

ΠΑΝΤΕΙΟΝ ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΟΙΝΩΝΙΚΩΝ ΚΑΙ ΠΟΛΙΤΙΚΩΝ ΕΠΙΣΤΗΜΩΝ

PANTEION UNIVERSITY OF SOCIAL AND POLITICAL SCIENCES



PSYCHOLOGY DEPARTMENT

MASTER'S PROGRAM "PSYCHOLOGY" 2022-24

SPECIALISATION: APPLIED COGNITIVE AND DEVELOPMENTAL
PSYCHOLOGY

**How Does Complex Emotion Influence Time Perception?
An Experimental Study in Early Developmental Stages**

THESIS

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0622M027

Athens, 2024

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To my students

Acknowledgements

I would like to express my deepest gratitude to my parents and grandparents for their encouragement throughout another academic journey.

I am also thankful to my sisters, Elina and Stavrina whose enthusiasm, motivation and belief have been a constant source of strength and to my little brother Christos, whose insights and perspectives as a child have impelled me to enrich my psychoeducational approaches when engaging with children and adolescents.

A heartfelt thanks to my partner and friend George Dimas (PhD) whose help but – above all – love and patience have been my anchor.

I am also indebted to my Supervisor, all the Professors, PhD students and Guest Lecturers of the Psychology Master's Program for letting each task be an enjoyable moment.

I would be remiss in not mentioning the children, the professionals and the academics that I had the pleasure to meet throughout my training experience and extend my sincere gratitude for entrusting me with meaningful projects that challenged me to grow both professionally and personally.

I am deeply appreciative of all my friends, colleagues, all teachers and staff at school where I work, whose daily understanding and support have been invaluable.

Finally, this endeavour would not have been successful without my beloved students and their families whose collaboration and trust continue to inspire me every day.

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Abstract

This thesis investigated the effect of complex emotions on time perception in preschool children, aiming to enhance our understanding of emotional modulation of time perception. Building on research that indicates emotions can alter subjective time experience, this experimental study focused on how specific complex emotions (embarrassment, worry, gratitude, and relief) impact the perceived event duration. Subjects included 22 children aged 4.5 to 5 years from a Greek private school. The methodology comprised a pre-test of emotional understanding, a temporal bisection task, and an emotional valence assessment. Key findings suggest that complex emotions do affect time perception, with negative emotions like worry and embarrassment leading to an overestimation of time intervals, while positive emotions like gratitude and relief have a lesser impact. Although these results were not statistically significant, they align with previous research indicating that emotions with negative valence tend to slow down perceived time. The study highlights the importance of considering emotional states in educational and psychological practices, suggesting that understanding how complex emotions influence time perception can aid in developing better strategies for emotional regulation and learning in early childhood. Further research is needed to explore the role of other cognitive factors, such as arousal and cognitive load, in the relationship between complex emotions and time perception. The study discusses implications for educational and psychological interventions, emphasizing the need to support children's emotional and cognitive development through differentiated approaches. Future research should investigate developmental patterns in emotion-time interactions and integrate measures of cognitive load, motivation, and attentional focus to advance our understanding of these mechanisms.

Keywords: time perception, complex emotions, valence, preschool children, cognitive development, temporal bisection

Introduction

Emotion and Time Perception in Early Childhood

We possess a sense of time from a young age (Droit-Volet & Wearden, 2002). This sense, however, can be subjectively altered in children and adults by a central element, *emotion* (Almeida et al., 2016; Droit-Volet, 2019; Droit-Volet et al., 2016; Gil & Droit-Volet, 2012; Wittmann et al., 2010; Wittmann & van Wassenhove, 2009). More specifically, this intrinsic sense of timing allows even young children to have some level of understanding of the passage of time. Yet such a perception of time is not static and can be considerably influenced by various factors at different stages of life. Research shows that emotions tend to play a key role in shaping our subjective experience of time. This phenomenon has been noted in both children and adults, indicating a pervasive and strong interaction between affective states and time perception. Research by Almeida et al. (2016) and Droit-Volet (2019) shows that emotions have the potential to either accelerate or decelerate the sense of time, dependent on the underlying nature and intensity of the emotional experience. Further investigation by Droit-Volet et al. (2016) and Gil and Droit-Volet (2012), provided evidence suggesting the idea that emotional arousal can distort the perception of time, leading to either an overestimation or underestimation of time duration.

