which would likely induce a negative emotion like sadness. In this case, direct or Socratic questioning can be used to try to dispute and rationalize these thoughts [34]. For example, we could ask Sam if there have been instances where his boss has praised his work in order to explore if there are any past experiences that contradict or challenge his negative interpretations. We can associate this with the concept of cognitive reappraisal. This metacognitive strategy consists in modifying the interpretation of an event, by proposing a new meaning. In [42], we have reviewed studies that show that cognitive reappraisal can elicit positive affects, notably in reassessing attributional style (see also [43]). Taken together, cognitive theories and therapies show that (a) reasoning bias can lead to depressed mood, and (b) mood can be modified by the replacement of biased reasoning processes with more “rational” reasoning.

This evidence, rising from cognitive clinical psychology, can be related to dual-process theory. Firstly, the production of automatic thoughts would be supported by System 1. Both refer to thoughts that occur spontaneously and effortlessly and impose themselves on the individual. Functionally, System 1 would allow maintaining the current mood state [23, 30]. That is why it has been proposed that a positive mood is associated with System 1. Secondly, the cognitive reappraisal or direct questioning used to correct automatic thoughts and moods would be supported by System 2 [11]. This system has been associated with the objective of modifying and regulating the current mood state [23, 30]. That is why negative is related to System 2. In other words, cognitive therapy aims to reappraise automatic thoughts elicited by System 1 in using controlled processes of System 2. The dual process theory of depression [23] supports the involvement of System 1 and System 2 in mood regulation. System 2 is supposed to regulate negative mood. However, under certain conditions, it fails to do so, which can lead to the development of a depressed mood. Three specific conditions would prevent System 2 from efficiently regulating mood [23]. Firstly, if System 1 is characterized by a negativity bias, but there is not enough cognitive resource to correct it with System 2 [23]. Secondly, if System 1 is characterized by a negativity bias, but there is no expectation violation [23]. Because of the integration of maladaptive schema, the occurrence of negative automatic thoughts can be expected. Thus, the deployment of System 2 to correct negativity bias could not occur [23]. Thirdly, if System 1 is characterized by a negativity bias and if System 2 is deployed but in a maladaptive manner [23], then rumination should occur [23]. System 2 would then be deployed but could not correct the bias. It would rather contribute to maintaining this bias.

### **3.2 Emotional intelligence, reasoning and mood**

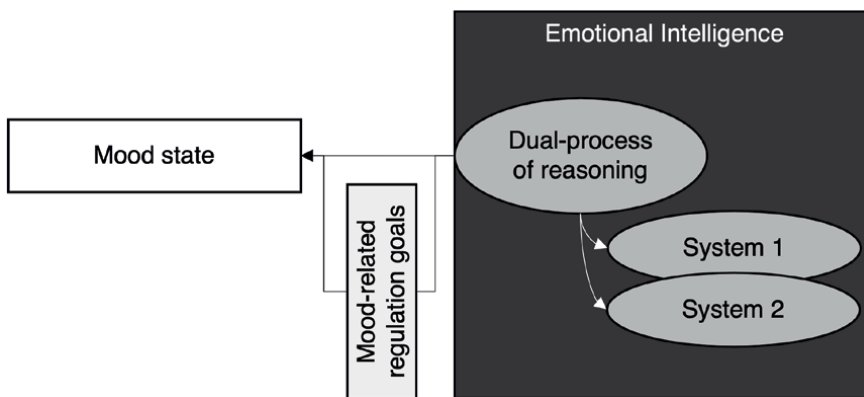
This kind of influence of reasoning on mood could be linked with the *understanding* and *managing* subcomponents of EI [9]. Indeed, *understanding* subcomponent notably allows determining the antecedents of emotions and appraising situations that elicit affect [9]. Automatic thoughts are a way to appraise an event and an antecedent of affects. Mood depends on how the antecedent is determined and how it is appraised. In other words, mood depends on EI. Likewise, *managing* subcomponent can influence mood. First, it has been shown that dysfunctional regulation strategy (e.g., rumination, suppression) can lead to depressed mood [44–46]. Second, this subcomponent notably allows evaluating the strategy of affective state regulation [9]. We have shown that regulation strategy could be based on a dual-process of reasoning. Therefore, the underlying reasoning abilities of EI could influence mood through a dual-process of reasoning.

The *facilitating* subcomponent corresponds to the capacity to use the current affective state to optimize problem-solving. For example, it has been shown that positive mood promotes a global information processing whereas negative mood promotes local information processing ([9]; see also [47] for a review). However, when Huntsinger and colleagues primed a local focus, they reversed the link between mood and global-local processing [48]. That is, participants in positive mood had a greater local focus than participants in negative mood. Thus, the authors proposed that positive mood promotes the processing of more accessible information [48]. This is consistent with the proposition that positive mood promotes the use of System 1 process whereas negative mood promotes the use of System 2 process. Conversely, it has been shown that participants with an induced global processing had higher positive moods than participants with an induced local processing [49]. Therefore, the affective state is used to process information in a specific manner. Reciprocally, how information is processed can induce a specific mood state.

The *perceiving* subcomponent of EI [9] can also influence mood. For example, it has been shown that perceiving happy faces after negative mood induction can lead to mood repair [50]. Likewise, perceiving happy faces increased positive mood and decreased negative mood in both participants with and without depressive symptoms, whereas perceiving sad faces decreased positive mood and increased negative mood in such participants [51].

### 3.3 Summary

In this section, we reported evidence suggesting that the way we reason contributes to regulating our mood states, and this is partly achieved by EI (**Figure 2**). Indeed, empirical studies from cognitive science and theoretical evidence from psychopathology demonstrate that how people perceive, manage, use and understand emotion, influences their mood states. Such influences could be underlain by the goal of mood regulation. EI-related reasoning can lead to mood improvement. This new mood will influence reasoning in a new way. It should be noted that the reasoning process depends on the pre-existing mood. Indeed, the latter can influence the effectiveness of the former. For example, the cognitive load preventing System 2 from correcting the negativity bias of System 1 could be caused by an already deeply entrenched negative and depressed

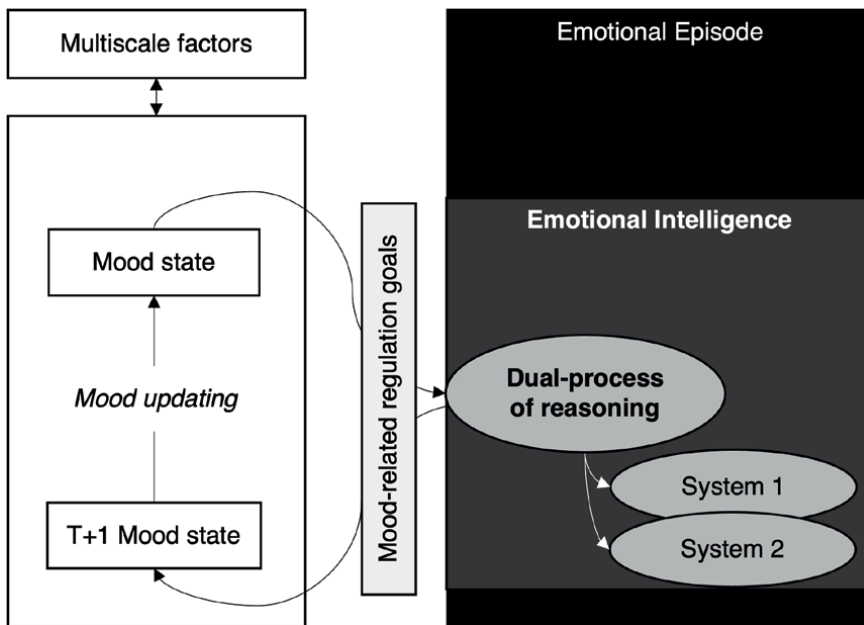


**Figure 2.** Influences of EI-related reasoning processes on mood through dual-process of reasoning with the goal to regulate mood.

mood. For example, it has been shown that System 2 is helpful for the perception of facial emotion [11]. However, patients suffering from major depressive disorder exhibit impairment in the recognition of happy facial expressions (e.g., [52]). Just like patients suffering from autism spectrum disorder (see [11]), depressive patients could use System 2 to relearn to flexibly perceive facial expressions, including emotionally positive parts of the stimulation. In a retroactive manner, this could improve their mood, likely reducing the negativity bias and thus further enhancing their ability to perceive positive emotions. Overall, there would be a kind of cycle including both mood and reasoning, in the context of need regulation, which dynamically and in real-time enacts EI.

#### 4. EI enactment from mood-reasoning loop

The key proposal of this chapter is the understanding of EI as a purposeful ability. In relation with mood, EI is characterized by the purpose of need regulation and mood state. Based on those principles, it is necessary to conceptualize EI within a complex and dynamic framework. We propose a model of EI building upon past dynamic models [10, 11], with a specific focus on the mood scale. Prior to an emotional event, individuals already experience a mood state that can influence their emotional reaction to stimuli. The end of the emotional event can modify the dynamics of the mood state, acting as a residual effect of the emotion.



**Figure 3.** Hypothetic enactive model of EI. EI emerges from pre-existing mood state during an emotional episode through the mobilization of dual-process of reasoning attuned to needs-related mood regulation. EI reasoning abilities release a residual mood ( $T + 1$ ) from dual-process of reasoning with the goal of regulating mood. There is an updated mood which will participate in the emergence of the EI during the next emotional episode, creating a cycle. Therefore, we have a dynamic and contextual emergence of EI, embodied in the regulation of needs-related mood. Note. The mood state does not only depend on the processes occurring within an emotional episode. It also depends on other multiscale factors that account for the emergence of mood besides the emotional episode (e.g., need frustration or satisfaction).

Mood → EI		EI → Mood	
Topics	Example of study	Goal and involvement	Topics
Interaction between task relevance and induced mood influence on reasoning	Study the interaction between induced positive mood and task relevance	<ul style="list-style-type: none"> <li>Past studies focused on induced negative mood</li> </ul>	The influence of each EI-related reasoning processes on mood
		<ul style="list-style-type: none"> <li>Improve our understanding of processes that underly mood influence on reasoning</li> <li>Support the dynamic and nonlinear conceptualization of EI</li> </ul>	Perceiving: Assess the extent to which the manipulation of positive/negative faces perception influences negative/positive moods
	Operationalize the relevance with needs-related mood regulation	<ul style="list-style-type: none"> <li>Assess the goal-relevant effect hypothesis</li> </ul>	Facilitating: Expand research showing that global/local focus can influence mood
		<ul style="list-style-type: none"> <li>Support the dynamic and nonlinear conceptualization of EI</li> </ul>	Test hypothesis that using emotion to facilitate cognitive process can update mood state
The influence of mood on EI-related reasoning processes	Assess the causal influence of induced positive/negative mood on emotion perception, use, recognition and regulation.	<ul style="list-style-type: none"> <li>Provide a clear empirical framework of the influence of mood on EI-related reasoning</li> </ul>	Understanding: Pursue research showing that event appraising influences mood and determines the involved reasoning process
		<ul style="list-style-type: none"> <li>Help practitioners in clinical practice to determine the extent to which the current patients' mood state is involved in their success or failure</li> </ul>	Assess the involvement of dual-process of reasoning in this hypothesis Test hypothesis that managing emotion can update mood state

**Table 1.** Future research prospects in the field of EI to assess the hypothetical enactive model of EI presented in the current chapter.

We propose that pre-existing mood prior to the emotional episode enacts the EI during the emotional episode. To do so, mood influences System 1 and System 2 processes that underpin reasoning processes of EI. Such influence has a teleological function to regulate mood. In other words, the dual-process of reasoning is attuned to need-related mood. EI is enacted from this teleological attunement. The reasoning processes during emotional episode, underpinned by System 1 and System 2, could influence mood after the emotional episode. There would be residual mood from this emotional episode, depending on the deployed dual process and its effectiveness. This updated mood influences future reasoning processes during the emotional episode in a new manner, and so on (**Figure 3**).

## **5. Concluding remarks**

To conclude, we recommend conceiving EI as a dynamic ability that emerges from various influences, such as, among others, internal mood and reasoning processes. In this teleological approach to EI, System 1 and System 2 processes are attuned to need-related mood regulation. Retroactively, reasoning processes underpinning EI can influence mood through dual-system process of reasoning. Therefore, EI would be enacted from both mood and reasoning processes. Subsequent mood states, resulting from the latter processes could then modify reasoning processes involved in EI in a new manner. Thus, there are mood-reasoning loops ruled by the teleological function of cognition, from which EI is enacted (**Figure 3**).

This model paves the way for numerous future research prospects in the field of EI (see **Table 1** for a nomenclature and examples of future direction). Future research should experimentally assess the proposed model. Although this model is derived from empirical studies, it remains hypothetical. Further studies are needed to systematically test this model.

At the clinical level, such a view on EI offers promising insights for enhancing the assessment of EI. It emphasizes: (a) the context-sensitive feature of EI; (b) the need to consider mood state as a factor that influences EI performance; (c) the need to distinguish performance from ability. That is, it is not because an individual fails in a given task that they have poor EI abilities. Rather, the failure may be due to contextual factors (e.g., negative mood). They could be capable of succeeding in a different context.

This tentative model presents a theoretical contribution to our understanding of EI. By focusing on the reciprocal and dynamical relationships between mood and the dual-process of reasoning, it expands our view of EI as a purposeful, context-sensitive and dynamic ability. This complex and dynamic theoretical framework provides a deeper understanding of *how* and *why* EI could be enacted.

## **Conflict of interest**

The authors declare no conflict of interest.

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Section 2

Emotional Intelligence in  
Applied Settings

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# Could Emotional Intelligence and Period of Year Influence Clothing Color Selection?

*Terumi Konno, Koichiro Kakiyama and Yasuhiro Kawabata*

## Abstract

Human emotional intelligence manages one's own emotions and determines appropriate behavior in social life. This study investigates whether emotional intelligence and period influence the factors of clothing color selection. Different frameworks and situations were represented, and they were limited to regular examination periods for college students. The purpose of the study was to compare and evaluate how the tension factor, which is generally expected to increase during the examination period, makes a difference in the choice of clothing color. Experiment 1 was conducted during the regular period ( $n = 103$ ) and the examination period ( $n = 107$ ). Analysis of the collected data for the 13 hues showed a significant increase in the percentage of G (green) and W (white) jackets during the examination period. Conversely, the use of N (gray) and Bk (black) decreased significantly. In Experiment 2, we investigated the reasons for the choice of clothing color. In the regular period, the main reasons for choosing the color of clothing were the person's preference (23.8%). However, 70.6% of the subjects in the examination period cited their mood, compared to 4.8% in the regular period. These findings suggest that the difference in the choice of clothing color in both periods could be influenced by emotional intelligence.

**Keywords:** clothing color selection, three color attributions, state of tension, mood, emotional intelligence

## 1. Introduction

People have the opportunity to choose and decide their own actions in every situation. In such cases, they may choose to collect a large amount of information, or they may choose according to their own moods and feelings. High emotional intelligence enriches people's lives [1]. Understanding one's current situation and having an accurate grasp of one's emotions leads to appropriate behavior [2]. Meyer [3] describes emotional intelligence as a capacity consisting of four aspects. The first is emotional perception, the second is emotional assimilation, the third is emotional understanding, and the fourth is emotional management. This chapter discusses the relationship between clothing color choice and emotional intelligence. Specifically, we investigated college students' clothing color choices in two situations in their lives. While the regular period is characterized by neutral emotions, it is easy to imagine

that the exam period elicits different emotions than the regular period, such as nervousness, to varying degrees related to the exam outcome of grades [4]. Therefore, we hypothesized that people would use their emotional intelligence to perform actions to correctly perceive and appropriately manage their emotions, i.e., that they would select clothing colors appropriate to the situation rather than perceive and appropriately manage their emotions. Therefore, we conducted an experiment to compare differences in clothing color choice during both periods.

In general, people have the opportunity to choose the color choice of their clothing, and their criteria vary from person to person. Daily clothing choices can be divided into three categories: (1) personal factors, (2) functional factors, and (3) social factors.

(1) Personal factors are fundamentally free from external constraints. Clothing is each person's identity, preferences [5–8], and own mood.

(2) Functional factors are influenced by seasons and weather. Specifically, people may give up wearing clothes made of water-sensitive materials or in water-sensitive colors during inclement weather, such as heavy rain.

(3) Social factors are elements of social constraints on clothing, indicated by codes such as TPO (Time, Place, Object principle) that are linked to the cultural background of a country or region. For example, there are color codes for ceremonial occasions. In some places, these codes are strict. At a Japanese wedding, it is taboo for the invited women to wear the same white color as the bride, and at a funeral, the color for attendants is black. The main factors in clothing selection are design (shape) and color (hue). Kashem [9] reports whether university students are influenced in their behavior by their teachers' attire. Teachers who dress formally are respected by students and influence the educational environment. Related research has shown that women wearing masculine clothing during job interviews are more likely to be hired [10], whereas those wearing feminine clothing at work are considered inferior in ability. Glick et al. [11] reported that when college students were shown images of four kinds of managers and receptionists in either sexy or business-like fashion (based on two clothing conditions and two occupation conditions) and asked to rate each of them, they reported that their reaction was judged to be incompetent for managers wearing sexy fashion. These results suggest that sexy attire harms women in higher-status jobs but not women in lower-status jobs. In other words, this is an example of how TPO involving the same clothing style can have diametrically opposite impressions on different individuals and groups. The wearing of different colored clothes by the same person influenced the rating of likability by others. Those wearing yellow clothing were reported to be rated less favorably by others than those wearing other colors. As a result, when wearing yellow, the person's evaluation became lower. In other words, this is an example of hues affecting other people's evaluations [12]. The social factor provided by the presence of others and what people believe those others think of their clothes can affect judgment. People may choose their attire based more on the impression they think they cause on others than on their preferences because they may consider that the impression others have depends on the design and color of their clothing in formal situations. According to Ofori et al. [13], a survey of university students in Ghana to determine their level of appropriate knowledge about textiles and clothing found that 69% of students lacked knowledge about clothing choices, colors, and good attire. They also reported that 85% of students wear different clothing at home and at university, suggesting the educational system and religious and social pressures may be determining their choices.