Moreover, more studies (Wittmann et al., 2010; Wittmann & van Wassenhove, 2009) have also echoed this body of literature by studying the neural and cognitive mechanisms that underlie this interaction. Their findings indicate that the brain's processing of emotional stimuli may modify its ability to measure time accurately, thus altering the subjective experience of time passing. Considering the above studies, it is obvious that emotions are a key aspect of subjective change in time perception. In fact, this interaction between emotion and time appears to be both complex and multifaceted, which necessitates and therefore merits a deeper investigation towards a full understanding of how it is manifested in the early developmental stages.

The current thesis aims to further explore this convoluted interplay between complex emotional states and time perception in preschool children. Prior research utilizing standardized emotional stimuli (e.g., words, images, and videos), supports the 'internal-clock' model, indicating that emotional arousal (high/low) and valence (positive/negative) can distort time perception independently of other cognitive

functions. However, the influence of complex emotion facial expressions on time perception, particularly in preschool children and in relation to valence, is not yet fully understood. Although some studies have begun to explore this area, the findings regarding the effect of emotional valence on time perception remain inconclusive, highlighting a gap in our current knowledge (Gil et al., 2007; Gil & Droit-Volet, 2012).

Valence Mechanism and Time Perception

Valence is defined as the subjective assessment of an emotional state ranging from positive to negative (Harmon-Jones et al., 2011; Lazarus, 1991). This concept is central to understanding how emotions influence our perception of time.

Traditionally, the valence approach to time perception suggests that positive emotions tend to hasten, while negative emotions tend to slow down the perception of time. However, recent findings have shown that this relationship is not as straightforward as previously thought. For instance, certain negative emotional states, such as sadness and anger, have been observed to accelerate the perception of time, which challenges the notion of valence (Benau & Atchley, 2020; Gable et al., 2016; Gil & Droit-Volet, 2009; Yin et al., 2021). This complexity is further highlighted by studies like those of Droit-Volet et al. (2004), which found that while the valence of emotional images did not impact duration estimates, arousal levels played a significant role. Specifically, duration estimates increased with higher arousal when emotional images were present during encoding.

Supporting this nuanced view, the study by Van Veenburg and Balsam (2014) aligns with Droit-Volet et al. (2004), suggesting that valence alone does not interfere with duration judgments of emotional images. However, these judgments do increase with higher arousal levels when emotional images are involved during the encoding process. This indicates that arousal, rather than valence, may be a more critical factor in the temporal distortion caused by emotions.

Moreover, Angrilli et al. (1997) demonstrated that high-arousal negative stimuli, such as fear and anger, lead to overestimation of time intervals, whereas low-arousal positive stimuli, such as contentment, do not significantly alter time perception. This suggests that the interaction between arousal and valence is complex and warrants further exploration as well. Studies by Lake et al. (2016) and Tipples (2018) also emphasize the role of valence on time perception, showing that emotional intensity can significantly modulate the perceived duration of events.

In light of these findings, it is necessary to consider additional factors in temporal alterations, such as the type of emotion (simple or complex) and its association with valence levels. This more nuanced approach can probably provide a deeper understanding of how different emotional states influence our perception of time. Below, we present evidence suggesting that complex emotions, which often involve mixed valence and varying levels of arousal, act as an affective mechanism influencing time perception. This comprehensive approach aims to reconcile discrepancies in the literature and offer a more detailed framework for understanding the emotional modulation of time perception.

Complex Emotions

To-date prior research on the emotional development during early developmental stages is mostly directed towards infants' and children's understanding of *simple* (also referred to as *primary* or else *basic*) emotions (Ekman, 1992) such as *happiness*, *sadness*, and *anger* (Denham, 1998; Eggum et al., 2010; Grossman, 2010; Herba et al., 2006; Kahana- Kalman & Walker-Andrews, 2001; Lewkowicz, 2010; Soken & Pick, 1992; Vaillant-Molina & Bahrack, 2013; Walker-Andrews, 1997), whereas the issue of complex emotions (*pride*, *embarrassment*) is somehow neglected. Complex emotions (also cited as *secondary*) imply the ability to self-assess in relation to internalized norms of behavior (Bosacki & Moore, 2004). It has been found that children become self-aware and can evaluate their own behavior by three (3) years of age (Denham, 1998; Lewis, 1995). It is at the age of almost four (4) years (older preschoolers) when children begin the process of grasping certain complex emotions or else known as "later emerging" emotions (Widen & Russell, 2008) such as *fear* (Borke, 1971; Bullock & Russell, 1984; Denham & Couchoud, 1990; Widen & Russell, 2004; Widen & Russell, 2008), *surprise* (Widen & Russell, 2010a, 2010b), or *anxiety/worry* (Pons et al., 2004; Russell & Paris, 1994; Eisenberg et al., 2010). Understanding of basic emotions provides a premise for developing awareness of more complex emotions (Russell & Paris, 1994).

In an early exploration of children's emotional understanding through interviews, Harris et al. (1987) found that the rapid development of understanding less simple emotional terms is an abrupt process. Complex emotional concepts are not acquired until almost six (6) or seven (7) years of age, as supported by Harris (1989) through verbal tasks and Seidner, Stepik, and Feshbach (1988) through simple

vocabulary tasks (puppet interview). However, Russell and Paris (1994) rating verbal responses in story-telling completion, proposed the “Weak Abruptness Hypothesis”, suggesting that not all children at a particular age, such as 4-year-olds, have fully grasped a specific complex concept. More specifically, labeling tasks have shown that preschoolers acquire core aspects of complex emotions (*pride, gratitude, shame, worry, and jealousy*) partially by being able to associate them with the sensation of pleasure/unpleasure (i.e., the valence dimension positive/negative) and arousal (high/low arousal) they entail (Bosacki & Moore, 2004; Capps et al., 1992; Russell & Paris, 1994). Children's ability to correctly perceive the varying valences associated with complex emotions such as relating *pride* to *happiness* or *embarrassment* to *sadness*, demonstrates a partial understanding of these more complex emotional concepts (Paris & Russell, 1994). Yet their understanding is rather at an early stage as they lack a subtle sense of the specific contextual input that may trigger these emotions. Interestingly, within a neurodevelopmental perspective to time perception children at the age of three to five (3-5), are not yet fully aware of time and its relevance. Therefore, time judgments are often context-dependent like either other significant non-temporal information or imminent physiological and emotional states (Droit-Volet, 2012).

Even among older ages (7-9 years old), the acquisition of complex emotional concepts is not an all-or-nothing process (Graham et al., 1984; Graham & Weiner, 1986; Graham, 1988; Thompson, 1989; Russell & Paris, 1994). Collectively, these studies highlight children's broader cognitive abilities as they explore the complexities of emotional experiences, gradually shifting beyond basic emotions to a more sophisticated understanding, within the realm of their developmental stage.

Furthermore, Droit-Volet and Meck (2007) and Gil and Droit-Volet (2007) used female face images (angry, happy, sad and neutral) in a bisection task. A bisection task is a psychophysical method used to measure perception, where participants judge whether a given stimulus duration or intensity is closer to a shorter or longer reference value. This task is often employed in studies of time perception and other sensory modalities (Allan & Gibbon, 1991). They found that a temporal bias for *anger* exists from the early age of three years and remains across children's developmental stages. Earlier, Droit-Volet et al. (2004) using related stimuli had claimed the same for the complex emotion of *fear* and *shame*, whereas *sadness* was slightly overestimated by 5-year-olds as compared to 8-year-olds and adults. By