According to Maeda and Noguchi [14], although there were some gender differences in the items that university students and the public place importance on when

wearing clothing, >65% of respondents in the questionnaire regarded personal factors, such as design, as the most important factor related to clothes. The second major factor was social factors, such as location and opportunity, for ~46% of male students and 65% of general women. Weather, a functional factor, along with comfort, was ranked third by >40%, followed by size (approximately 35%), which is both a personal and functional factor. The physical condition was cited as a reason by less than 5% of the respondents, a minority. In terms of personal factors, some studies have investigated changes in physiological responses and task performance before and after wearing clothing [15]. For example, clothing one likes or dislikes has psychological and physiological effects, increasing amylase in saliva and stress scores. In a gender comparison of personal factors in clothing color selection, Karita and Murakami [16] reported that women tend to place more importance on “recommendation by others,” “aesthetics,” and “moderation,” whereas men tend to assign much less value to these factors.

Several other studies have investigated changes in physiological responses and task performance before and after wearing clothing [17–18]. In a study on the influence of color on athletic performance and task performance, the effect of color on athletic performance was examined in the Olympic martial arts performance of athletes wearing blue and red uniforms [19]. When competencies were very similar, the higher winning percentage of the red uniforms was associated with competition performance. A color mechanism to explain this result is that wearing red is reported to enhance testosterone, which is associated with dominance and aggression. Another study found that the clothing worn affected performance on a cognitive task, with subjects wearing a doctor’s white coat showing enhanced levels of sustained attention and an increased number of errors found in a choice task compared to those wearing regular clothing [17]. This suggested that the color of the clothing could increase performance. When looking at red in the context of achievement, some studies have reported that it affects performance on difficult tasks that require mental manipulation and flexibility [20–22]; Elliot et al. examined the effect of red and other color stimuli on task outcomes after showing participants red and other color stimuli and found that red performed worse on anagrams, analogies and math tasks compared to green and achromatic control color [20]. They reported that the reason for this red effect might be that red is associated with failure and danger [21]. However, regarding this red effect, Gnambs [22] conducted a meta-analysis of previous major studies on color and task performance. He found no effect for anagram and knowledge tests and reported a weak effect only for reasoning tasks, raising doubts about the actual color effect. Some studies have also reported the effects of blue compared to red and achromatic colors. Jung [23] found that in the different color conditions (blue, red, and achromatic), video viewers in the blue condition and their resulting word recognition task performance were better than those in the red condition, and further, word recognition task performance in the blue condition was better than word recognition task performance in the other color conditions.

Past research has investigated personal factors in clothing selection and its implications in fulfilling cognitive tasks; however, little of that research has reflected on the participants’ intentions in selecting clothes. Only a few studies have verified that participants make clothing color choices willingly under certain circumstances. No single factor determines color choices based on people’s situations. We can infer that color selection responds to a complex combination of personal, functional, and social factors and that the order of priority changes subject to time, place, and situation. Except in situations where the impression one makes on others is important, such as

at work or in a job interview, personal factors such as preference and intentions, such as being in line with one's own mood, are thought to take precedence.

Several studies on color and emotion have demonstrated that positive emotions make people choose brighter colors, while negative emotions make people prefer darker tones [24–27]. Our physical and mental state, including mood and physical aspects, influence our behavior. In other words, if we consider this color choice in the same way as we consider color choice in clothing, we may choose brighter-colored clothing when we are in a positive mood. When we are in a negative mood, we may subconsciously want to wear darker colors. Jonausukaite et al. reported the correlation between color and mood [28], participants were first exposed to music and reading that induced four mental states: joy, relaxation, fear, and sadness. They then selected seven chromatic colors and achromatic colors on a display that were appropriate for that emotion. The results showed that warm colors, such as yellow, were associated with the sensation of joy. Saturated colors were also shown to correlate with joy and relaxation.

In terms of emotional intelligence, people strive to manage their behavior appropriately and keep it at its best. Therefore, the purpose of this study was to explore the effects of emotional intelligence and period on clothing color choice. Based on the above, Experiment 1 investigated university students' clothing color at different time periods. Different periods may have different emotions, and we examined whether one's cognition can manage these changes and choose clothing colors in line with one's emotions; in other words, choose the appropriate behavior for that period. The subjects were university students, who are less likely to be influenced by social factors in their clothing choices. Naito [29] reported that university students tend to dress similarly to how they dress when going to school or to department stores and are less likely to be influenced by social influences. The periods were limited to university students' regular periods and exam periods, when emotions were likely to change dramatically. We sought to compare and evaluate how the element of tension, which is generally expected to be heightened in exam period situations, makes a difference in color choice. In terms of tension, a study of psychological changes between regular periods and exam periods at a physical therapist training facility found that students tended to be more anxious and depressed during exam periods than during regular periods [4]. Another related study similarly found that students were more nervous and stressed during exam periods [30]. Interestingly, an Internet search for ways to relieve anxiety and tension during exam periods in Japanese yielded 324,000 hits [31].

Examination periods differ from regular school life in terms of mental and physical conditioning. While many people approach exams with the expectation of relieving pressure and anxiety, others approach exams as some sort of challenge to boost their mood and motivation. Based on the above, Hypothesis 1 clarifies whether the selection rate of the color of the clothing during regular and exam periods is different. For Hypothesis 2, based on anxious feelings during the exam period [30–31] and previous research showing that negative feelings tend to choose darker colors [24–27], it is decided to clarify whether the selection rate of the clothing color of the dark color will increase during the exam period. For this reason, we divided the data collection period into the regular period and the exam period. In Experiment 1, the method of data collection and the number of students differed during both periods. The PCCS199a color cards (hereafter referred to as "color cards") were used to collect data during the regular period. The PCCS199a color cards are color cards based on the color scheme system of the Japan Color Research Institute. This color system represents colors in terms of hue and tone. Tone is a grouping of lightness and saturation,

and colors that give the same impression are grouped together regardless of their hue. Students evaluated the color of their clothing and visually compared the color card that was closest to the color of their clothing. They then selected that color card and pasted it on the paper. In contrast, no cutting and pasting was done during the exam period. An answer about the color of the clothing was added to the end of the answer sheet for the medical color test question. The 3 cm square and PCCS symbols identical to those on the color card were printed on the answer sheet, and the participants were asked to write only the symbols in the answer box. This was done because we did not think it appropriate to use scissors or perform other detailed tasks in the tense situation of the test. However, since the task of selecting colors from the printed materials had been done during the previous regular period and was found to be an appropriate response for color selection, this method was used during the exam period. In addition, 103 subjects for the regular and exam periods were the same students, while four were present only during the exam period. Therefore, the data for both periods were analyzed by independent analysis with an unpaired t-test and a chi-square test, rather than by within-subjects analysis.

In Experiment 2, we test whether the choice of clothing color has any relationship with emotion management in emotional intelligence. The aspects of emotional intelligence are: first, emotion perception; second, emotion assimilation; third, emotion comprehension; and fourth, emotion management. In this experiment, it is inferred that emotions differ significantly during different periods of time: regular college periods and exam periods. We will investigate what they used as the basis for their decisions to perceive, understand, and manage their emotions, taking appropriate actions. In other words, Hypothesis 3 reveals that emotional intelligence influences the behavior of clothing color selection. Specifically, participants were asked to recall scenes from the regular and test periods and were asked about the color of their clothing and the reason for their choice. Participants in Experiment 2 differed from those in Experiment 1. The participants who recalled scenes from the two periods were identical, and the method of analysis was independent analysis with a chi-square test.

## **2. Experiment 1**

### **2.1 Methods**

Two groups of students were selected covering the regular and examination periods: the regular period (103 students, 57 males, 46 females,  $M = 19.25$ ,  $SD = \pm 0.81$ ) and the examination period (108 students, 58 males, 50 females,  $M = 19.24$ ,  $SD = \pm 0.87$ ) from July to August 2018 who had taken “medical color,” which is a compulsory elective subject for university students. Information on the color of the upper and bottom clothing was collected, and clothing data from both periods were compared. Before the experiment, the participants were informed that the survey was being conducted strictly for research purposes and that their participation would not be related to their grades. The number of participants for each period differed because not all students attended during the regular period.

During the regular period, the weather conditions were cloudy skies, a temperature of 19°C, and a humidity of 82%. Participants first used a PCCS199a color card (hereafter referred to as a “color card”). Initially, they evaluated the color of their clothing, compared the most visually similar color card, and selected a color slip that approximated their clothing color. Next, the selected color chart was cut out into a

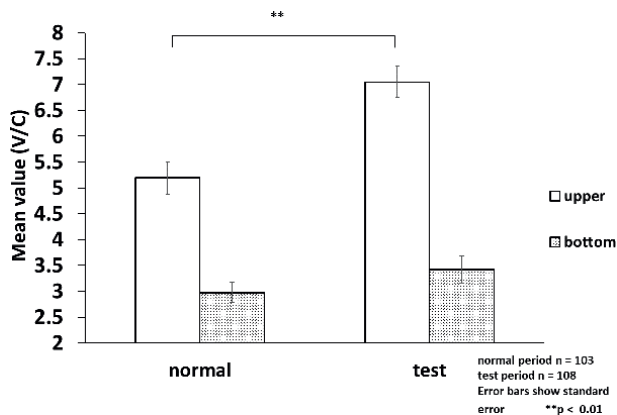
1-cm square and pasted on a questionnaire, and the PCCS symbol was entered in the bottom column. If the clothing color was multicolored, the color with the largest area was pasted. If the ratio was the same for the two colors, it was cut into half the size and pasted on the questionnaire.

During the examination period, the weather was sunny, with a temperature of 21°C and a humidity of 63%. Participants could confirm that there was no mistake in cutting, pasting, and entering the PCCS symbol in the regular period experiment; hence, the visual comparison of the samples with a color card was completed. The students were asked to fill in only the PCCS symbol in the answer column without cutting and pasting the results. The color card indicated was chosen because it is the most used color chart in Japanese educational settings, whereas the Munsell color system has many color cards. It was thought that it would be difficult for non-expert participants to use a different chart. The color card in this experiment facilitates the selection of 199 cards, making the color-matching process more manageable. The color data obtained for the upper and bottom clothing, identified as tones and color symbols of the PCCS color card, were converted into Munsell values.

## 2.2 Results

### 2.2.1 Differences in the hue of the clothing during the regular and examination periods

Using the Munsell values written on the color card for the brightness and saturation of clothing, we examined how much the upper and bottom clothing differed between the regular period and the examination period. The theoretical brightness of the Munsell values is 0–10, and the saturation is 0–14, but since the range is narrowed when it is a paper color sheet, the brightness is shown as 1–9.5, and the saturation is indicated by the Munsell value of 0–14. The difference between the means of the two periods was analyzed via independent samples t-test. Consequently, the brightness of clothing (**Figure 1**) in the case of the upper clothing increased by 1.20 during the examination term when compared with that during the regular period, showing a significant difference (**Table 1**). The bottom clothing increased by 0.45, but no remarkable change was appreciated (upper clothing:  $t = 4.69$ ;  $p < 0.01$  ES: *Cramer's V* = 0.46;

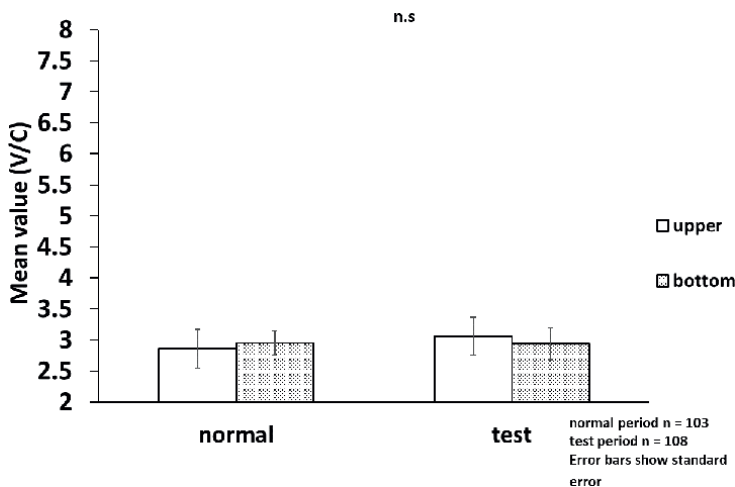


**Figure 1.** Mean value of the brightness of the upper and bottom clothing during the two periods. \*\* indicates  $p < 0.01$ . Error bars are standard errors. (the same is shown hereafter.) In the figure below, examination is abbreviated as exam.

<b>Brightness</b>			
	<b>Mean</b>	<b>SD</b>	<b>SE</b>
Upper (n = 103)			
Regular	5.20	3.17	0.31
Exam	7.05	3.03	0.30
Bottom			
Regular	2.98	1.94	0.19
Exam	3.42	2.64	0.26
<b>Saturation</b>			
	<b>Mean</b>	<b>SD</b>	<b>SE</b>
Upper (n = 107)			
Regular	2.86	4.10	0.41
Exam	3.06	4.74	0.47
Bottom			
Regular	2.95	3.29	0.32
Exam	2.94	4.05	0.40

**Table 1.**  
 Residual analysis value of the color of the upper and bottom clothing for the two periods. The above table shows brightness and the below table shows saturation. In the table below, examination is abbreviated as exam.

bottom clothing:  $t = 1.50$ ;  $p = 0.13$ ). As far as saturation is concerned (**Figure 2**), the average value of the upper clothing increased by 0.20 during the examination period compared to the regular period. There was no notable difference. The mean value of the bottom item decreased by 0.009 during the examination period compared to the regular period; moreover, there was no significant difference (bottom:  $t = 0.31$ ;  $p = 0.75$ ; bottom:  $t = 0.02$ ;  $p = 0.98$ , ES: *Cramer's V* = 0.15, respectively).



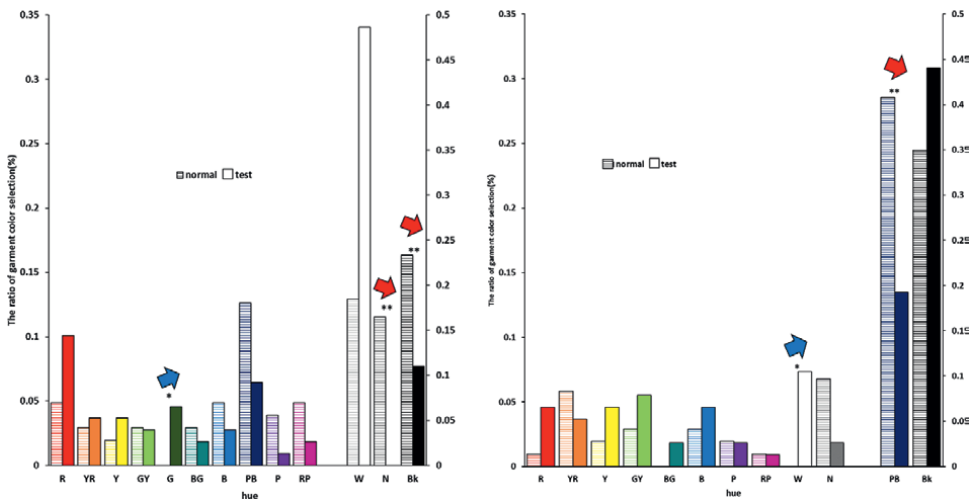
**Figure 2.**  
 Mean value of the saturation of the upper and bottom clothing during the two periods.

### 2.2.2 Differences in the hue of the clothing during the regular and examination periods

To examine the association between period and color of the clothing, an independent samples chi-square test was used to analyze the results. The periods were the regular and the exam period, and for the hues, a total of 13 hues were used: 10 colored hues (R, YR, Y, GY, G, GB, B, PB, P, and RP) and three achromatic hues (W, N, and Bk) (**Figure 3**). The results were significant for upper clothing:  $\chi^2(12) = 50.64$   $p < 0.01$  ES: Cramer's  $V = 0.49$ . For bottom clothing:  $\chi^2(11) = 27.19$   $p < 0.01$  ES: Cramer's  $V = 0.35$  (G was not selected, so the degree of freedom was 11), indicating that it is significant. In other words, it was clear that there was a relationship between the period and the hue of the selected clothing. Having established the relationship between period and the color of the clothing, a crosstabulation analysis [31–35] was continued to see where the association existed (**Table 2**). Comparing the count of observations and expected counts during the exam period, the observed and expected counts of G for the upper clothing were 5 and 2.5, respectively, significantly increased ( $p < 0.05$ ). Similarly, the observed and expected counts for N were 0 and 8.7, respectively, significantly decreased ( $p < 0.01$ ); the observed and expected counts for Bk were 12 and 18.3, respectively, significantly decreased ( $p < 0.01$ ). The exam period counts for bottom significantly increased ( $p < 0.05$ ), with 8 observed and 4.1 expected for W, and significantly decreased ( $p < 0.01$ ) with 21 observed and 32.4 expected for PB.

### 2.2.3 Differences in the tone of the clothing during the regular and examination periods

The same data were then analyzed using the chi-square independence test to examine the relationship between period and color tone. The color tone system is

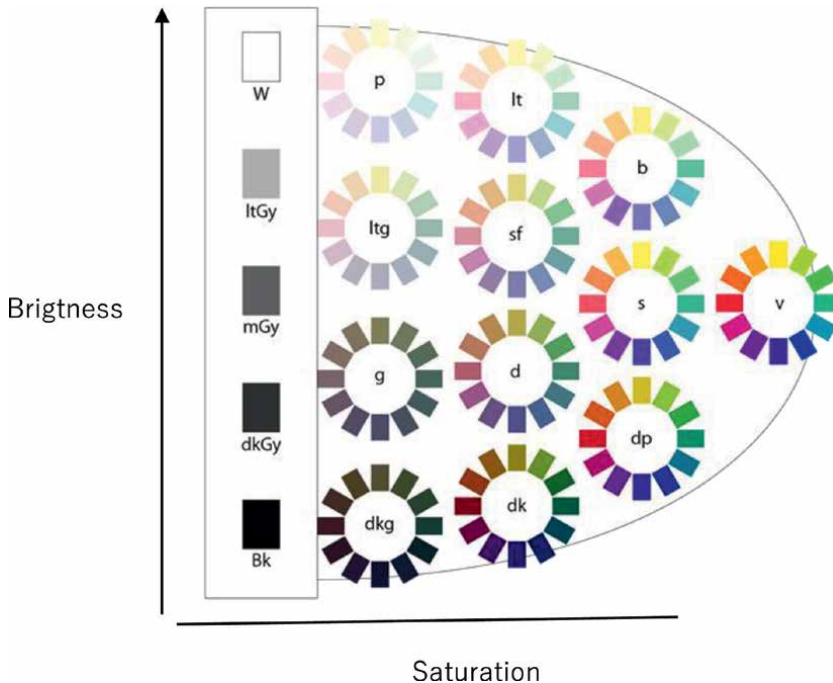


**Figure 3.** Ratio of the hue of upper and bottom clothing between the regular and examination periods. The left figure shows the color of the upper clothing. The right figure shows the color of the bottom clothing. (The left bar shows the regular period, and the right bar shows the examination period; \* indicates  $p < 0.05$ ; \*\* indicates  $p < 0.01$ .) The blue arrows indicate a significant increase. The red arrows indicate a significant decrease. The value of N is 0 in the examination period for the upper clothing, and the value of W is 0 in the regular period for the bottom clothing.