contrast, *disgust* had no change in bisection functions. Moreover, research by Wearden et al. (2014), also focused on how complex emotions can affect time perception and more specifically the internal clock speed. Through their work, it is revealed that emotions have an important impact on the internal clock speed, revealing that both simple and complex emotions can significantly affect the perception of duration of the different intervals. More specifically, they highlighted that the complex emotions, which are related to social and contextual cues developed from an early age in a human's life, lead to an interaction between cognitive development and emotional situations, which actually determine the way and precision in which children perceive time. Such findings highlight the issue of complex emotions' effect on time perception as a valuable area for further study. While the existing literature provides a foundation, deeper research is needed to enhance the robustness and applicability of these findings. Reexamining how complex emotions change in terms of valence may help identify timing mechanisms that are not influenced by other mental processes (such as memory). A deeper investigation would not only enrich our understanding of cognitive and emotional developmental processes based on participant's subjective evaluation of an affective state (positive or negative), but will also provide practical implications for education, emotional regulation, and potential clinical applications in preschool children: i) Insights obtained through this research may be applied in educational environments. In case certain emotions are found to distort the perception of time, teachers can adapt learning settings that best fit the emotional states enhancing the learning efficiency. Establishing a positive emotional atmosphere can help children sense as though classroom time flows quickly, potentially increasing engagement and reducing anxiety. ii) Understanding the way such feelings interrelate with time perception, educators and psychologists can teach children powerful emotional regulation strategies. Such strategies are critical in helping children manage their feelings in a healthy way, possibly mitigating anxiety and depression as they grow into adolescence. iii) The perception of time can be particularly distorted by emotional states for children with developmental or emotional disorders, such as attention deficit hyperactivity disorder (ADHD) or autism present in the 21st century's inclusive classroom. Investigating these interactions might yield better targeted treatments and interventions addressing the specific needs of these groups of children.

Thus, our study aims to address preschoolers' complex emotional understanding and its relation to time perception in the series of three experimental tasks: First, the emotion understanding pretest including both basic, complex and a neutral emotion. Then the main experiment through the time bisection task to test the effect of balanced complex emotions on temporal perception. As mentioned, the dimension of valence (positive or negative) is a novel aspect of this research. Hence, as a final step, emotion valence assessment will be elaborated following Russell's (1980) Self-Assessment Manikin (SAM) model for the valence dimension. The Self-Assessment Manikin (SAM) test is a non-verbal pictorial assessment tool used to measure an individual's emotional response along the dimensions of pleasure, arousal, and dominance. It utilizes a series of images representing different levels of each dimension, allowing participants to indicate their feelings without the need for verbal descriptions. Results on complex emotion valence and time associations will be discussed.

Aims of the study

Given these complexities, this thesis aims to delve deeper into how emotions—particularly complex ones in young children—affect the subjective experience of time through an experimental approach. Specifically, this research seeks to refine our understanding of the emotional modulation of time perception by investigating the impact of both positive and negative valenced complex emotions on how time is perceived. This study will reconcile the discrepancies found in current theoretical approaches by following a series of tasks designed to measure and analyze time perception in the context of complex emotional influences. The methodology will include an emotional comprehension task, where children will engage in activities designed to elicit and measure their understanding of different emotions, both simple and complex. This will be followed by the main temporal bisection task, a well-established experimental procedure used to assess how individuals perceive the duration of time intervals. Finally, an emotional valence assessment task will be conducted to evaluate the emotional states of the participants after the temporal bisection task's stimuli exposure. With the integration of these tasks, the research aims to deliver a coherent overview of how complex emotions in young children affect their subjective experience of time, leading to a clearer understanding of the correlation that exists between emotions and time perception. Finally, compared to the

previous literature, our study aims to investigate whether a consistent effect of both basic and complex emotions exists in the way preschool children perceive and process time intervals in a controlled experimental environment. Research on understanding complex emotions in pre-schoolers is an evolving domain and several approaches have been explored. The proposed idea is that implicit measures, such as timing, should be considered more seriously in the study of emotions - and specifically in complex emotions - in children. In this notion, implicit processes which may occur more automatically and convey emotional processing information that explicit measures such as self-report, may not accurately reflect in young children. On the understanding of emotions and their effect on time perception in general, a deeper look to the literature reveals a few shortcomings (Angrilli et al., 1977; Bar-Haim et al., 2010). This study addresses the need for a new insight into the way complex emotion and time perception interplays in preschool children, so far lacking in the scientific literature. Recognizing the impact of complex emotions on time perception in preschool children holds practical implications for educators and caregivers to effectively implement emotional regulation approaches in the classroom and at home. For instance, children with distorted perception of time may find it difficult to understand and control their emotions. To help children manage their emotions, educators, therapists and caregivers must be aware of patterns that may consistently be associated with certain emotions – like *fear* – to specific temporal biases. Educators will be able to tailor their teaching strategies, the pace of lesson transitions and learning activities accordingly, to accommodate children’s emotional needs. Having a firm understanding of how complex emotions influence time perception allows schools to create environments that promote emotional well-being from the early childhood education, a crucial era for cognitive growth, socio-emotional and physical development, enabling a smooth transition into primary school. Also, following the social constructionist approach to emotion (Harre, 1986; Gergen, 2001), it has been found that internal and psychological causes tend to have a predominant role in *pride*, while external and social motives may have a higher impact on *embarrassment* (Denham, 1998); thus, delving deeper into the effects of complex emotions on time perception depicted in social interactions would enable researchers to further contextualize the ways in which social and cultural settings shape emotional experiences and cognitive processes in this particular age group.

This study seeks to identify a series of already tested complex emotions through a time bisection task. More precisely, our prospective study focuses exclusively on visual stimuli, mainly images designed to be easily interpreted and appealing to young children. Such an approach hinges on the recognition of non-verbal emotional expressions illustrated by visually depicted facial expressions as a powerful means of eliciting emotional responses in specific time spans. Finally, contrasted to the literature that mostly focuses on complex emotional language (concepts and labels) as means of emotional understanding and expression (Harris, 1989; Kopp, 1989; Denham, 1998; White, 1994) our approach by utilizing solely images goes beyond the linguistic barrier.

Research Hypothesis

Consistent with the majority of literature yet contrary to the most recent relevant studies on the effect of emotion on time perception, notably those by Benau and Atchley (2020) and Yin et al. (2021), we posit that preschool children may not fully understand complex emotions. However, these emotions might still affect their perception of time, similar to the influence of basic emotions so far confirmed from the literature on valence effect, where positive ones are perceived as having a shorter duration and negative ones as having a longer duration. Consequently, we hypothesize that negative complex emotions will be overestimated in terms of temporal durations, while positive complex emotions will be underestimated.

Our general hypothesis is that, as basic -positive or negative- emotions, so *complex* emotions can have a measurable impact on children's perception of time. An issue that needs to be further addressed would be time misjudgment in children during their exposure to pictures that evoke complex emotions (e.g., *embarrassment*, *worry*) that have the same valence (e.g., negative). More specifically, since unpleasant stimuli creates time overestimation whereas pleasant stimuli underestimation (Angrilli et al., 1997), would that be the case with older preschoolers (children up to 5-years-old) concerning complex emotions with negative/positive valence connotations? An answer to this question can provide a deeper understanding of how preschool children develop the capacity to integrate and manage complex emotional experiences in a more nuanced way.

After our participants are exposed to a main bisection task results will be discussed in terms of the psychometric response function including the Point of

Subjective Equality (PSE) and Weber Ratio (WR). The (PSE) is defined as the stimulus value at which participants perceive two stimuli as equivalent in a specific attribute, such as duration (Gescheider et al., 1997). It is commonly used in psychophysical experiments to determine perception thresholds. The WR is a measure also used in psychophysics to quantify the smallest noticeable difference in stimulus intensity, relative to the baseline intensity. It is calculated as the ratio of the difference threshold (the smallest detectable change) to the original stimulus intensity, reflecting the sensitivity of sensory perception.

Thus, we hypothesize that the complexity of the emotions will result in statistically significant differences in the PSE and WR results. Additionally, we expect that the valence of the emotions (positive/negative) will lead to statistically significant differences in the PSE and WR results.