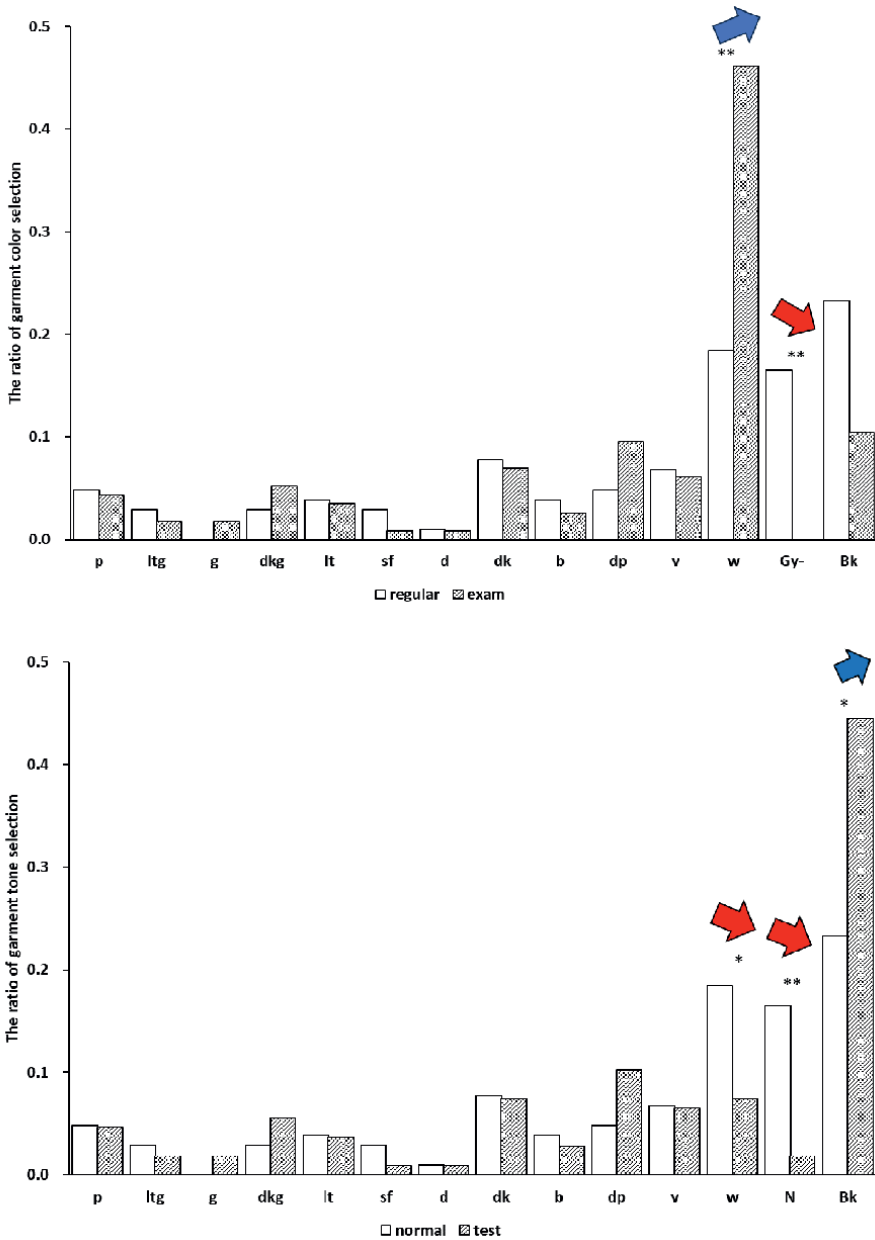
	R	YR	Y	GY	G	BG	B	PB	P	RP	W	N	Bk	Total
Count	5	3	2	3	0	3	5	13	4	5	19	17	24	103
Expected count	7.8	3.4	2.9	2.9	2.5	2.5	3.9	9.8	2.5	3.4	35.3	8.3	17.7	103.0
Count	11	4	4	3	5	2	3	7	1	2	53	0	12	107
Expected count	8.2	3.6	3.1	3.1	2.5	2.5	4.1	10.2	2.5	3.6	36.7	8.7	18.3	107.0
Count	16	7	6	6	5	5	8	20	5	7	72	17	36	210
Expected count	16.0	7.0	6.0	6.0	5.0	5.0	8.0	20.0	5.0	7.0	72.0	17.0	36.0	210.0
	<b>R</b>	<b>YR</b>	<b>Y</b>	<b>GY</b>	<b>G</b>	<b>BG</b>	<b>B</b>	<b>PB</b>	<b>P</b>	<b>RP</b>	<b>W</b>	<b>N</b>	<b>Bk</b>	<b>Total</b>
Count	1	6	2	3	0	0	3	42	2	1	0	7	36	103
Expected count	2.9	4.9	3.4	4.4	0.0	1.0	3.9	30.6	1.9	1.0	3.9	4.4	40.8	103.0
Count	5	4	5	6	0	2	5	21	2	1	8	2	48	109
Expected count	3.1	5.1	3.6	4.6	0.0	1.0	4.1	32.4	2.1	1.0	4.1	4.6	43.2	109.0
Count	6	10	7	9	0	2	8	63	4	2	8	9	84	212
Expected count	6.0	10.0	7.0	9.0	0.0	2.0	8.0	63.0	4.0	2.0	8.0	9.0	84.0	212.0

**Table 2.** Clothing color \* periods crosstabulation. The upper table shows upper clothing, and the lower table shows bottom clothing.

a system of color combinations defined by the Color Institute. It groups combinations of color brightness and saturation and classifies each group as a group of color that give the same impression (**Figure 4**). The results show that the color tone of the upper clothing was  $\chi^2 (13) = 30.82 p < 0.01$  ES: *Cramer's V* = 038. There was a significant relationship between color tone and period for the bottom clothing color tone with  $\chi^2 (13) = 30.00 p < 0.01$  ES: *Cramer's V* = 0.37 (**Figure 5**). Having identified a relationship between color tone and period, a crosstabulation analysis [31–35] was continued to see which variables were relevant (**Table 3**). Comparing the count of observations with the expected count, for upper clothing color tone, W was observed (53) and expected (36.7) and significantly increased ( $p < 0.01$ ) in the exam period, while N was observed (0) and expected (8.7) and significantly decreased ( $p < 0.01$ ) in the exam period. For the bottom color tone, “muddy shade d” was significantly reduced ( $p < 0.01$ ) with counts of observations (1) and expected counts (3.6) in the regular period, while “dark shade dk” was significantly reduced ( $p < 0.05$ ) with counts of observations (8) and expected counts (12.8) in the regular period. w was significantly increased ( $p < 0.05$ ) in the regular period with counts of observations (8) and expected counts (4.1). Previous studies have reported negative emotional states during the exam period [4], and that negative emotion leads to the selection of colors with lower brightness [24–27]. The color with the highest brightness was white, and the color with the lowest brightness was black. Assuming that the emotion during the exam period was negative, one would expect to see more black and lower tones in both upper and bottom clothing, but white increased in the upper clothing, while



**Figure 4.** Tone diagram (position of brightness and saturation). Vertical axis is brightness. The horizontal axis indicates saturation.



**Figure 5.** Percentage of clothing tones during the regular period and the examination period. The upper figure shows upper clothing, and the lower figure shows bottom clothing; (\* indicates  $p < 0.05$ ; \*\* indicates  $p < 0.01$ ). The blue arrows indicate a significant increase. The red arrows indicate a significant decrease. The value of N is 0 in the examination period shown above. The value of W is 0 in the regular period shown in the figure below.

muddy tone d and dark tone dk decreased in the bottom clothing. **Figure 4** shows that the brightness of these two tones also ranged from low to medium. In other words, Hypothesis 2 was not supported for color tone as well as brightness and hue.

Period		<b>p</b>	<b>ltg</b>	<b>g</b>	<b>dkg</b>	<b>lt</b>	<b>sf</b>	<b>d</b>	<b>dk</b>	<b>b</b>	<b>dp</b>	<b>v</b>	<b>w</b>	<b>N</b>	<b>Bk</b>	<b>Total</b>
Regular	Count	5	3	0	3	4	3	1	8	4	5	7	19	17	24	103
	Expected count	4.4	2.0	1.0	2.9	3.9	2.0	1.0	4.4	3.4	4.4	10.8	35.3	8.3	19.1	103.0
	Count	4	1	2	3	4	1	1	1	3	4	15	53	0	15	107
Exam	Expected count	4.6	2.0	1.0	3.1	4.1	2.0	1.0	4.6	3.6	4.6	11.2	36.7	8.7	19.9	107.0
	Count	9	4	2	6	8	4	2	9	7	9	22	72	17	39	210
	Expected count	9.0	4.0	2.0	6.0	8.0	4.0	2.0	9.0	7.0	9.0	22.0	72.0	17.0	39.0	210.0
Period		<b>p</b>	<b>ltg</b>	<b>g</b>	<b>dkg</b>	<b>lt</b>	<b>sf</b>	<b>d</b>	<b>dk</b>	<b>b</b>	<b>dp</b>	<b>v</b>	<b>w</b>	<b>N</b>	<b>Bk</b>	<b>Total</b>
Regular	Count	4	5	4	7	1	5	6	17	1	7	3	0	7	36	103
	Expected count	4.4	3.4	2.9	6.3	2.4	2.9	3.4	12.2	2.0	8.8	4.9	3.9	4.4	41.0	103.0
	Count	5	2	2	6	4	1	1	8	3	11	7	8	2	48	108
Exam	Expected count	4.6	3.6	3.1	6.7	2.6	3.1	3.6	12.8	2.0	9.2	5.1	4.1	4.6	43.0	108.0
	Count	9	4	6	8	4	2	9	7	9	22	72	17	39	208	211
	Expected count	9.0	4.0	6.0	8.0	4.0	2.0	9.0	7.0	9.0	22.0	72.0	17.0	39.0	208.0	211.0

**Table 3.** Clothing tone \* periods crosstabulation. The upper table shows upper clothing, and the lower table shows bottom clothing. The value of g is 0 in the regular period, and the value of g is 0 in the exam period shown above. The value of W is 0 in the regular period shown below.

## 2.3 Discussion

Experiment 1 investigated whether the period (regular or exam period) affected the color choice ratio of clothing in terms of brightness, saturation, and hue. Regarding brightness, the examination period was higher than the regular period, and the brightness of the upper clothing was significantly different between the two periods. In other words, a color was selected in the exam period that contained a greater percentage of white than in the regular period. Thus, Hypothesis 1 was supported. Next, we examined whether darker colors of clothing would be selected during the exam period compared to the regular period, and Hypothesis 2 was not supported. Previous studies have reported that the emotional state of university students during the study period was more negative [3]. Furthermore, several studies examining the relationship between emotions and colors [24–27] reported that negative emotions may lead to the choice of dark colors. Therefore, it was predicted that participants would choose dark colors for the clothes they wore during the study period, but in the present experiment participants did not choose dark colors. The results suggest that emotions may not have been as negative during the exam period. Alternatively, assuming that brightness is associated with positive emotions, participants may have chosen the color of their clothing for positive reasons, such as motivating themselves. No differences were found between the two periods in terms of color saturation. In other words, there was no difference in color choice with regard to being bright or not in the regular and exam periods, and no relationship between period and saturation. In this regard, the proportion of the choice of the color of the clothing was high for achromatic colors and low for chromatic colors in both periods, so there was no significant difference between the two periods. No difference was found between the two periods in color saturation. In other words, there was no difference in the choice of bright colors for the regular period and vice versa. There was no relationship between period and saturation.

As for hue, the hues of the examinees' clothing differed between the two periods, with four different hues selected for the upper clothing and two different hues for the bottom clothing, supporting Hypothesis 1. In other words, it may be inferred that the difference in the periods resulted in different emotional states and appropriate behavior in line with those emotions, i.e., different choices of the color of the clothing for the student's own clothing. In other words, it can be inferred that different periods of time resulted in different color choices for the candidates' own emotional states and appropriate behavior in line with those feelings, i.e. the choice of color for their clothing. Perhaps the difference in color choice was the result of students adopting measures such as using their own emotional intelligence and feeling more comfortable during the exam period. What do these differences in color choice during exam periods imply? In other words, it suggests that the examinees are accurately identifying their emotions and acting accordingly, thereby controlling their emotions and creating the appropriate situation. By hue, both the top and bottom of the spectrum show a higher percentage of W's worn during the exam period compared to the regular period. Studies have reported that viewing achromatic colors decreases heart rate in the short term, and it can be assumed that heart rate is generally more affected during exam periods than during regular periods [34]. The reason why students increased their choice of white during the exam period is unclear, but interestingly, it is consistent with research showing that achromatic colors relieve tension; studies have reported that G relaxes people, and that the color G is associated with a higher heart rate during the exam period than during the regular periods [35]. Therefore, for

the increased selection of G during the exam period, it is possible that people desired a relaxed state during that period. This may be because a moderate state of relaxation affects task performance. For example, in a study linking the colors Y, G, W, B, Bk, R, P, and N to electroencephalogram (EEG) [36], and in a study examining the relationship between the relaxing effects of beverage colors and EEG, the appearance of alpha waves was reported more frequently in clear containers with G-colored water. In this experiment on the color of drinking water, the green color was colored green with food dye, although the Munsell value and chromaticity were not specified. Therefore, assuming a relationship between the green color of drinking water and relaxation, the selectivity of G is obvious, but it is possible that clothing was selected for the same effect. However, other external factors, such as green being the fashionable color of the year, should also be considered. The above observations are only possible interpretations. To confirm this pattern, it is necessary to continue the experiment for multiple years to eliminate the factor of fashionable color.

Hypothesis 2 was not supported. For upper clothing, N and Bk decreased during the test period, while for bottoms, PB decreased during the test period. In other words, brighter colors tended to be chosen for the exam period compared to the regular period. Jeans are probably the first bottoms that come to mind for university students. If the wearing rate and color of jeans decreased during the exam period, the reason may lie not only in the color but also in the comfort of wearing them. The fabric or shape of the jeans may be too stiff or too constricting, making them unsuitable for sitting for long periods of time. Since the reasons for clothing choice are not only color but also texture and shape, this is a topic for future research.

Regarding tone, period was confirmed to affect the ratio of clothing color choice, supporting Hypothesis 1. For the upper clothing tones, the selection ratio of W ( $p < 0.01$ ) increased significantly during the exam period, while N ( $p < 0.01$ ) decreased during the regular and exam periods, compared to the regular period. For bottom clothing, the muddy shade d ( $p < 0.05$ ) and the dark shade dk ( $p < 0.05$ ) decreased during the exam period compared to the regular period. W ( $p < 0.01$ ) also increased (**Figure 5**). These results reveal the effect of period on tone and support Hypothesis 1. However, the results did not support Hypothesis 2. Although we expected a greater proportion of darker colors to be selected during the exam period, for upper clothing and bottom clothing, there was an increase in the lighter color group.

These results suggest that the time of year may alter the brightness (upper clothing), hue (upper and bottom clothing), and tone (upper and bottom clothing) of the clothes' colors. In other words, differences in emotional states at different times of the year may influence the Color of the clothing in different periods. In other words, it is suggested that participants used their emotional intelligence to clarify their own current situation and to make a decision about their behavior in choosing the color of their clothing. However, it is not clear whether this emotional intelligence influenced the choice of clothing color, unless the reasons for the choice of clothing color are questioned. Therefore, we decided to conduct Experiment 2.

### **3. Experiment 2**

The results of Experiment 1 revealed that the choice of clothing color varies with the time of year. However, it is unclear whether there is an effect of emotional intelligence. It is possible that students feel a change in their own emotional state that is different from their usual state during exam periods and use this as a criterion for

choosing the color of their clothing. Therefore, in Experiment 2, we aimed to determine whether emotional intelligence influences the choice of the color of the clothing and whether the reasons for choosing the color of the clothing differ between the normal and exam periods (Hypothesis 3). Participants were asked to indicate what color of clothing they intended to wear to school during regular exam periods and periods. For the exam period, participants were asked to imagine taking a memorization test and were asked what color clothing they would choose on the morning of the exam period and why. Participants were different from those in Experiment 1.

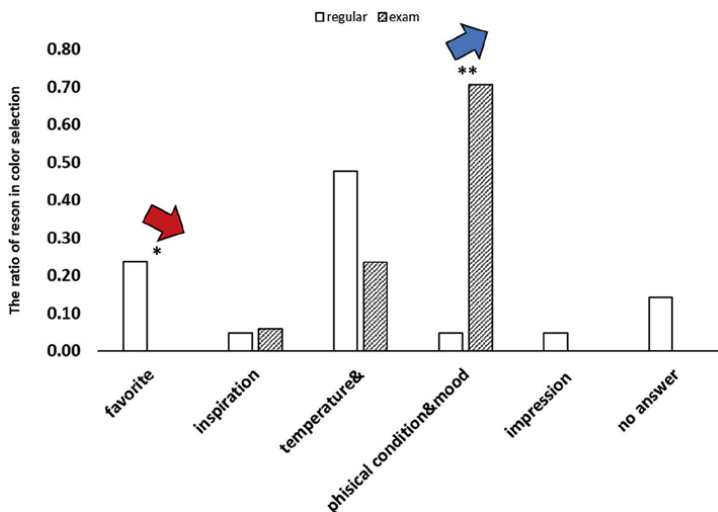
### 3.1 Methods

#### 3.1.1 Participants

Participants (6 males, 10 females, 1 no response, mean age;  $M = 19.63 \pm SD 1.02$ ) in April 2022 who had taken “Practice in Psychology”. Participation in the experiment was voluntary and could be interrupted during the experiment. The experiment was not graded and was unpaid.