Methodology

Participants

G*Power 3.1 (Faul et al., 2007) was used to perform an *a priori* power analysis for a single group with *F* test type for a within-subjects design, and ANOVA repeated measures, planned for analyzing variances (time durations) with the same subjects (preschool children) across different conditions (four different complex emotions). While embarking on novel research areas like complex emotion and time perception interplay in early developmental stages, the effect size for this analysis was estimated based on Cohen's (1988) guidelines due to lack of recent literature (within the last 5 years) specifically addressing the influence of complex emotions on temporal perception in preschool children. In the absence of precise empirical data from recent related studies, it is indicated that the best estimate of the effect size is $f = 0.25$ representing the average change in time perception scores between complex emotional conditions, quantifying the impact of each stimulus. This means that complex emotions are expected to have a medium impact on perceived durations among preschool children. This size suggests that differences due to emotional stimuli are neither so subtle as to be difficult to detect nor so large as to be salient without careful analysis. In the context of developmental psychology, an even modest change in time perception due to emotional states can provide important implications for understanding cognitive and emotional development in early childhood. Since our

study aims to reveal findings that could potentially inform educational practices, psychological assessments and interventions, a medium effect size ($f = 0.25$) means that we attempt to identify outcomes that could realistically be expected in typical developmental settings and emotional experiences. This effect size was therefore entered into the power analysis with the following input parameters: $\alpha = .05$, power = .95, correlation among repeated measures = .50, non sphericity correction $\epsilon = 1$. The power analysis result suggested that $N = 36$ are required in this study to detect a difference within the subjects with 95% probability. However only twenty-two (22) children managed to successfully participate in all the experimental phases.

Therefore, participants in the experiment are twenty-two (22) 4.5 to 5-year-old children officially enrolled in an early childhood educational program of a Greek private school located in the eastern-north suburbs of Athens. Acknowledging and reporting socio-economic data would provide transparency in our study, enabling a more nuanced interpretation of the results based on the socio-economic context of the children involved. To achieve this, we collected and reported parental education levels and occupation. Anonymity was ensured for all participating children, and consent was obtained from the school administration. Exclusion criteria was any diagnosis of mental disorder.

Tools, Apparatus and Materials

The whole experimental process is conducted in the preschool setting, specifically inside a kindergarten, which is provided with furniture and rooms designed to be age-appropriate for young children. During the temporal bisection test, each participant is comfortably seated in a low, safe chair and desk set in front of the researcher, allowing them to directly view the laptop screen. An interactive flipbook is utilized for the emotion understanding pre-test, entitled *Open and Learn the Emotions*. This picture book, which already exists on the market (ISBN: 978-618-01-2942-7), includes various emotional expressions (positive, negative, neutral, basic, and complex) and features a short story on each page about a child (e.g., a boy named Harry) in a stereotypical scenario (e.g., a day at the kindergarten illustrating pride or embarrassment). The book contains seven short stories, each of which is designed to present two different emotional contexts, resulting in a total of fourteen (14) emotions being explored across all narratives. These emotions are happiness, sadness, worry, calm, disgust, joy, fear, courage/bravery, strength, weakness, embarrassment, pride,

anger, and pleasure. A small box and 504 small, printed cards that display the book's facial expressions are also utilized at that phase. Each card is personalized with the name of each child before distributed accordingly to all participants. The bisection task is set in Open Sesame, a software with python based environment, regularly used for building and running behavioural experiments in psychology and neuroscience. is conducted using a MacBook Air M1, 2020 model, equipped with 8GB RAM and running Version Sonoma 14.6, featuring a 13.3-inch display with a resolution of 1440 × 900. The laptop is positioned approximately 60 cm from the participant's line of sight. A simple interface on the laptop allows the participants to respond using the S and L keys on the keyboard. To minimize visual distractions, a red, empty wall is positioned directly in front of the laptop and the participant. The experiment is elaborated during teaching hours in a small silent room located in the hallway outside the classrooms furnished only with a child's table (holding the laptop) and a chair. Finally, for the valence evaluation process of the emotion analysis, the Self-Assessment Manikin test is used, which includes pictorial representations of valence domains (positive/negative) printed on A4 papers. Children are provided crayons. This test assesses the emotional responses (happy/sad) to a nine point scale (1-9) elicited by the stimuli presented during the bisection test (Appendix B).

Procedure

At first, all children were informed that they were going to participate in a new activity in class. During the emotional understanding task, which is described in detail in the following section, children were seated comfortably as they would regularly do in circle time, listening to narrations, holding the relevant cards distributed by the experimenter. After each story they were instructed to label the correct emotion by putting their selected card in a box. During the next days each subject was again informed that they would participate in another activity outside the classroom, this time on their own, in a special quiet space where they would usually do extra curriculum projects. After giving consent, the child was led into the room and asked to sit in the chair and table set for the bisection task which is also extensively described below. Each child was told to watch the laptop screen in front of them and after the introduction process, she/he was guided to press specific keys on the laptop in front of them to start the trial phase. Each child was advised to relax after the experiment and was awarded with big stickers for their participation. Finally, the emotion valence assessment task took place inside the classroom, with all children

been provided with and crayons to colour the appropriate Manikin in a nine-point scale of the pictogram in the A4 papers in front of them. Specific directions were given to all children concerning this phase, thoroughly described in the relevant paragraph below.

Emotion Understanding pre-test. Before the main experiment, a comprehension test was conducted to assess children's emotional understanding including three components: a short-story narration condition and a labeling and matching the emotion condition. This test aims to assess emotional understanding tailored for preschoolers aged five years old involving a design that allows children to demonstrate their ability to identify and label both simple and complex emotions. More specifically, our method is informed by the methodologically validated work of Bosacki and Moore (2004) who also used stories of imaginary young children in stereotypical social situations that evoke emotions followed by a mixture of forced-choice and open-ended questions. This method also enhances the idea that verbal report is a valid indication about the pre-school children's emotional experience, as supported by Denham (1998). In this way, we aim to evaluate preschooler's ability to infer the correct meaning from stories about emotion and the causal factors of emotional states. The theoretical framework of stories as powerful cues to emotion understanding in preschool children is also supported by previous findings (Balconi & Carrera, 2007; Camras & Allison, 1985; Reichenbach & Masters, 1983; Widen & Russell, 2002).

Thus, ensuring a reliable approach to assessing emotional comprehension through stories, face depiction and labeling is based on past research (Bosacki & Moore, 2004; Widen & Russell, 2010). However, in our adaptation, the experimenter employs solely closed questions, prompting the child to choose and label emotions from two distinct options, supported by the book's illustrations. This phase will serve as a critical precursor to our main experiment evaluating the effect of complex emotions on time perception in preschool children.

Designed as a fun activity, participants in their role as *Emotions Explorers* are introduced to the aforementioned flipbook. The experimenter introduces the book by saying "I brought a picture book with stories from different kids. This is Natalia, Giannis, Myrto, Stelios, Harris, Amalia, and Urania. [...]" while showing the page with the neutral facial expression. "[...] They are going to show us how they feel sometimes."

It is essential to specify that the recognition of these emotions mainly derives from the context and narrative content of each story rather than exclusively from the visual stimuli of facial expressions. This approach is supported by research showing that children's understanding of emotions is greatly enhanced by contextual narrative, which provides a more enriching and relatable framework for identifying emotions than visual cues per se (Erikson, 2008; Koivula, et al., 2020). Furthermore, including both simple and complex emotions align with findings, arguing that young children's emotional understanding goes beyond primary emotions when appropriately situated (Thompson & Lagattuta, 2006; Widen & Russell, 2003). Consequently, the stories are framed to evoke specific emotional responses within a narrative structure, helping to validate the emotional stimuli displayed (see Appendix A).