#### 3.1.2 Procedure

The exercise was conducted in the morning when the temperature was  $\sim 20^{\circ}\text{C}$ , and the humidity was  $\sim 50\%$  in sunny weather. The location of the interview was Sapporo City (Japan). Information on the color of the upper and bottom clothing was collected, and clothing data of both periods were compared in Experiment 1. Before the experiment, the participants were informed that the survey was being conducted strictly for research purposes and that their participation would not be related to their grades. The total number of reasons for the responses in the two periods differs because there were multiple responses.



**Figure 6.** Percentage of reasons for choosing the color of clothing during the regular period and during the exam period; (\* indicates  $p < 0.05$ ; \*\* indicates  $p < 0.01$ ). The blue arrows indicate a significant increase. The red arrows indicate a significant decrease. The values of “favorite,” “impression,” and “no answer” are 0 during the examination period.

Period		Reason							Total
		Favorite	Inspiration	Temperature	Physical	Impression	No answer		
Regular	Count	5	1	10	1	1	3	21	
	Expected count	2.8	1.1	7.7	7.2	0.6	1.7	21.0	
Exam	Count	0	1	4	12	0	0	17	
	Expected count	2.2	0.9	6.3	5.8	0.4	1.3	17.0	
Total	Count	5	2	14	13	1	3	38	
	Expected count	5.0	2.0	14.0	13.0	1.0	3.0	38.0	

**Table 4.**  
The reason of color selection \* periods crosstabulation.

They were asked about the reasons for choosing the color of their upper and bottom clothing during the two periods the questions were answered by the following. Six options were used, namely, (1) the color of the clothes, (2) intuition, (3) temperature, (4) mood, (5) impression from others, and (6) other reasons (multiple answers were given) (Table 3). In addition, respondents were also asked to give detailed introspection reports on the reasons for their selections by means of free-text descriptions.

### 3.2 Results

We analyzed the relationship between period and reasons for choosing the color of clothing with a chi-square independence test (Figure 6).

The results showed a significant difference at  $\chi^2(5) = 20.69, p < 0.01$ , ES: Cramer's  $V = 0.74$  (Table 4). It was clear that the reasons for the choice of clothing in the two periods differed. We continued the analysis using crosstabulations to see which reasons for the choice of clothing were affected by the period. Regarding the choice reasons, favorites were significantly reduced ( $p < 0.05$ ) in the count of observations (0) compared to the expected count (2.2) during the study period. Physical condition and mood increased the expected count observed during the study period (12) compared to the expected count (5.8). ( $p < 0.01$ ) In other words, duration affected the reasons for color selection, with a decrease in the selection reason of favorite and an increase in the selection reasons of physical condition and mood during the exam period.

The total count of reasons for the responses in the two periods differs because there were multiple responses. The values of "favorite," "impression," and "no answer" are 0 during the examination period.

### 3.3 Discussion

Experiment 1 suggested an effect of period on the choice of the color of the clothing, Experiment 2 examined the effect of emotional intelligence. To this end, we examined students' reasons for choosing clothing color during regular and exam periods. For students taking exams, choosing a clothing color that may help them reduce anxiety, focus on tasks, and improve their academic performance is an important decision. This is especially significant if the exam is more important than expected. The results clearly showed that the reasons for clothing choice in both periods differed, suggesting the influence of emotional intelligence. Compared to the regular period, the percentage of reasons for choice decreased significantly from 30 to 0% for "I like the color of the clothes" in the test period. In addition, "physical condition" and "mood" significantly increased from 9% to 70.6%. In other words, during the exam period, respondents did not indicate any preference for the color of the clothing. On the contrary, the percentage of respondents who chose the color of the clothing based on their physical condition and mood increased. This may be due to the lack of time to pay attention to clothing during the exam period, or it may be due to the use of emotional intelligence, a strategy to be comfortable and get good grades during the exam period. Furthermore, when participants were asked to give their reasons for choosing the color of their clothing, 10 of the 17 participants chose it to relieve tension or calm their mood, and four chose it to lift their mood or lift their spirits. These findings suggest that participants perceive their own emotions and select clothing colors in the most appropriate state for the test. Such emotion management has important implications for behavioral decision making. In other words, the study suggests that perceiving one's own emotions during the exam period and using them as a source of

information for one's behavior corresponds to a component of emotional intelligence: perceiving one's own emotions and managing those emotions for one's behavior. In other words, it is suggested that the participants rely on emotional intelligence to take the action of choosing the color of the clothing.

#### **4. Conclusion**

Experiment 1 examined whether different periods (regular or exam period) affect the ratio of clothing color choice in terms of brightness, saturation, and hue. It was suggested that brightness, hue and tone were affected. Therefore, Hypothesis 1 was clarified. Previous studies [24–27] have found a relationship between negative emotions and dark colors. However, the results were not consistent. The fact that the participants did not choose dark colors may indicate that there is no relationship between negative emotions and the choice of color (especially in this case, the color of clothing). It is also possible that they chose the color of their clothing for other reasons, such as to motivate themselves during the test period. No difference was found for saturation. This may indicate, for example, that even if there was a change in saturation, the proportion of achromatic colors (white, gray, and black) was high, and the change in chromatic colors could not be detected. Regarding hue, four different hues were selected for the upper clothing and two different hues for the bottom clothing. Next, Hypothesis 2 examined whether darker colors would increase the rate of choice of clothing color, based on the assumption that university students may experience negative emotional states such as nervousness during the exam period. However, Hypothesis 2 was not supported because the results showed an increase in white and a decrease in black.

The above results showed that the choice of the color of the clothing differed between the different periods, but the reason for this color choice was not clear. Therefore, in Experiment 2, we examined the influence of emotional intelligence. The emotional states of the participants differed between periods, and the appropriate behavior in line with their emotions, i.e., their reasons for color choice of the clothing, should be clarified to infer that the differences occurred. The reasons for the choice of the color of the clothing should be clarified. To this end, we investigated the reasons for students' choice of clothing color during regular and exam periods. For students taking exams, choosing a color of clothing that may help them reduce anxiety, focus on tasks, and improve their academic performance is an important decision. It was evident that the reasons for clothing choice during both periods differed. Comparing the percentages of reasons for choice with the regular period, "I like the color of the clothes" significantly decreased from 30 to 0% in the test period. In addition, "physical condition" and "mood" significantly increased from 9 to 74%. In other words, the reason for the choice may have influenced the color of the clothing. Furthermore, when participants were asked to provide their reasons for choosing the color of their clothing in an open-ended response, 10 out of 17 participants chose it to relieve tension or calm their mood, while four participants chose it to boost their mood or lift their spirits. These findings suggest that participants perceive their own emotions and select clothing colors in the most appropriate state for the test. Such emotion management has important implications for behavioral decision making. This experiment suggests that perceiving one's emotions during the examination period and using them as a source of information for one's behavior corresponds to the component of emotional intelligence: perceiving one's emotions and managing those emotions for one's behavior. The choice of clothing color and the reasons for it may have allowed the participants to perceive their emotions, understand their emotions, and take appropriate

action during the examination period. It is suggested that physiological and emotional intelligence may have influenced the choice of clothing color. The study revealed that the choice of clothing color and the reasons for the choice of clothing color allowed the participants to perceive their emotions, understand their feelings, and take appropriate action during the exam period. In other words, the results suggest that period and emotional intelligence may influence the choice of the color of the clothing. This may be a specific example of the use of emotional intelligence for general behavior. Future research is needed to develop the results of this study further, which were inspired by previous research showing that the outcome of tasks differs depending on the color of clothing. If changing the color of clothing has the potential to influence mental states and change attitudes and behaviors in different situations, this possibility would be worth investigating. Further research is needed to contrast the results. There is evidence that color preferences vary with cultural factors [37, 38]. In the future, it would be interesting to investigate people's choices in other cultures, places, and environmental conditions with different preferences, priorities, and other functional and external variables that may induce mood and psychological and physical states that influence decision making.

Finally, although we did not consider gender differences in clothing in this experiment, a recent trend in Japan is that women's skirts and dresses are more colorful than men's pants. The same is true for the color scheme of jackets. It would be interesting to analyze these gender differences in due course. Considering that up to a certain age, parents' clothing preferences are reflected in the survey, it is necessary to limit the age range covered by the survey, and there is room for further study on how the color of clothing is affected by age. In addition, children under high school age living in Japan may live with their parents and may not be able to wear their favorite colors of clothing because their parents have opinions about their clothing preferences in Japan. Therefore, it is therefore desirable to conduct the survey among university students, who are old enough to choose their clothes with some degree of freedom.

The results of this study are limited to Japanese university students only. It is possible that emotional intelligence was used to direct behavior in this study, but it is unclear whether there were differences in performance outcomes with or without a choice of clothing color. In the future, we plan to conduct some kind of test, such as a memory test, to compare the performance of the group that was allowed to freely choose the color of their clothing with that of the group that was not allowed to choose. Finally, there are many aspects of emotional intelligence that have not yet been fully investigated. It is necessary to continue our research with a view to collaborating with interdisciplinary fields.

## **Acknowledgements**

This research was supported by JST SPRING, Grant Number JPMJSP2119.

## **Conflicts of interest**

The authors declare no conflict of interest.

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## Chapter 6

# Perspective Chapter: Emotion and Economic Decision Making

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### Abstract

This chapter delves into the intricate relationship between emotions and economic decision-making, challenging the traditional rational agent model prevalent in mainstream economics. Drawing from psychology, neuroscience, and behavioral economics, we explore how emotions influence decisions under risk and uncertainty, intertemporal choices, and social decisions. It argues that emotions, far from being peripheral, are central to the decision-making process. The chapter also discusses the evolutionary origins of emotions, highlighting their adaptive functions in small hunter-gatherer societies characterized by social interdependence and environmental uncertainty. It also highlights the potential of emotional intelligence and strategies such as distancing to temper negative emotional sway, enabling unbiased appraisals of situations. Emotions provide important information for making complex decisions, and one important component of emotional intelligence lies in understanding and harnessing the power of emotions to make more informed and optimal choices in economic settings. The chapter serves as a review for anyone interested in the intersection of emotions and economics, offering both theoretical insights and practical strategies for improving decision-making.

**Keywords:** emotion, economic decision-making, behavioral economics, risky decision-making, intertemporal decision-making, emotional intelligence

### 1. Introduction

For decades, the neoclassical framework based on the rational choice model has been dominating in the mainstream economics. This framework postulates that individuals, as rational agents, make decisions based on objective evaluations of costs and benefits in order to maximize the expected utility. The archetype of such decision-makers is often termed “Homo Economicus,” beings envisioned to navigate the economic landscape through a purely cognitive lens, untouched by the whims of emotions. The character of Spock from Star Trek epitomizes this notion; though not entirely devoid of emotions, his decisions predominantly resonate with logical, emotion-detached reasoning.

The rational choice model essentially has a consequentialist perspective, where utility is only a function of realized outcomes. Though not completely ruling out the role of emotions, this model assumes the influence of emotions can be cogently

discerned and factored into the utility function through cognitive mechanisms [1]. Emotions unanticipated or unregulated by cognition are deemed obstacles to optimization and hence are glossed over by a rational decision-maker and left out of the model.

Emerging research in both psychology and economics, however, suggests that this traditional view is incomplete and potentially flawed. Many studies have indicated that utility transcends realized outcomes, encompassing emotions experienced in the anticipatory phase preceding those outcomes [2, 3]. A compelling case for the centrality of emotion in decision-making comes from neuroscience. Antonio Damasio [4] presented the case of a successful lawyer whose decision-making ability was crippled post-minor brain surgery. Despite retaining his intellectual prowess, he was paralyzed in the face of decisions. These symptoms were found to be linked to a lesion severing the connection between the amygdala, a hub of emotional processing, and the prefrontal cortex, the seat of “rational” thinking. This case accentuates that emotions are not mere adjuncts but fundamental to decision-making – without the final push by emotions, people simply cannot reach any decisions.

Further insights into the interplay of emotions and economic behavior come from studies like that of Knutson et al. [5], which revealed that purchasing decisions are often predicted by activations in brain regions associated with emotions rather than rational deliberation. The nucleus accumbens (NAcc) was activated in anticipation of rewards, while the insula was activated in anticipation of pain. The pros and cons of purchase were distilled into feelings, which then competed in a contest of conflicting emotions to determine the final decision. Consequently, it is suggested that reason primarily serves to inform these feelings, rather than to dictate the decision-making process. In essence, information can only influence a decision if it “talks” to emotion. The results of these studies resonate with the philosopher David Hume famous saying “Reason is, and ought only to be the slave of the passions.”

The notion that emotion is a significant player in decision-making is not novel. Emotion has long been intertwined with the study of economics, tracing back to the foundational works of Adam Smith and Jeremy Bentham. Before his well-known book *The Wealth of Nations*, Smith delved into the emotional resonance in human interactions, in his earlier and lesser-known book *The Theory of Moral Sentiments*. Bentham’s conception of utility intertwined pleasure and pain, hinting at an emotional appraisal at the heart of economic decisions. However, as economics evolved over time, the attention paid to emotion dissipated, giving way to the neoclassical school of thought which emerged in the late nineteenth century. This shift marked a transition toward a more mathematical and systematic exploration of economic behavior, sidelining the emotional and moral substrates of economic decisions. The appeal of quantifiable predictions that neoclassical economics offered seemed to overshadow the nuanced and often messy realm of emotions.

This exclusion of emotion from economic models has faced challenges in recent years, notably with the rise of behavioral economics. Scholars have highlighted the numerous ways in which real-world economic behavior deviates from the predictions of neoclassical models. They argue that emotions, biases, and heuristics significantly impact economic decisions [6]. Acknowledging the interplay of emotion and rationality is crucial for a holistic understanding of economic behavior. As the field continues to evolve, the insights from both classical and modern thinkers provide a richer understanding of emotions and economic decision making.

This chapter discusses the complex relationship between emotion and economic decision-making, challenging the conventional wisdom and exploring the nuances

that emotions bring to our choices and actions. Beginning with an exploration of the evolutionary basis and functions of emotions, the chapter navigates through their influence in varying economic contexts: decisions under risk and uncertainty, intertemporal decisions, social decisions, and finally, a discussion on strategies for enhancing emotional intelligence in decision-making. Through this journey, the chapter aims to foster a richer understanding of the intertwined realms of emotions and economic decision-making, beckoning toward a more holistic appreciation of the economic behavior landscape.

## **2. Emotions and decision making**

Our emotional responses to events can be swift and powerful, sometimes leading us to act before our rational side has a chance to intervene. Numerous studies have demonstrated how emotional responses can overpower rational reasoning. As pointed out by Jonathan Haidt [7], our emotional system is like an elephant, while our rational system is like the rider on the elephant. Even though the rider thinks he is in control, it is the elephant that often determines our actions. If the elephant wants to go in a certain direction, it is challenging for the rider to steer it elsewhere.

From an evolutionary standpoint, the emotional brain, or the limbic system, evolved before the “rational brain” that primarily “resides” in the prefrontal cortex. This evolutionary sequence suggests that emotions have been a fundamental part of human decision-making long before the development of complex cognitive abilities and executive functions. Indeed, studies in neuroscience have shown that the neural pathways for emotional responses are quicker than the pathways for cognitive processing, suggesting that emotions respond to environmental stimuli before cognitive appraisal occurs [8, 9]. The “somatic marker hypothesis” proposed by Antonio Damasio [10, 11] suggests that emotional processes guide or bias behavior and decision-making. When faced with a decision, internal bodily states associated with previous emotional experiences can be re-evoked as somatic markers. These markers serve as a kind of “gut feeling” or intuitive signal, helping to guide decision-making, even before we consciously deliberate on the options.<sup>1</sup> For instance, in the real-world scenario of financial trading, a trader might experience a gut feeling, derived from past emotional experiences, that guides their decision on whether to buy or sell, often before a thorough analysis is performed.

Somatic markers enable us to quickly reach decisions in complex environments, and they do an excellent job of guiding us toward beneficial choices in most situations. However, in novel or significantly altered environments, these emotional cues might mislead. For instance, fear associated with risk and uncertainty can lead to risk aversion and a present bias [2]. While these responses may have been evolutionarily advantageous in environments characterized by high uncertainty and danger, they manifest as low-risk tolerance and heightened impatience, which are maladaptive in the modern world and generally feature safer and more stable conditions [6]. This calls for a balanced interplay of emotion and rationality in decision-making.

When discussing emotional influence on decision making, researchers have identified two distinct types of emotions [13]: integral emotions and incidental

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<sup>1</sup> Damasio even argued that emotional responses to the environment is vital for the emergence of consciousness [12].

emotions. Integral emotions arise directly from the judgment or choice at hand. They are intrinsically linked to the specifics of the decision-making process and are evoked by the potential outcomes or the process itself. For instance, when faced with an investment decision, the anxiety about potential loss or the excitement of a potential gain are task-related emotions. These emotions are directly tied to the perceived benefits or risks of the decision and are integral to the cognitive evaluation of the situation. They often serve as immediate feedback mechanisms, guiding individuals toward or away from certain choices based on the emotional valence associated with each option [2].

Incidental emotions, on the other hand, are derived from an individual's current state or recent experiences unrelated to the judgment or choice at hand [13]. Although incidental emotions are not directly related to the decision-making task, they are shown to sway the decision-making process [14]. For example, someone who has just experienced a personal loss might approach a completely unrelated decision with heightened caution or pessimism. Incidental emotions can act as background filters that color our perceptions and judgments [15, 16].

Integral emotions can be further categorized into immediate emotions and anticipated emotions [1]. While immediate emotions are experienced at the time of the choice, anticipated emotions are projections about future emotional states. Anticipated emotions refer to the emotions that individuals anticipate they will experience as a result of their decision. For example, when contemplating a significant career move, one might anticipate feelings of disappointment if the change does not pan out as hoped, or anticipate feelings of satisfaction and pride if it proves successful. These anticipated emotional outcomes can significantly influence the decision-making process. Anticipated emotions as a projection by cognition are consistent with the rational choice model and can be easily integrated into the utility of the potential outcomes. As a result, economists have traditionally focus on anticipated emotions [1, 17, 18].

In the subsequent sections, we will explore how different types of emotions influence decisions in contexts of risk and uncertainty, intertemporal choices, and social interactions.

### **3. Decisions under risk and uncertainty**

Decision under uncertainty is a common part of everyday life, from financial investments to health-related decisions. As a convention, when the probabilities of each possible outcome are known, we call it decision under risk or risky decisions, and we reserve the term decision under uncertainty for situations where the probabilities of outcomes are unknown. Balancing exploration and exploitation is vital for achieving a good outcome for decisions under uncertainty [19]. Since most existing studies on economic decision-making focus on risky decisions, this section will primarily explore decision-making in risk scenarios, transitioning to discussions of uncertainty toward the end.

The realm of risky decisions unveils the intricate relationship between emotion and rationality. Whether it is the choice to buy insurance or to, purchase a lottery ticket, to invest in an asset or to through a medical operation, emotions often serve as a guiding force in shaping our decisions. This first part of the section aims to explore the complexities of risky decision-making, focusing on the fourfold pattern of risk preferences and the concept of “risk as feelings” [2].

### 3.1 Emotions and the fourfold pattern of risk preferences

Central to decision theory, risky decisions have been traditionally examined through the expected utility (EU) Model in economics. This model posits that individuals, represented by their utility preferences, strive to maximize expected utility, indicating stable risk preferences through the curvature of the utility function.

The EU model, with its assumption of stable risk preferences, however, struggles to elucidate certain common economic behaviors: why do individuals simultaneously buy insurance and lottery tickets? The former suggests risk aversion, while the latter indicates risk-seeking. Contrary to stable preferences, studies have revealed that people’s risk preferences depend on the level of probabilities and whether they are in the gain or loss domain, summarized as the fourfold pattern of risk preferences in **Figure 1**: Individuals generally exhibit risk-averse tendencies for high-probability gains or low-probability losses, and risk-seeking behaviors for high-probability losses or low-probability gains.

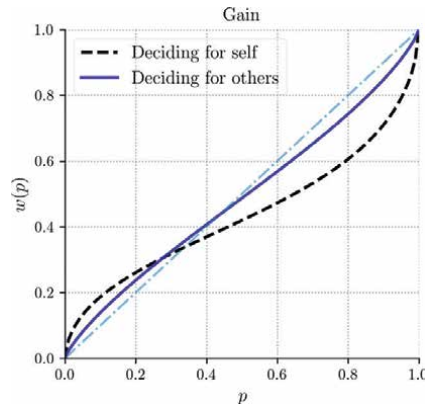
In an effort to incorporate psychological realities and explain many of the empirical regularities that are inconsistent with the EU model, Kahneman & Tversky [20] proposed the Prospect Theory (PT). Unlike the EU model, PT considers a value function defined over gains and losses relative to a reference point. The value function reveals that losses impart more impact than equivalent gains, shifting the focus from a mere level of wealth to the psychological impact of gains and losses.

An essential component of the Prospect Theory is the probability weighting function, which depicts the non-linear transformation of objective probability  $p$  into subjective weight  $w(p)$ . This function captures the idea that people tend to distort the probabilities of outcomes when making decisions under uncertainty. Instead of evaluating outcomes based solely on their objective probabilities, individuals tend to overweight low probabilities and underweight high probabilities [20, 21]. **Figure 2** demonstrates two probability weighting functions, where the dashed line is more distorted than the solid line.

The nonlinearity of the probability weighting function encapsulates two pivotal psychological effects: the certainty effect and the possibility effect. A dramatic shift in probability weighting occurs when probabilities transition from absolute certainty to slight uncertainty or vice versa. The certainty effect takes place when the probability of a desirable outcome changes from infinitesimally less than 1 to a probability

	GAIN	LOSS
HIGH PROBABILITY	<p><b>Risk Averse</b>  <i>e.g., investing in risk-free assets instead of higher-return stocks (afraid of not acquiring prospect)</i></p>	<p><b>Risk Seeking</b>  <i>e.g., taking risky operation to avoid debilitating disease (hope to avoid prospect)</i></p>
LOW PROBABILITY	<p><b>Risk Seeking</b>  <i>e.g., buying lottery tickets to become rich (hope to acquire prospect)</i></p>	<p><b>Risk Averse</b>  <i>e.g., buying insurance to avoid large payment (afraid of acquiring prospect)</i></p>

**Figure 1.**  
 The fourfold-fold pattern of risk preferences.



**Figure 2.** Probability weighting function estimated based on the data from by Sun et al. [22], comparing decisions made for oneself and for others. The study involved 181 participants assessing the willingness to pay for 56 lotteries, evenly split between the gain and the loss domains. In the gain domain, participants specified the willingness to pay for a lottery offering a probability of  $p$  to obtain the payoff  $\$x$  and a probability of  $(1 - p)$  to obtain the payoff  $\$y$ . In the loss domain, they indicated the willingness to pay to avoid a lottery with a probability of  $p$  to lose  $\$x$  and a probability of  $(1 - p)$  to lose  $\$y$ . the probability  $p$  takes the values of 1, 5, 10, 25, 50, 75, 90, 95, or 99%, whereas  $(x_i, y_i)$  takes the values of (50, 0), (100, 0), (200, 0), (400, 0), (100, 50), or (200, 100). For decisions made for one self and decisions made for others in the loss domain. In their study, 181 participants were randomly assigned to two groups: Making decisions for themselves or for another participant. Participants evaluated their willingness to pay across 56 lotteries, split evenly between gain and loss domains. Each lottery  $i$  offers a probability of  $p_i$  to obtain the payoff  $x_i$  and a probability of  $(1 - p_i)$  to obtain the payoff  $y_i$ . the probability  $p_i$  takes the values of 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95%, or 99%, whereas  $(x_i, y_i)$  takes the values of  $(\pm 50, 0)$ ,  $(\pm 100, 0)$ ,  $(\pm 200, 0)$ ,  $(\pm 400, 0)$ ,  $(\pm 100, \pm 50)$ , or  $(\pm 200, \pm 100)$ . Probability weighting functions for each domain were estimated using maximum likelihood estimation based on the functional form proposed by Tversky and Kahneman probability weighting functions for both domains were then estimated using maximum likelihood estimation according to the model by Tversky and Kahneman [21]. In th this plot here shows the estimated probability weighting function in the loss domain, where the horizontal axis  $p$  represents the objective probability of the corresponding payoff, and the vertical axis  $w(p)$  represents the subjective probability weighting inferred from decisions.

of 1. This shift provides individuals with the assurance that a particular outcome will definitely occur, transitioning from a state of slight uncertainty to absolute certainty, signifying a qualitative shift. Conversely, the possibility effect occurs when a probability of a desirable outcome increases from 0 to a small positive value. This increase, no matter how minor, represents a qualitative change, instilling a strong hope in individuals that a certain outcome could materialize. These transitions are considerably more salient and emotionally impactful compared to minor probability changes in the intermediate range, such as from 0.2 to 0.3 or from 0.6 to 0.7, which do not entail a qualitative shift in certainty or uncertainty.

The prospect theory, and the probability weighting function in particular, has a profound connection with emotional influence. Loewenstein et al. [2] propose the “risk as feelings” hypothesis, which posits that people experience emotional reactions to various forms of risk, and make choices that are partially driven by these anticipated emotions [23]. The “risk as feeling” hypothesis elucidates the probability weighting function and the fourfold pattern of risk preferences. **Table 1** delineates how the fourfold patterns of risk preferences are caused by the anticipated emotions of the potential prospect.

When faced with a high probability gain, as the gain is likely, the reference point aligns with the gain. This is because when individuals expect to receive something (especially when the odds are in their favor), not receiving it feels like a loss, even

Risky decision	Reference point	Anticipated emotion	Outcome
Large probability gain	With the gain	Losing the likely gain Generates great disappointment	Risk averse
Small Probability gain	Without the gain	Winning the unlikely gain generates great elation	Risk seeking
large Probability loss	With the loss	Avoiding the likely loss generates great elation	Risk seeking
Small probability loss	Without the loss	Suffering the unlikely loss generates great disappointment	Risk averse

**Table 1.**  
*The fourfold pattern and the corresponding anticipated emotion.*

if nothing has been physically taken away. The anticipated disappointment of missing out on a probable gain drives individuals to opt for the safer choice, showcasing risk-aversion. Conversely, when facing a high probability of loss, the hope of evading an almost certain negative outcome motivates this choice. The anticipated elation renders the individual risk-seeking in this scenario.

A classic example associated with a small probability gain is the purchase of lottery tickets. The extremely low chance of winning a significant amount does not deter individuals; instead, it fuels the hope of acquiring a life-changing sum. The anticipated elation, should they win, renders them risk-seeking. In the scenario of a small probability loss, individuals' risk aversion is evident in the widespread purchase of various types of insurance, ranging from health to home insurance. The fear of experiencing a catastrophic loss, however unlikely, propels individuals to pay premiums for peace of mind.

### 3.1.1 Emotional influence on the probability weighting function

The prospect theory assumes that probability weights are independent of the outcomes. The risk-as-feelings hypothesis, in contrast, foretells that outcomes inciting strong emotions would significantly influence judgment and decisions, displaying as overweighting the probabilities of such outcomes occurring. For instance, studies have revealed that individuals were more inclined to pay a premium for insurance against death due to terrorism as opposed to general causes [24], driven by the intense negative emotion tethered to terrorism. Moreover, Rottenstreich & Hsee [25] discovered that probability weighting is more skewed with affect-rich outcomes like the opportunity to meet and kiss a favorite movie star, experiencing a brief but painful electric shock, or receiving a coupon for a European vacation, in comparison to affect-poor financial outcomes. Hence, the probability weighting function tends to be flatter when the outcomes can evoke strong emotions – the solid and dashed lines in **Figure 2** could illustrate the differences between affect-rich versus affect-poor outcomes.

In alignment with the risk as feelings hypothesis, any factor that diminishes the intensity of anticipated emotions could lessen the distortion in the probability weighting function. Enhancing the psychological or social distance between an individual and the outcome serves as one such method. For example, decisions made for others are likely to be less swayed by anticipated emotions, thereby reducing the distortion in the probability weighting function. This principle is widely acknowledged

in the medical profession, where ethical guidelines advise against physicians treating themselves or close family members to curb emotional bias from impairing rational judgment (Ethics Manual, American College of Physicians; Code of Medical Ethics, American Medical Association).

Various studies corroborate the wisdom embedded in these ethical guidelines. Using the inclusion of others in the self (IOS) scale (Figure 3) [26] to manipulate social distance, Sun et al. [27] demonstrated that as social distance increases (from self to others, or from close friends to mere acquaintances), individuals become less risk averse, increasing their average payoff received in risky situations. Sun et al. [22] further elucidated that this heightened expected payoff is tied to a flatter probability weighting function as social distance increases, mediated by the reduced intensity of anticipated emotions. Figure 2 demonstrates, just as the comparison between the affect-rich vs. affect-poor outcomes, a decision made for oneself has a flatter probability weighting function.

Interestingly, the impact of increased social distance on the probability function is more accentuated in the gain domain. The probability weighting function in the gain domain, under the decision-for-other condition, closely aligns with the 45-degree line, indicating risk neutrality. The lesser effect of social distance in the loss domain could stem from the ease of empathizing with others' losses compared to their gains [28], leading to a more substantial reduction of emotional intensity in the gain domain as social distance expands. Sun et al. [22] supplied evidence supporting this conjecture.<sup>2</sup>

According to the aforementioned studies, delegating the decision to an agent emerges as a viable strategy to improve risky decision-making. Nonetheless, finding responsible and competent agents may prove challenging. So, how can we improve decisions when we have to make decisions on our own? Sun et al. [30] explored the efficacy of self-distancing strategies in refining risky decision-making. Participants were randomly allocated to diverse conditions. In the self-distancing condition, they were guided to “consider each gamble in a rather distanced way; take a certain distance from what happens; look at what happens in each gamble from the perspective of an external observer.” Conversely, the self-immersing group was instructed to “consider each gamble with an emotional interest in it; enter into what happens; look at what happens in each gamble from the perspective of an involved participant.” Meanwhile, the neutral group was simply instructed to complete the task. Remarkably, a mere two lines of instructions led to participants in the self-distancing

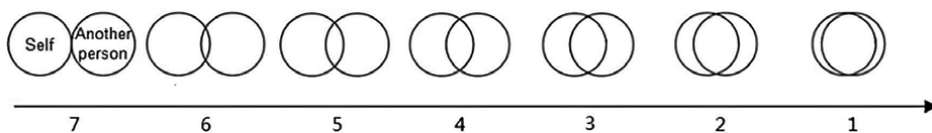


Figure 3. The inclusion of others in the self (IOS) scale proposed by Aron et al. [26].

<sup>2</sup> Sun et al. [29] asked participants to report their anticipated emotions from the potential outcomes of risky decisions on a Likert scale. They found that the emotions experienced by individuals making decisions for others differ from those experienced by individuals making decisions for themselves, leading to an attenuation or even a reversal in the shape of the four-fold pattern.

group accruing higher expected payoffs compared to their counterparts in the baseline and self-immersing groups.

### **3.2 Description-experience gap**

The studies discussed so far in this chapter on risky decision-making have employed description-based tasks, where individuals receive explicit information regarding the probabilities and outcomes tied to each option. However, real-world decisions often unfold without such clear delineations, necessitating an estimation of probabilities based on past experiences. For instance, investors may lack knowledge about the risks tied to a particular investment, learning about them over time by investing and observing the returns. Hence, some researchers advocate the use of experience-based tasks to enhance external validity, where individuals, devoid of prior knowledge about the consequences, learn about the probabilities and outcomes through actual experience.

The comparison between description-based studies and experience-based studies unveils a notable description-experience gap [31]. Contrary to the predictions of prospect theory and the findings of description-based studies, individuals tend to underweight the probabilities of rare outcomes in experience-based tasks. Moreover, while individuals generally exhibit risk aversion for gains and risk-seeking for losses in description-based studies, the converse is true in experience-based studies.

Decision-making within experience-based tasks can be modeled as a two-stage process. First, individuals formulate beliefs regarding the probabilistic distribution of payoffs for each option, drawing on past experiences, and ascribe a level of confidence to these beliefs. Second, based on these beliefs and confidence level, individuals endeavor to strike a balance between exploration and exploitation. This entails capitalizing on existing knowledge to select the optimum option (exploitation) while also probing different options to amass more accurate knowledge that could potentially yield superior outcomes in the future (exploration) [19, 32]. The merit of exploration over exploitation hinges on the extent of knowledge one possesses regarding different options and the time horizon of the decisions.

Laureiro-Martínez et al.'s [33] study reveals a differentiation in brain activity during exploitation and exploration tasks (cf. [34]). Exploitation resonates with brain regions tied to anticipation and reward, suggesting a more emotionally-driven or reward-driven process, whereas exploration is closely associated with the brain's executive centers governing attention, indicative of a cognitively demanding process. This neural differentiation posits that individuals may be naturally predisposed toward exploitation due to its rewarding facet, while exploration may necessitate heightened mental effort given the engagement of executive control centers.

A large part of the description-experience gap can be attributed to the emotions invoked during decision-making. Unlike description-based choices, where decisions are swayed by anticipated emotions stemming from potential outcomes, emotions in experience-based choices are often molded by recent actual outcomes. The somatic marker hypothesis posits that emotions experienced upon the realization of an outcome would create and shape somatic markers that influence subsequent decisions through conditioning and memory [10]. Essentially, past emotions distilled as somatic markers steer the choice among different options.

The somatic marker hypothesis sheds light on the description-experience gap from an emotional standpoint. Decisions in experience-based tasks are more prone to recency and memory effects. Given the infrequency of rare events, more

common events, which are likely to be recent, are accorded greater weight. Moreover, extremely rare events, unlikely to transpire given the constrained number of trials in lab experiments, seldom leave an emotional imprint on decision-makers, elucidating the tendency to underweight rare events.

Because larger rewards engender more potent emotional and memorable impressions, they exert a greater sway on decisions. This memory effect elucidates the risk-seeking behavior in gains and risk aversion in losses observed in experience-based studies. For instance, when faced with a choice between a sure gain of \$50 (Option A) and a 50-50 chance of gaining \$30 or \$70 (Option B), the thrill of receiving \$70 from Option B imprints a stronger somatic marker, inducing individuals toward Option B. Conversely, in a scenario involving a sure loss of \$50 (Option A) versus a 50-50 chance of losing \$30 or \$70 (Option B), the sting of losing \$70 from Option B creates a stronger somatic marker, deterring individuals from opting for Option B.

### **3.3 Incidental emotions and market behavior**

Incidental emotions – those unrelated to the task at hand – can also influence decisions under risk and uncertainty. Wright & Bower's [35] study illustrate this. They manipulated participants into a happy or sad mood by reflecting on corresponding personal experiences, subsequently observing that happy individuals estimated higher probabilities for positive events and lower probabilities for negative events.<sup>3</sup>

Moreover, various research has unearthed the differential effects of negative emotions on risk preferences. For instance, Raghunathan & Pham [36] discovered that sadness propels individuals toward risk-seeking behaviors, while anxiety drives them toward risk aversion. Likewise, Lerner & Keltner [37] uncovered that anger and fear have opposing impacts on risk preferences, with anger fostering risk-seeking and fear promoting risk aversion. Expanding on these findings, Fessler et al. [38] employed an evolutionary lens to forecast gender-based differences in the effects of incidental emotions on risk preferences, identifying that anger enhances risk-taking in men, while disgust reduces it in women.

In an intriguing study, Hirshleifer & Shumway [39] identified a correlation between market index returns and sunshine levels. Their findings suggest that the positive moods induced by sunny weather lead investors to adopt more optimistic views of the economic outlook. Similarly, Edmans, Garcia, & Norli [40] noted a decline in a country's stock market returns following significant losses in nationally popular sports, hinting at the extensive reach of incidental emotions into economic and financial realms.

## **4. Intertemporal decisions**

Intertemporal decision-making involves choices where the costs and benefits occur at different points in time. Conventional economic models like the discounted

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<sup>3</sup> In a related study, Schwartz & Clore [15] investigated whether one's mood at the time of judgment impacts assessments of life satisfaction. They manipulated moods by prompting participants to recall recent happy or sad events or by conducting interviews on sunny or rainy days. The findings revealed that positive moods led to higher reported happiness and life satisfaction, while negative moods resulted in lower evaluations.

utility model often fall short in capturing the nuances of these decisions. This section explores the emotional factors that sway intertemporal choices, diverging from traditional economic models. Unveiling these emotional dynamics can provide crucial insights for individuals and policymakers, aiding in navigating the intricacies of decisions stretched over time.

#### **4.1 Emotions toward immediate vs. future outcomes**

Anything that occurs in the future will involve some degree of risk and uncertainty. Since intertemporal decisions involve weighing present against future outcomes, they inherently possess an element of risk and uncertainty due to the temporal delay. Consequently, the emotional dynamics previously discussed in decisions under risk and uncertainty are relevant in understanding intertemporal choices as well. A case in point is the prevalent present bias, where individuals opt for a smaller present reward rather than wait for a larger future reward. This tendency can be partially elucidated by the certainty effect, a concept explored in our discussion on risky decision-making: a reward available presently is perceived with certainty, while a future reward, regardless of the delay, is shrouded in a layer of uncertainty concerning its eventual realization. The elusive nature of uncertain rewards often falls short of motivating individuals to relinquish immediate rewards that trigger strong emotional reactions. Due to this, the allure of instant gratification frequently supersedes the rational consideration of future gains, propelling individuals toward choices detrimental to their long-term interests, like impulsive shopping or unhealthy dietary choices.

Neuroscientific studies affirm the link between decision-making under uncertainty and intertemporal decision-making. As demonstrated by McClure et al. [41, 42], the limbic and paralimbic cortical structures, rich in dopaminergic intervention and associated with emotional influence, become activated when choices involve immediate rewards. In contrast, the frontoparietal regions of the brain, which are related to higher cognitive functions, are activated during all forms of intertemporal choices. Intriguingly, when individuals opt for larger delayed rewards, there is a notable uptick in activity within the frontoparietal regions compared to the limbic regions. This implies a heightened level of cognitive control and deliberation in overriding the emotional allure of immediate gratification. The more pronounced activity in the frontoparietal regions during such decisions highlights the role of cognitive evaluation and foresight in pursuing delayed rewards, which are often perceived to be more beneficial in the long run. So, based on the concept of the two systems of thinking [6], the slow, deliberate System 2 governs the balance between immediate and future rewards, while the intuitive, emotional System 1 is drawn toward the immediate rewards. When compared with the observations of Laureiro-Martínez et al. [33], the connection between decision under uncertainty and intertemporal decision-making becomes apparent: the exploration of new knowledge, which requires the executive function of the brain, is analogous to making intertemporal trade-offs, while exploitation to maximize short-term gains aligns with opting immediate rewards.

The neural basis of intertemporal decision-making clarifies the important role that emotion plays. Immediate rewards typically elicit stronger emotions compared to future rewards. Long-term benefits, such as being distant, appear intangible and psychologically remote, contrasting with the tangible rewards at hand. This emotional distance often renders the delayed option less appealing and, hence, seldom chosen, giving rise to the self-control problem.

Thaler & Shefrin [43] employ a principal-agent model to elucidate this concept. The model depicts the intrapersonal conflict between the planner (primarily associated with the frontoparietal regions of the brain) and a series of ephemeral doers (largely linked to the limbic and paralimbic cortical structures). A doer at each time point is tasked with making the decision, and these self-centered doers are indifferent to the future doers. On the other hand, the planner values long-term benefits but has restrained control over the doers. The planner's dominion over the doers significantly wanes when fatigued, swayed by visceral factors, or when the temptation is apparent and accessible. For instance, a cognitive load that exhausts the brain's executive function leads to a preference for cake over fruit salad [44]. When immediate rewards are out of sight or when they divert their attention to other enjoyable thoughts, children in the Stanford marshmallow test manage to wait considerably longer [45]. Moreover, trainee truckers possessing superior cognitive skills, indicative of a stronger planner, have been found to exhibit more patience (less present bias and discounting) and are more likely to persist on the job, even in a setting with a significant financial penalty for early exit [46].<sup>4</sup>

Given that the emotional pull from immediate rewards tends to shift focus toward short-term outcomes, it is reasonable to hypothesize that a stronger emotional connection to one's future self would promote long-term thinking. Indeed, studies on the "future self-continuity" hypothesis find that individuals who feel a stronger connection to their future selves are more likely to save money and make healthier choices [47, 48].<sup>5</sup> Moreover, since languages vary widely in how they encode time, the manner in which speakers articulate their future selves may unconsciously shape their future-oriented concerns. Chen [49] examined the hypothesis that languages that grammatically link the future and the present may nurture future-oriented behaviors. Comparative analyses across different countries, and among demographically similar native households within the same country, reveal that languages with such grammatical structures tend to correlate with higher savings, increased wealth at retirement, reduced smoking, lower rates of obesity, and safer sexual practices.

## **4.2 The role of anticipation**

Besides the integral emotions felt toward present outcomes and the anticipated emotions regarding future outcomes, the emotions expected to be experienced during the wait for future outcomes also significantly impact intertemporal decision-making. Individuals derive pleasure from savoring upcoming positive outcomes and discomfort from dreading negative ones. The emotional journey during the waiting period can substantially sway the ultimate decision, often contradicting the economic rationale posited by the discounted utility model. Common scenarios illustrate this, where individuals might deliberately delay pleasurable events like an exotic vacation or a lavish dinner, while hastening undesirable events such as a dental appointment or a risky surgery.

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<sup>4</sup> Burks et al. [46] also discovered that individuals possessing higher cognitive skills are more inclined toward taking calculated risks and exhibit enhanced social awareness while making decisions in a sequential prisoner's dilemma scenario.

<sup>5</sup> Connection to one's future self can be visualized by the IOS scale shown in **Figure 3**, with "another person" replaced by future self.

Loewenstein's [3] pioneering work unveiled some captivating facets of how anticipated emotions guide intertemporal decisions. Participants in the studies were willing to pay a premium to evade an electric shock deferred for 1 year or 10 years over a shock set to occur within 3 days. Similarly, individuals were ready to pay more for a kiss delayed by 3 days than an immediate kiss or one postponed by 3 hours or 1 day. Berns et al. [50] explored the neural basis for people's inclination toward hastening dreaded events. They discovered that the anticipation of electric shock augmented neural activity in the posterior components of the cortical pain matrix. Moreover, neural activity responding to anticipated pain forecasted tendencies to expedite shocks.

### **4.3 Affective forecasting**

As previously discussed, suboptimal intertemporal decision-making can arise from present bias and impulsivity – situations where decision-makers fail to implement choices that align with their long-term well-being, given their current and future preferences. Another factor contributing to suboptimal decisions is their inaccurate prediction of future preferences.

While there is evidence showing people are aware of their present bias,<sup>6</sup> they also exhibit projection bias, the tendency to overestimate how closely our future preferences will mirror our current preferences [52]. For example, Conlin et al. [53] found that individuals' purchasing decisions were significantly influenced by the prevailing weather conditions; colder weather heightened the propensity to purchase cold-weather items, even if they did not necessarily need them. These impulse purchases were frequently followed by a desire to return the items later.

Projection bias is particularly relevant in intertemporal decisions involving strong emotional states. For instance, being in a positive mood might lead individuals to underestimate the likelihood and the potential impact of adverse events, giving rise to overly optimistic decisions. One underlying cause of projection bias is empathy gaps [54]. The concept of the "hot-cold empathy gap" refers to how people struggle to understand and predict their feelings and behaviors across different emotional states. Specifically, when individuals are in a "hot" state (such as feeling hungry, thirsty, angry, or sexually aroused), they tend to underestimate how different their preferences are from times when they are in a "cold" state, which is a more calm and unemotional condition. This underestimation means they might not fully recognize how much their current intense feelings influence their choices and might believe that these choices reflect their normal preferences, which is often not the case. Conversely, when they are in a cold state, they also fail to accurately predict how much their preferences might change when they are in a hot state.<sup>7</sup> For example, Sayette et al. [56] discovered that smokers in a cold state underpredicted the value they would attribute to smoking during a hot state, elucidating one reason why tobacco addiction is challenging to overcome.

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<sup>6</sup> Giné et al. [51] showed this through a study where smokers were inclined to spend on commitment products for smoking cessation, acknowledging their present-biased tendencies.

<sup>7</sup> The same empathy gap can also materialize interpersonally. Sun et al. [55] illustrate how discrepancies in risky decision predictions arise from interpersonal empathy gaps. Predictors often underestimate the intensity of the actors' emotional states, leading to a disparity between predicted and actual decisions. This gap transcends a mere failure of imagination, representing a fundamental limitation in our capacity to fully grasp the emotional experiences of others.

Furthermore, research has indicated that individuals often overestimate the intensity and duration of emotions triggered by a future event when forecasting their emotional responses, a phenomenon psychologists refer to as impact bias [57]. Brickman et al. [58] revealed that individuals overestimate the emotional impact of both positive events (such as winning a lottery) and negative events (like becoming paraplegic) on their happiness. Gilbert et al. [59] documented a phenomenon termed immune neglect, which describes the overestimation of the impact of a wide range of negative events on individuals' emotional well-being, including the dissolution of a romantic relationship, failure to achieve tenure, electoral defeat, negative personality feedback, children's death, and rejection by a prospective employer, on individuals' emotional well-being.

## **5. Social decisions**

Social decisions form a cornerstone of human interaction and economic transactions, often swayed by a blend of rational deliberations and emotional impulses. For instance, a shared sense of threat might spark collective actions [60]. Emotions like guilt, shame, and anger can act as credible commitments to certain actions, steering us toward favorable outcomes. In this section, we will delve into the emotional facets of social decisions, using the Ultimatum Game as an illustrative example.

The Ultimatum Game is a two-player game where the players move sequentially [61]. The first player, known as the proposer, proposes a way to divide a sum of, say, \$10. The second player, the responder, can either accept the proposition, leading to the division of the \$10 as proposed, or reject it, whereupon both players receive nothing.

Under the assumption of rationality, the responder would accept any positive offer as it surpasses receiving nothing. Foreseeing this, the proposer would tender the smallest possible amount. However, real-world outcomes of the Ultimatum Game reveal that this Nash equilibrium predicted by game theoretical analysis falls short of predicting human behavior accurately. Typically, median and modal offers hover between 40 and 50%, with the mean offer lying between 30 and 40%. Offers below 20% face rejection around half of the time – a pattern that holds even when factors like high stakes, reputation, and anonymity are introduced [62].

The deviation from presumed rational behavior is rooted in emotional responses. Negative emotions toward unfair offers often overshadow monetary incentives, with anger toward unfair allocations by the proposer prompting responders to resort to costly punishment. Studies reported correlations between the likelihood of rejection and the intensity of self-reported anger [63] and between the rejection of unfair offers and the activation in the anterior insula – a brain region linked to emotions like anger, disgust, and pain [64].

Bosman et al. and Roider et al. demonstrate that cool-off periods do not diminish the rejection of unfair offers [65, 66]. However, when responders can communicate negative emotions to proposers, rejection rates tend to decrease [67]. This suggests that anger compels responders to act against unfairness. Specifically, when responders can express their anger through negative messages, they are less likely to reject the offer outright, as the message itself serves as a means to express attitude toward unfairness.

Incidental emotions also exert a significant influence. For example, incidental sadness lowers acceptance rates [68], while clinical depression correlates with higher acceptance rates [69]. Interestingly, happy responders are less inclined to reject unfair offers, and happy proposers are more likely to make unfair offers [70]. In different contexts,

incidental happiness [71], incidental gratitude [72], and receipt of gratitude [73] bolster altruistic tendencies, whereas incidental guilt amplifies willingness to donate blood [74].

## 6. Emotional intelligence in decision-making

Originating from the Latin word “*movere*,” denoting “to move,” the term “emotion” often encapsulates the sensation of being propelled by an external force. As highlighted in the introduction, the dynamic between emotion and rationality may be analogized to that of an elephant and its rider [7]. It is futile for the rider to combat the elephant; indeed, it is, in a sense, undesirable to entirely discard emotions because they furnish vital insights aiding our decision-making processes [8, 10].

Despite the substantial impact of emotions on decision-making discussed above, many people ascribe their actions to rational contemplation, neglecting emotional undercurrents [75]. However, mastering emotional intelligence in decision-making lies in comprehending and channeling the energy of emotions [76]. Being aware of the influence of emotions allows us to implement strategies that mitigate their negative effects and harness them constructively [13, 77].

As explored in the section on risky decision-making, when the objective is to dampen emotional intensity, employing distancing – a form of cognitive reappraisal – can be beneficial. This strategy propels a psychological distance between the decision-maker and the outcome. Rather than succumbing to the immediate emotional surge, an individual employing the distancing strategy would appraise the situation from a detached or objective vantage point. This mechanism of distancing has proven efficacious in improving risky decisions [30].

In practice, various methods can be employed to actualize this distancing, each capable of mitigating the intensity of the immediate emotional response [78]. Here are some approaches:

- **Spatial Distancing:** Envisioning the scenario from a remote viewpoint, akin to observing it from afar or from a bird’s-eye perspective, can foster a sense of detachment [30].
- **Temporal Distancing:** Contemplating how one feels about the current situation in a distant future can also create a sense of distancing, leading people to realize the impermanence of their emotions [79].<sup>8</sup>
- **Perspective Shifting:** Adopting a third-person perspective can help in achieving a more distanced stance. For instance, rather than mulling over, “What should I do now?”, one might ponder, “What should [your name] do now?” This subtle modification in viewpoint can assist individuals in appraising the situation more objectively, thus aiding in making more rational decisions amidst emotional turbulence [1].

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<sup>8</sup> The 10/10/10 rule conceived by business writer Suzy Welch can be considered as a practical application of this approach: individuals are encouraged to assess the potential impact or significance of a distressing event by considering how they will feel about it 10 minutes, 10 months, and 10 years in the future, aiming to shift one’s perspective and alter their immediate reaction.

Entrepreneurship provides a compelling case study for the role of emotional intelligence in economic decision-making. Data reveal a stark statistical reality of startups. In the US, for example, 50% of all startups founded between 1976 and 2001 exited within the first 4 years, and almost three-quarters of venture-capital-backed startups between 1987 and 2008 exited with an equity value of zero [80]. However, entrepreneurs often harbor the belief that they are special, and these figures do not apply to them. This optimistic bias sways them to overestimate their capabilities and underestimate potential hurdles like competition from other enterprises, embodying an illusion of control that overlooks the influence of luck and external factors on success, as pointed out by Astebro et al. [80].

A study by Camuffo et al. [81], employing Randomized Controlled Trials, delved into the merits of a “scientific approach” to entrepreneurial decision-making, providing a practical instance of utilizing a distancing strategy to temper the optimistic bias of entrepreneurs. The study encompassed 116 Italian startups, segregated into a control group and a treatment group, each undergoing business training. While the control group was guided to rely on intuition for evaluating their ideas, the treatment group was directed to frame their ideas as hypotheses, subject to validation through data. This method notably amplified the psychological distance between the entrepreneurs and their ideas. The findings revealed that the control group largely adhered to their initial business strategies and products, amassing an average revenue of under \$300. Conversely, the treatment group showed a greater propensity to pivot to new business models, accruing over \$12,000 in revenue. This underlines the notion that the emotional intelligence derived from embracing a scientific approach can pave the way for more lucrative business decisions.

Intel’s history offers a notable illustration of this concept [82]. Amid escalating competition in the memory market and an enticing prospect in microprocessors, Intel’s executives found themselves at a pivotal juncture. Trapped in a quandary for a long time, Andy Grove, the president at the time, presented a hypothetical scenario to the chairman and CEO, Gordon Moore: “If we were ousted and the board installed a new CEO, what actions do you think he would take?” The answer was unequivocal: transition the focus to microprocessors. After the transition was made, the stock value of Intel in 2012 was 47 times that in 1985, implying the success of adopting an outsider’s perspective.

## **7. Conclusion**

The extensive exploration of emotional influence on economic decision-making throughout this chapter illuminates a realm of human behavior often inadequately addressed by traditional economic theories. The rational agent model that is still dominating mainstream economics neglects the consequential role of emotions. However, the dissections of various economic decision-making scenarios within this chapter underscore the indelible imprint of emotions on our choices. Far from being mere peripheral elements, emotions emerge as central players, often steering decisions in directions that might seem perplexing through the lens of strict economic rationality. Understanding the interplay between emotional and cognitive factors holds immense promise for individuals, policymakers, and professionals across diverse fields.

Emotions evolved as swift arbitrators of decision-making in ancient environments of small, closely-knit tribes, where faces were familiar and resources scarce [83]. They facilitated survival, fostered social cohesion, and helped navigate the high-stakes,

often life-or-death situations that were part of existence. The rapid, emotion-driven decision-making that was crucial in such settings continues to resonate in the complex economic decisions we face in today's vastly different yet equally challenging environments [4]. The evolved functions of emotions extend beyond the personal sphere into the social realm, impacting not just individual choices but collective actions and societal norms. This integral nature of emotions in our decision-making apparatus highlights their role not as adversaries of rationality but as indispensable allies: emotions do not stand in opposition to rational economic decision-making; rather, they are an inherent component of it [8, 13].

As discussed, recognizing the impact of emotions is crucial for making sound economic decisions. Emotions should not be neglected; instead, they should be recognized, acknowledged, and utilized. We have reviewed how the distancing strategy provides a practical method to mitigate the negative effects of emotions. Moreover, in certain situations, their positive impacts can also be enhanced. For example, strengthening emotional attachment to one's future self or a desired outcome could foster a longer-term perspective, potentially resulting in improved outcomes [47]. In social interactions, emotions such as anger can be strategically used to achieve an advantage [84]. Research on how to optimally leverage emotions for economic decisions is still in its early stages, but the prospects are promising.

In summary, the myriad hues of emotions tint our decisions, often in subtle manners yet with profound implications. The objective should not be a futile endeavor to extricate emotions from decisions but a deliberate effort to comprehend their influence, harness their potency, and weave this understanding into the texture of economic theories and practices.

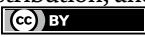
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# Perspective Chapter: Emotional Intelligence from a Neuropsychological Perspective

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## Abstract

Social cognition enables the processing of information necessary to evolve within a social group. Neuropsychology explores models linking brain networks to social information processing. Social cognition is closely tied to the concept of Emotional Intelligence (EI), defined as the mental ability involved in accurately perceiving, understanding, using, and regulating one's own emotions and those of others. EI could explain the variability of socially guided behavior. Therefore, EI seems to be an interesting concept for neuropsychologists. EI abilities are summarized, showing the neuroanatomical correlates, the tools enabling their assessment, and the functional impact in everyday life. Perceiving emotions in others, alexithymia, empathy, emotional memory, decision-making, theory of mind, and mind regulation are neuropsychological processes that can be explained through the lens of the concept of Emotional Intelligence. Creating standardized tools to assess perception, identification, emotional regulation skills, establishing emotional intelligence profiles, and comparing them to rational intelligence should contribute to enhancing our comprehension of social interactions and their associated dysfunctions.

**Keywords:** social cognition, emotional intelligence, empathy, neuropsychological assessment, executive functioning

## 1. Introduction

The complexity of human social interactions defines our nature as individuals. A wide range of information processing mechanisms allow humans to process information related to social interactions. Social cognition concerns the various psychological processes that enable individuals to take advantage of being part of a social group [1]. In the field of neuropsychology, attempts have been made to develop explanatory models of social information processing and to draw parallels with the involved brain networks.

The “social brain” [2] comprises specific brain circuits that facilitate the processing of social information, including (1) the amygdala network, which evaluates the emotional value of stimuli; (2) the mentalization network, that supports the ability to think about the mental states of oneself and others; (3) the empathy network, which detects and responds to others' distress; and (4) the mirror network, enabling observation and execution of actions [3].

Emotional Intelligence (EI) is closely intertwined with social cognition. It refers to an individual's capacity to perceive, comprehend, utilize, and regulate their own emotions, as well as the emotions of others. By having a higher EI, individuals may better understand and manage social interactions. Different models of EI have been developed, focusing on either trait-based approaches or specific-ability approaches. The Mayer & Salovey model represents one of the specific-ability models and presents an adequate concept's validity (e.g., [5]). This model considers overall EI as a combination of abilities from four branches: perceiving emotions, using emotions to facilitate thinking, understanding emotions, and managing emotions [4–6].

The aim of this chapter is to establish the connection between these EI abilities and specific processes in neuropsychology and social cognition by presenting the corresponding brain structures, assessment tools, and the functional impact and associated pathologies related to each branch.

## **2. Perceiving emotion**

According to Mayer and Salovey model, perceiving emotion is the first branch of EI. Perceiving emotion has two main functions: (a) the identification function of emotional content; (b) the expression function [6]. These functions encompass a set of skills of problem-solving that allow carrying out an emotionally intelligent reasoning [6]. This set of skills includes the recognition of emotion in other people from facial, postural and voice expressions [6]. It also includes the recognition of one's own emotion from feelings, though and physical manifestations, as well as the recognition of emotional content from non-living material (e.g., music, arts) [6]. Finally, perceiving emotion involves expressing accurately and appropriately one's emotions [6]. For instance, in the context of EI, perceiving emotion enables individuals to determine if a friend is afraid. Individuals utilize the skills encompassed within this component to observe that the friend's eyebrows are raised, jaw is dropped open and lips are stretched horizontally backward, upper eyelids are raised, lower eyelids are raised, mouth is stretched, and voice has a higher pitch and more strained tone [7].

### **2.1 The neural correlates**

#### *2.1.1 Single neural system accounts for perceiving different emotions*

Limbic system is often defined as the affective brain. This group of brain structures is a main supporter of emotional reactions [8]. However, limbic structures alone cannot fully explain emotional processes [10]. They are linked with other main structures necessary for perceiving emotions (e.g., frontal lobe, see Ref. [8]).

In addition, the right brain hemisphere theory [9] postulates that the right hemisphere would play a dominant role in perceiving emotion. Such a statement is essentially based on lesion studies. However, this dominance of the right hemisphere is not supported by meta-analysis [10].

Although single neural system accounts of emotion perception have been appealing, they are challenged by results of meta-analysis.

#### *2.1.2 Specific and distinct neural accounts for perceiving different emotions*

An alternative view is to conceptualize emotion perception from discrete brain structures specific to each emotion in addition to a generic brain system common for

several emotions. Some neural structures seem to be specialized in the perception of specific emotions.

Amygdala is a key brain structure involved in perceiving emotion. It supports both the expression and identification of fear [9–13]. The amygdala seems to allow priority processing of external information associated with an emotional connotation. This region plays a role in fear circuits through two mechanisms. Firstly, it detects threats at an unconscious level and controls behavioral and physiological responses. Secondly, it influences the emergence of a conscious feeling of fear through cognitive systems [14].

Perceiving disgust emotion would be underpinned by the insula and the basal ganglia. Particularly, basal ganglia are involved in the recognition of disgust signals (*e.g.*, facial expression), and both the experience and expression (*e.g.*, facial and vocal expression) of disgust [10, 12]. Insula also supports recognizing and experiencing feelings of disgust [10, 15]. Mainly, experiencing disgust would be underpinned by the anterior insular region while recognizing disgust would be supported by the ventral anterior insula [16]. Perceiving facial expression of surprise recruits the medial temporal lobe, especially the right parahippocampal gyrus [15]. Murphy et al. [10] suggested that supracallosal anterior cingulate cortex (ACC) supports happiness and sadness perception, while Phan et al. [12] proposed that these emotions are respectively underpinned by basal ganglia and cingulate cortex.

The specificity account also proposes that brain regions can play a generic role in perceiving emotion. Meta-analyses proposed a generic role of the frontal cortex (*e.g.*, medial prefrontal cortex, ACC) in the recognition and experience of emotions [10, 12]. The amygdala allows priority processing of external information with an emotional connotation. The embodied and enactive theory of emotion [9, 17] proposed a somatosensory account of emotion recognition. Facial feedback helps to feel and decode emotion. Faced with an emotional cue, people subtly imitate the associated emotion with a facial expression [17, 18]. These muscle contractions are used as afferent information by the brain to recognize the emotion [18].

### *2.1.3 Beyond faces: neural correlates of vocal emotion and emotional touch*

Beyond face, emotion perception can involve voice, touch, and posture. Perceiving emotion from voice involves areas localized in temporal regions (especially in the right hemisphere), in the medial prefrontal cortex, and posterior superior temporal sulcus (STS) [19]. Insula would support vocal disgust perception. Vocal fear and anger are underpinned by amygdala [19]. Concerning emotional touch, research is restricted to the perceived pleasure. It has been shown that right posterior insula is involved in experiencing pleasure during touch [19].

## **2.2 Neuropsychological assessment**

### *2.2.1 Assessment of emotion perception in other people*

#### *2.2.1.1 Perceiving emotion from facial expressions*

Most of neuropsychological tests assessing the perception of others' emotions are based on the perception of emotion from facial expression. There are many tests and batteries that assess this capacity.

A well-known test used in neuropsychology is the Ekman's Facial Emotion Recognition task [[20], see also [21]]. It has been adapted to be included in the Mini Social Cognition and Emotion Assessment (SEA) [22]. In this battery, the Ekman's

test is a forced-choice naming task. Thirty-five facial expressions are presented on a screen. Subjects have 12 seconds to indicate, for each face, which emotion is expressed among neutral, joy, anger, surprise, disgust, fear, and sadness. The Faces Test [23] is another princeps test. It is also a naming task of twenty emotional facial expressions with a binary forced-choice. A revised version of this test is included in the Bordeaux Social Cognition Assessment Protocol [24, 25]. Both tests share a common limit. They assess the perception of others' emotions only through naming task.

Neuropsychologists can use the Florida Affective Battery [[26], see also Ref. [27]]. It includes a set of five subtests to assess the perception and recognition of emotion (happiness, sadness, anger, fear, and neutral) from facial expressions. The subtest one is a facial identity discrimination test. It is a non-emotional task employed to make sure that patients do not suffer from visual and/or neuro-visual impairments. The subtest two is a facial affect discrimination task. Patients indicate if two faces express the same emotion. The subtest three is a naming task in which patients have to label emotion from a facial expression. Conversely, the subtest four is a selection task. Among five emotion facial expressions, patients have to indicate which one expresses the target emotion. Finally, the matching task (subtest five) requires matching a target face with a face that expresses the same emotion. The latter is presented among four distractors.

Likewise, the Comprehensive Affect Test System proposes several tasks to assess emotion perception from facial expression: a non-emotional facial identity discrimination task, facial emotion discrimination task, facial emotion naming task, facial emotion matching task, facial emotion selection task [28]. The strength of these tests lies in their inclusion of a diverse range of tasks that go beyond mere emotion naming task, enabling a more comprehensive assessment of emotion perception. However, both tests show two common main limits: the limited quality of psychometric properties and the nature of the stimuli. All the tests presented thus far employ caricatured stimuli. The intensity of facial emotion is high and presented during a relatively long time. In social interactions, the expression is often shorter and subtler than the emotions displayed in the test.

The Test of Facial Emotion Recognition, TREF [29], is a facial emotion naming task of fifty-four photos. There are nine photos for each of the six assessed emotions (anger, disgust, joy, fear, sadness, contempt). Each of nine photos corresponds to a different level of expression intensity from 20 to 100%. The lower the percentage, the more subtle the facial emotion expression. This test is included in the standardized battery ClaCoS [30]. It has the advantage of manipulating the emotional intensity of stimuli and employing color images.

Tests discussed thus far have a common limit. They use static facial expression. In social interaction, facial expressions are not static; instead, people can perceive the dynamics of emotional facial expressions. Furthermore, although patients have a limited time to answer in these tests, the duration of facial emotion expression is usually shorter in daily interactions. The Emotest [31] has been created to assess the recognition of facial expression from dynamic facial expressions. It is a computer task including twenty-four dynamical stimuli.

#### *2.2.1.2 Perceiving emotions from other modalities*

We have reviewed several tests assessing emotion visual recognition from facial expression with a consistent improvement of tools. These tools can be useful in clinical practice. However, their evaluation is restricted to the visual perception of

emotions through facial expressions, while in certain cases, there are dissociations in the ability to perceive emotions based on the nature of the stimulus. Furthermore, in clinical neuropsychology, several pathologies are associated with visual and/or neuro-visual impairments. For this patient in those cases, these tests cannot be administered. Therefore, neuropsychologists must: (a) be attentive to not overgeneralize the impairment of emotion recognition; (b) use and develop new tools for assessing emotion recognition in other modalities.

The Emotion Recognition Index [32] assesses emotion recognition with a six forced-choices emotion naming task. It includes a subtest with facial stimuli and a subtest with vocal stimuli. Both express either sadness, fear, anger, happiness, or “neutrality”.

The Florida Affective Battery [26] includes in addition to the set of five subtests to assess recognition of emotion from facial expression, the Florida Affective Battery includes a set of 3 prosodic subtests: nonemotional prosody discrimination, emotional prosody discrimination, name the emotional prosody and conflicting emotional prosody; a set of 2 cross-modal subtests: match emotional prosody to an emotional face, match emotional face to the emotional prosody.

Likewise, the Comprehensive Affect Test System [14] has subtests that assess emotion recognition based on prosody and multimodality. They include: (a) a non-emotional prosody discrimination task; (b) an emotional prosody discrimination task; (c) an emotional prosody naming task with neutral content; (d) a matching task in which patients select a facial expression among distractors associated with a target emotion prosody, and (e) interference tasks in which participant must either name emotion from prosody while ignoring semantic content or name emotion from semantic content while ignoring prosody.

The stimuli of the Florida Affective Battery and the Comprehensive Affect Test System are statics. It would be interesting to develop subtests that combine the cross-modal tasks of these tests with the Emotest. The Multimodal Emotion Recognition test [33] provides such a tool by incorporating static and dynamic visual face stimuli, auditory stimuli, as well as crossmodal stimuli. Emotion expressions vary according to five emotions and two level of arousal intensity. Thus, this test includes ten facial expressions: anxiety, panic fear, happiness, elation, cold anger, hot anger, sadness, despair, disgust, and contempt. Each emotion is presented in three videos in four modalities: video only (dynamic facial expression), audio only (vocal expression), audio with video (dynamic facial and vocal expression), and photos from films (frozen facial expression).

In the same vein, the Geneva Emotion Recognition Test [[34, 35]; see also Ref. [36] for a short version] is a forty forced-choices emotion naming task from crossmodal stimuli. Emotions are expressed through dynamic face expressions, voices, and body gestures.

### *2.2.2 Assessing perception of one's own emotion*

#### *2.2.2.1 Expressing one's emotion*

For the assessment of emotion expression, neuropsychologist can use several self-report tools (see Ref. [37] for a review of tools). The test of Self-Conscious Affect is the most widely used and well-validated tool to assess guilt and shame expression [38–40]. Subjects read scenarios and then indicate how they would react on a five-point scale of fifty items.

The Toronto Alexithymia Scale-20 (TAS-20) is a worldwide scale used to assess alexithymia [41, 42]. One factor of this scale corresponds to the difficulty to describe emotions to others (*e.g.*, “It is difficult for me to find the right words for my feelings”).

The Ambivalence Over the Expression of Emotion Questionnaire includes 28 items that assess the difficulty in emotion expression with a five-point Likert scale (*e.g.*, “It is hard to find the right words to indicate to others what I am really feeling”) [43].

Expressing emotion can also be captured in the self-report tool that assesses coping strategies. The Emotional Approach Coping scale [44] includes a subscale that assesses the ability to express emotion outward (*e.g.*, “I allow myself to express my emotion”).

The emotion-focus strategies items of the COPE Inventory include an assessment of emotional expression [45].

Such scales can provide relevant information regarding the patient’s abilities to express emotions. While useful, self-report scales have intrinsic limitations that can be related to construct and or reliability/measurement issues, and to the reliance on participants’ introspection. To provide informative self-report on their emotional expression abilities, it presupposes that patients are capable of recognizing their own emotions.

#### *2.2.2.2 Recognition of one’s own emotion*

The Levels of Emotional Awareness Scale, LEAS [46], is a widely used tool to assess people’s ability to recognize their emotional experience [47]. Subjects have to describe their anticipated feelings and those of another subject in response to twenty scenarios. Each item is scored according to the level of emotional awareness. For each scenario, a score is attributed for self and other feelings, respectively. Translations in eight languages including German, French, Italian Dutch, Portuguese, Japanese, Danish, and Spanish are available. This scale seems to be very interesting and relevant for clinical practice. However, it requires that subjects are able to express their emotions.

The Toronto Alexithymia Scale-20, exposed above, includes also a factor and a set of items that assess feeling identification (*e.g.*, “I am often confused about what emotion I am feeling”) [41, 42].

Researchers have developed a Bodily Maps of Emotions [48] that assesses emotion expression through body sensations perception. In this task, participants have to color bodily regions of empty body silhouettes in which they feel an increase or a decrease in activation in response to emotional stimuli. This task is not yet validated for clinical use, but it could become an interesting tool directly targeting the physical experience of emotions and bypassing linguistic abstraction.

### **2.3 Functional impact**

Finely perceiving emotion is critical to social skills. For example, an impairment in the recognition of facial emotion is associated with disability, quality of life reduction, and disturbance in social relationship [49]. Thus, perceiving emotion is essential in daily functioning. For example, it has been shown that a better capacity to perceive emotion protects quality of life in bipolar type I disorder [50], is associated with social adjustment for school-aged girls [51], a better work functioning and independent living in schizophrenia [52], a better adaptive functioning in adults with autism spectrum disorder [53], and a better quality of life in psychological

and social aspects in multiple sclerosis [54]. Conversely, difficulties in perceiving emotion are associated with a higher likelihood to be unemployed or unable to work in bipolar disorder [55], a reduced psychological quality of life and a lower social participation following stroke [56], a communication, community functioning, social problem-solving, social skills and occupational dysfunction in schizophrenia [57, 58], and lower socializing abilities in autism spectrum disorders [59].

### **3. Using emotions to facilitate thought**

Regarding the Ability Model of emotional intelligence, the second branch of abilities involves using emotions to enhance one's thinking [6]. These capacities include both generating emotions to facilitate thought and tailoring thinking to emotion. Thus, this branch would allow us to (1) select problems based on how one's ongoing emotional state might facilitate cognition; (2) leverage mood swings to generate different cognitive perspectives; (3) prioritize thinking by directing attention according to present feelings; (4) generate emotions as a means to relate to experiences of another person; and (5) generate emotions as an aid to judgment and memory [6]. Using our emotions to facilitate thinking would allow us to put our emotions at the service of our cognitive functioning by allowing us, in particular, to guide our attention toward the most relevant environmental cues [60]. Individuals with a good ability to use their emotions to optimize their thinking understand that certain emotions are relevant to carrying out an activity or achieving a goal [60].

Part of emotional facilitation lies in knowing how to include emotional in, and how to exclude emotions from, thought. Some studies show that people with higher EI might have less interferences from emotional words in a Stroop emotional test (e.g., see [61]).

These abilities seem to involve the coordination between cold processing (as reasoning or memory) and emotions. Indeed, several neuropsychological studies have shown that emotional events are better memorized than neutral ones. Also, studies regarding decision-making have shown that emotional intelligence would make decision-making processes more efficient by reducing cognitive biases [62].

Emotions, as well as physical sensations, are the information processing heuristics that have an evolving function. In his presentation of Phineas Gage, Damasio already highlighted the impact of emotions on driving decision-making [63].

Some authors link this second branch of abilities to the concept of affective empathy [64]. It would be a catalyst through which another person's emotions can influence and mobilize social behavior [64]. Affective empathy refers to the capacity to share the emotional state of another person, becoming a major source of motivation for individuals to perform prosocial behaviors intended to benefit the other [65].

Empathy involves the generation of an emotional response from the observer to a situation that affects other individuals. Several authors differentiate two types of empathy: cognitive empathy, which refers to the person's ability to interpret and understand the experiences and feelings of others; and affective empathy, which involves the emotional reactivity of the person in the face of the emotion of others.

If cognitive empathy solicits neurocognitive abilities of mentalization, affective empathy solicits different capacities and is associated with its own neural networks. A process still different from affective empathy is emotional contagion, which leads to the observer not only being aware of the emotional state of the other person, but also feeling the same emotion [64].

### **3.1 The neural correlates**

#### *3.1.1 Affective empathy and emotional contagion*

These various processes seem to have different, but connected neural substrates. The ability to prioritize emotional information from oneself and others depending on contextual demand appears to be dependent on the temporoparietal junction (TPJ) [64]. The ability to sense another person's emotional states depends on the ventrolateral region of the Pre-Frontal Cortex (vlPFC) and the insula (involved in bodily feelings related to emotions) [64]. This empathy network, therefore, would allow face detection and response to others' distress [3].

#### *3.1.2 Emotional memory*

The memorization of events with positive or negative emotional valence plays a key role in decision-making processes [64]. The cerebral circuits, which support the processes of memorizing information containing an emotional valence, are well known, the Papez circuit associated with the amygdala. This circuit includes the perirhinal cortex and the hippocampus. The hippocampus is a key region in the encoding and retrieval of episodic information. The perirhinal cortex seems to play a role in the recognition of stored items. As for the amygdala, it allows the amplification of the consolidation and the retrieval of information with an emotional valence. The amygdala and nucleus accumbens are involved in associative learning [66].

#### *3.1.3 Mirror network*

The mirror neuron system (MNS) is a group of specialized neurons located in the parietal and prefrontal areas that “mirror” the actions and behavior of others [3, 67].

Brain imaging studies have shown that when humans observe actions, specific areas of the brain are activated. These areas include the inferior frontal gyrus (IFG), the precentral gyrus, the inferior parietal lobe (IPL), as well as the visual areas [68].

The MNS is somatotopically organized and fires while observing meaningless movements [68]. The IFG, the IPL, and the superior temporal sulcus (STS) regions participate in giving meaning to the movements [69].

The mirror neurons transform visual observation into knowledge [64]. Studies on humans during action observation have shown activation of the IFG, the IPL, and a region within the STS.

#### *3.1.4 Decision-making*

Being able to adjust and improve our behavior in response to changes in emotional significance is crucial for success in tasks that involve reversal learning and decision-making [70]. Damasio [63] described several cases of patient with frontal lesion which led to major difficulties in decision-making (disastrous professional and personal choices, difficulties in adjusting appropriately in activities of daily living, in adapting their social behavior, or in reacting appropriately to various professional or personal situations), whereas other cognitive functions were preserved. Those lead to the proof that (a) decision-making involves cognitive intelligence, but also emotional processing; (b) those skills are at least supported by frontal areas.

In order to make good decision, critical clues must be selected. Amygdala acts as an amplifier that will bias downstream cortical targets' activity in order to prioritize the processing of salient stimuli [64]. The orbitofrontal cortex, the amygdala, and the ventral striatum are involved in the emotional marking of stimuli [71].

The medial prefrontal cortex, including the orbitofrontal cortex, receives multi-modal sensory information and provides the main outputs from the cortical structures to the visceromotor structures of the hypothalamus and the brainstem [72]; the medial prefrontal cortex involved in the processing of pleasure [73], gratifying results [74] and in the formation of hedonic associations [75].

The ventromedial prefrontal cortex (vmPFC) involved in the association between a situation and a specific internal state would make it possible to create somatic markers which will either encourage or conversely constrain decision-making processes according to the harmful consequences and by seeking beneficial solutions [63].

### **3.2 Neuropsychological assessment of empathy**

The assessment of empathy in neuropsychology has usually been done with questionnaires. To our knowledge, no standardized behavioral test of empathy has been developed. The Interpersonal Reactivity Index (IRI) [76] self-questionnaire is the most widely used in research. It is composed of 28 items and differentiates between cognitive and emotional or affective empathy. Four sub-dimensions make up the questionnaire: perspective-taking, imagination, empathic concern, personal distress. Perspective taking and imagination make up cognitive empathy, and empathic concern and personal distress affect affective empathy.

The Empathy Quotient (EQ) of Baron-Cohen and Wheelwright [77] is a 60-item self-questionnaire (there is also a shorter, 40-item version) designed to measure empathy in adults.

The Basic Empathy Scale in Adults (BES – A) [78] is also a self-administered questionnaire comprising 20 items. Like IRI, this scale differentiates cognitive and affective dimension.

The Questionnaire of Cognitive and Affective Empathy (QCAE) [79] is a tool for self-assessing the cognitive and emotional components of empathy. It is more used in patients with psychiatric disorders in particular with schizophrenia.

### **3.3 Functional impact**

#### *3.3.1 Academic achievement*

Brasseur and Gregoire [80] observed in unskilled students as well as in high potential students that high scores in certain areas of emotional intelligence related to the ability to use emotions to improve reasoning (empathy score, interpersonal skills, adaptability, and assertiveness) were positively correlated with academic achievement as well as social skill.

#### *3.3.2 Social relationship*

Lopes and colleagues' study [81] observed that higher score at on the second branch of the model significantly predicted participants' self-perceptions of social competences. Another study shows a better ability to estimate one's skills in reacting

to events in their friends' lives [82]. Also, the higher the EI, the better the perception by others of one's own social competence (i.e., social commitment and the degree of being a team player) [82]. Lopes et al. [83] showed that higher EI score predicts better capacities in social interaction.

### *3.3.3 Occupational*

Day and Carroll [84] reported that participants with high EI had more citizenship behavior at the group level (e.g., showing concerns for the organization). The Affect Infusion Model [85] explains how affects can be used to influence cognitive processes. It proposed that the more complex the task, the more affects influence cognitive processes involved in that task [60, 85]. Thus, affective experience cannot be ignored in the workplace because according to this model affective state has a direct influence on decisions made at work [60]. For example, workers involved in complex tasks use their affective states to make decision based on heuristic or substantive reasoning [60].

### *3.3.4 Psychological and physical well-being*

EI is related to greater life satisfaction, self-esteem, and lower ratings for depression. In contrast, EI seems to be negatively correlated with some negative physical health behaviors even though this correlation was not systematically found or was small [5].

## **4. Understanding emotions**

After perceiving an emotion, the individual utilizes emotion-related information not only to make inferences about the social situation and the interlocutor but to also to make inferences about the interlocutors' representation of the observer [86].

Understanding the emotions and thoughts of others is essential for social interaction. This cognitive ability is referred to as "theory of mind" (ToM) or mentalizing [87]. It plays a fundamental role in the development of interaction skills.

### **4.1 The neural correlates**

Neuropsychologists differentiate two aspects of theory of mind. One is the cognitive ToM, and the other is the affective ToM [88]. Cognitive theory of mind refers to the ascription of mental states to the self and others [64]. However, the ability to distinguish and recognize both our own emotions and those of others, as well as being aware of the causes and trajectories in emotions, requires the utilization of the affective theory of mind. These two aspects of social cognition are associated with different brain circuits [64].

#### *4.1.1 Cognitive and emotional theory of mind systems*

A circuit connecting the regions of the superior temporal cortex and prefrontal cortex appears to be involved in the attribution of mental states.

Indeed, cognitive ToM appears to be systemically correlated in neuroimaging studies with the neural activity recorded in the TPJ, the middle temporal gyrus, the

precuneus, and the lateral and medial prefrontal cortices and lesions in any of these regions cause alterations in cognitive ToM (see [89] for a summary of available data). The dlPFC is associated with the cognitive but apparently not with non-affective aspects of the ToM [90].

The activation of the TPJ is diminished during an intention attribution task and in false belief detection tasks [91].

The vmPFC appears to treat emotional inferences. Lesions in the vmPFC cause impairments in the ability to infer thoughts and behaviors of others influenced by emotions. The lesions to the left hemisphere of this region are linked to difficulties in identifying social *faux pas* [64].

#### *4.1.2 First- and second-order beliefs*

The study of the theory of mind makes the difference between the ability to represent first-order mental states (my inferences about others' mental states) that appear early in development and the ability to identify second-order mental states (my representation about others' inferences about my mental states) [92]. This second representation is of later development (5–6 years) [93].

Increased brain activity was observed in ToM of first-order task in a complex network of the social brain: the medial prefrontal cortex (mPFC), TPJ, STS, and precuneus when subjects represented the beliefs of others [94].

Second-order representation appears to similarly activate the PFC and the STS, but also the posterior cingulate cortex and the PFC. In functional activation correlation studies, a greater correlation was observed between PFC/CCA activation and the hippocampus. And the task of prediction of second-order mental states also seems to couple the activity of caudate and insula [94].

#### *4.1.3 Implicit and explicit treatment*

Automatic inferences versus explicit information processing can also be differentiated. The explicit processing is more flexible in the ability to process information, is resource intensive, appears later in the development (around 4 years), and is related to the TPJ, precuneus, temporal poles, and STS network [95]. Automatic processing consumes fewer cognitive and energy resources, develops earlier (18 months), and is less flexible [95–98]. Similar regions seem to be concerned in automatic ToM with the addition of the prefrontal cortex [99].

## **4.2 Neuropsychological assessment**

Among the neuropsychological tests that allow for the assessment of inferences about cognitive and emotional states in others, the most relevant one is the Reading the Mind in the Eyes Test - RMET [77]. It measures affective theory of mind in participants who are presented with different actors' gazes and who have to choose among four response options that correspond to complex mental states.

The Attribution of Intentions task [100, 101] in the form of a comic strip evaluates the ability to understand physical causal inferences with human characters and inferences about the characters' intentions.

The Theory of Mind-15 (TOM-15) test [102] assesses the individual's ability to detect a cognitive false belief. It is presented in the form of a comic strip and includes both first-order and second-order false belief tasks.

The Faux Pas task [103] assesses the ability to recognize social awkwardness based on the presentation of multiple fictional and socially ambiguous stories.

The Mask test from the ClaCoS battery [30] is a test to evaluate the ability of theory of the mind by means of a film, where it is a question of attributing an emotional or cognitive mental state to the characters. This test allows differentiating of the types of response error: lack of ToM, default of ToM (a low inference is produced), and hyperToM mistake. These different types of error allow neuropsychologists to guide the type of cognitive rehabilitation proposed later.

### **4.3 Functional impact**

Difficulties in understanding and interpreting the thoughts and feelings of others can be associated to psychopathological conditions. This is seen in several conditions, including schizophrenia, borderline personality disorder, post-traumatic stress disorder, depression, and eating disorders but also with psychosocial conditions as childhood adversity [[104] for a review]. Dysfunctional ToM has been proposed as a transdiagnostic clinical marker [105]. Good performance in ToM capabilities is related to a better social functioning (e.g., less loneliness, less social rejection, and being rated as socially skilled by teachers [106–108]) and also to prosocial behavior, peer popularity, and reciprocal friendship [109–111].

## **5. Regulating emotions**

Although neuropsychology has traditionally made a distinction between the generation of emotions and the management of their impairments from reports on patients with brain lesions who demonstrated dissociation in these abilities [112], the concept of emotional regulation has been weakly addressed in neuropsychology [113].

Emotional regulation is a multifactorial concept that incorporates several psychosocial skills. One of the most widespread conceptual models on emotional regulation is Gross's Process Model of Emotion Regulation [114]. This model suggests that emotional regulation is supported by a series of behavioral strategies that depend on neuropsychological functions (situation selection, situation modification, attentional deployment, cognitive change, and response modulation).

### **5.1 Situation selection**

Situation selection is the competence that allows one to guide their actions in order to avoid or ensure future consequences. More concretely, it enables the prediction of trajectories of emotional experiences in the future [115]. It is supported by two neuropsychological functions, the capacity to generate an array of hypothetical future scenarios and the ability to decide among them based on their potential emotional impact [116].

These abilities rely on autobiographical memory and the capacity to make inferences about the future consequences of actions. Bilateral activation of the hippocampi appears to be important in utilizing episodic memory for these competencies [117], while the vmPFC appears to enable the generation and selection of multiple scenarios [118, 119].

Subjects having alterations in these areas present difficulties in decision-making and in using memory to generate scenarios [112].

If we imagine the example of a person with a subway phobia, a strategy of situation selection to manage emotions would be the choice of a less uncomfortable transport.

## **5.2 Situation modification**

Situation modification involves rapidly and flexibly devising alternative actions that could potentially alter the course of a situation [116]. This psychosocial competence requires good problem-solving skills and depends on the dlPFC [112].

Problem-solving requires task setting skills and the ability to change the action plan depending on internal or external constraints. These executive processes appear to be associated with the left lateral PFC cortex. However, the monitoring of the action plan and the detection of errors seem lateralized to the right hemisphere [120]. Behavioral perseverations are the behavioral correlation of difficulties in having flexible executive control [121].

Following the example of a person with difficulties traveling in subway, if there is a breakdown, the strategy of being able to quickly change the means of transport would be a modified situation strategy.

## **5.3 Attentional deployment**

Similar to how the situation selection skill enables the choice of situations that lead to an improvement in emotional experience, attentional deployment facilitates the shift of attentional focus toward more positive thoughts or stimuli [112].

This skill requires the use of networks of attentional control (sustained attention, inhibitory control in working memory, and detachment of attentional focus from negative stimuli). The fronto-parietal attentional control network appears to be the underlying anatomical substrate [112].

This network is functional early in development and is correlated with the regulation of negative emotions [122].

For our traveler stuck in the metro, this skill would change the attentional focus of catastrophic and negative automatic thoughts that would otherwise increase the experience of a grueling journey.

## **5.4 Cognitive change**

Cognitive change is the strategy of using verbal thinking to change one's emotions. This strategy is the basis of the cognitive or Socratic restructuring, a psychotherapeutic method from the Cognitive Behavioral Therapy (CBT) approach. Cognitive reappraisal involves recognizing the negative pattern the person thoughts have fallen into, and changing that pattern to one that is more effective.

Cognitive change is also a multifactorial skill requiring several neuropsychological components: working memory, inhibition, verbal fluency, and set shifting. Buhle and colleagues reported [123] that the implementation of this strategy consistently modulated the amygdala bilaterally and activated cognitive control regions (dmPFC, dlPFC, vlPFC, and posterior parietal lobe).

For the person stuck in the metro, the cognitive change skill can generate such altered thoughts in the face of automatic thoughts. For example, in the face of thoughts "I am always the one who finds difficulties in the subway" or "if I have a medical problem, I will not be able to get out of here"; the ability to change cognitively

and generate thoughts like “I take the subway every day and most of the time it runs without problems” or “there is no reason for me to have a medical problem, and there is an alarm that will allow the doors to open and rescue to arrive quickly.”

## **5.5 Response modulation**

Response modulation consists of either amplifying or suppressing the behavioral reactions generated by emotions [114, 124]. These answers are at the level of the facial muscles, gestures, and postures [116].

Neuroimaging studies show the activation of regions associated with interoception, emotional awareness, and cognitive inhibition.

Previous research on emotional response suppression has reported a correlation between this style of behavior evaluated with a self-assessment questionnaire and resting activation of the vmPFC [125].

Other authors [126] have found broader activation of the left lateral prefrontal cortex, the medial prefrontal cortex and the medial orbitofrontal cortex during an emotional suppression task compared to an emotional attending task. In the former, participants had to try to suppress their emotional responses to stimuli. In the latter, participants had to be aware of their emotional responses to stimuli without regulating them.

In addition to the differences at the functional level, at the structural level, the use of emotional regulation strategies is associated with greater volume of gray matter in the dorsal anterior cingulate/paracingulate cortex, the amygdala [127], the medial prefrontal cortex [127, 128] and the anterior insula [129] (which is involved in interoceptive treatment and emotional awareness).

To our knowledge, no research has studied the neural correlates of the emotional amplification response.

Cognitive inhibition is the basis for suppressing response and cognitive inhibition difficulties are presented in the form of behavioral impulsivity, that is, inability to control a behavioral reaction once it is elicited [130].

If we continue with the example of the person feeling unpleasant sensations in the subway, the response of emotional modulation could remove the facial and postural signs of anxiety.

## **5.6 Regulating emotion assessment**

The evaluation of these behavioral strategies has not been performed within the framework of neuropsychology. However, process psychotherapeutic approaches (CBT) increasingly incorporate questionnaires to assess emotional regulation. The Multidimensional Experiential Avoidance Questionnaire MEAQ [131] assesses Experiential Avoidance, which is defined as the tendency to avoid negative internal experiences.

The Mini-Cambridge Exeter Repetitive Thought Scale [132] allows identifying of repetitive automatic thoughts and differentiating between constructive and non-constructive thoughts.

## **5.7 Functional impact**

Difficulties in regulating emotions are a transdiagnostic symptom common to several disorders (e.g., substance use disorders [133], eating disorders [134], bipolar

disorder [135]). Notably, ADHD is conceptualized as a difficulty in modulating cognitive and emotional functioning [136].

Personality disorders also present difficulties in emotional regulation at the core of their expression [137]. Lopes et al. [83] showed that high emotional regulation capacities predicted: (a) reciprocal friendship nomination (i.e., the fact that the student X nominates the student Y as their friend, who in turn nominated the student X as their friend); (b) self and peer-perception of interpersonal sensitivity and prosocial tendencies; (c) and the proportion of positive peer nomination (i.e., the nomination of a student for positive criteria) versus negative peer nominations.

## **6. Conclusions**

The neuropsychological assessment of processes related to emotional intelligence and social cognition allows for the identification of difficulties in typical social interactions in a significant number of neurological, psychiatric, and neurodevelopmental conditions. In the case of adult individuals, these cognitive difficulties are often compensated for by executive strategies.

The development of assessment tools for emotion perception, emotion identification, and emotional regulation skills, along with the establishment of emotional intelligence profiles, has paved the way for the development of more systematic EI testing in neuropsychology practice.

At a time when hospital and private practitioners are often overwhelmed with diagnostic and support demands related to emotional difficulties, the conceptualization of emotional intelligence could prove to be an integrated, practical tool for neuropsychologists and psychotherapists.

The current theoretical confusion among terms such as intellectual giftedness, hypersensitivity, and emotional giftedness could be reduced thanks to the development of conceptual and psychometric tools within the sphere of emotional intelligence. All these above mentioned categories represent a form of intricacy between “cold” and “hot” cognition and the theoretical confusion mentioned could be partly due to the lack of a clear integration between “affective” and “cognitive” processes. In this state of affairs, several concepts have been developed separately. EI could serve as a set of criteria contributing to distinguishing between or to assimilating, the various categories.

Finally, the neuropsychological point of view interprets EI as a meta-concept that provides us with a connection between classical neurocognitive functions and social cognition, extending also the intellectual evaluation of the individual to better understand the success in social interactions.

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*Edited by Éric Laurent*

Intelligence has long been a focal point and an explanatory framework of performance and behavior for researchers in psychology and cognitive science. However, the concept of “intelligence” has been explored through various metaphors and models. In 1990, Salovey and Mayer coined the term “emotional intelligence” (EI) with respect to a set of processes consisting of identifying and regulating emotions, and more generally, adapting behavior to this emotional context. Three decades later, this book compiles seven chapters introducing the most influential models of emotional intelligence, stressing the developmental trajectories that are related to EI dynamics as individuals age and delving into cognitive and neural activities associated with EI. Additionally, the book discusses the application of EI research to the contexts of everyday life choices, economic decision-making, and neuropsychological practice. Altogether, the various chapters also provide the opportunity to reconsider the intricate nature of what has often been considered separately as “cognitive” and “affective” processes.

Published in London, UK

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