At first, each child is given a small piece of paper like a memory card that portrays exactly the image of the book which will be presented for each narration. All children are informed that they answer questions by choosing the (correct) card and putting it inside the “magic box”. This way facilitates transparency between the children's responses so that they are not influenced by each other's verbal responses. Following each short story narration, the child is first asked a forced-choice question to label between the two given emotions which are also depicted in each page of the book. The experimenter articulates each emotion that the child can choose from i.e. “What do you think Harry felt? Embarrassment or Pride?” flipping to the relevant facial expression inside the book. Each articulated emotion is also depicted in the picture book next to the story as flipped pictures of facial expressions. The child labels the (correct) emotion, by choosing between the cards in their hand and putting it inside the box. As in Bosacki and Moore (2004) so here, the order of the forced choice is counterbalanced. This involves consistently varying the order of choices amongst participants or stories. For each feeling the experimenter cautiously formulates the options the participant is invited to identify, ensuring the order in which the feelings are presented is alternated to mitigate possible bias. Such methodological adjustment is applied when considering the possibility that the order in which choices are introduced could influence the participant's decision, a concept supported by research on response order effects in surveys and choice tasks (Krosnick & Alwin, 1987; Schwarz, 1999).

Based on past literature (Capps et al., 1992; Dunn, Maguire & Brown, 1995) the order of the story and emotion is presented in a fixed manner starting with simpler

emotions and progressing to more complex ones. The experimenter documents the child's coded answers to the individual digital scoring form. Responses are coded on a 3-point scale: 0 = no response, uncertainty, or refusal; 1 = incorrect emotion choice, 2 = correct emotion identification).

Temporal Bisection Task. Since the main aim of the study is to show the role of complex emotion on time perception, after the emotional understanding test we used a temporal bisection task (Church & Deluty, 1977). Temporal bisection tasks are arguably the most usual temporal estimation task to assess the effect of emotion on time perception, whereas the subject judges whether a duration is longer or shorter than a target (Wearden 2016). To further investigate the impact of complex emotions on the bisection function, we calculated two indices commonly utilized in time perception research: the bisection point (BP) and the Weber Ratio (WR). The BP/PSE represents point of subjective equality (PSE), indicating the probe duration at which “short” and “long” responses are equally likely ($p(\text{long}) = 0.5$). The WR is an index of temporal sensitivity. These indices were derived from the slope and intercept of a linear regression applied to the steepest segment of each participant's bisection function.

Each preschooler is informed that they are going to participate in a digital activity and are then instructed to sit comfortably in front of the laptop. Adapting the experimental design from Gil's and Droit-Volet's (2007) study on how *anger* influences children's perception of time, our participants were involved in the experiment with durations between 400 and 1,600 milliseconds. For this experiment, the briefest time span was set at 400 milliseconds, while the longest span extended to 1,600 milliseconds. The durations for comparison included intervals of 400, 600, 800, 1000, 1200, 1400, and 1600 milliseconds. This ensures that the task is manageable for preschoolers and directly assesses their time perception within the specified range. The procedure consisted of two main parts: a training phase and a test phase. During the training phase, participants are shown a neutral image (a purple circle) for both the shortest and longest designated durations, alternating three times each. The experimenter guides the children by pointing out the circle's appearance duration as either short or long. The "S" key on the keyboard, signifying short duration, is marked with a red sticker, while the "L" key, indicating long duration, has green sticker. Participants must select either the left key ("S") or the right key ("L") in response to the time duration of the displayed image. The colors of the stickers correspond to the

keyboard's left (red marked key “S”) and long (green marked key “L”) positions, aligning with how students have been taught to understand left/right directions at school wearing these colors in bracelets. The first six responses including the purple circle would count as training to ensure children’s understanding of temporal categorization. Then the test phase including the complex emotions follows. This experimental setting is applied to all participants. The children learned to use the “S” and “L” buttons to denote the respective duration lengths. A correct answer was acknowledged with a positive visual cue, i.e. an image of a teddy bear hugging a heart with a green check mark sign, whereas an incorrect answer showed the teddy bear hugging a heart with a red X mark sign. Each participant went through several preliminary rounds, each comprising six trials (split evenly between three short and three long durations).

In the test phase, the children were informed they would be doing the same activity, but this time, the purple circle would be replaced by human faces, and no teddy bear would appear. They were instructed to press the correct key based on whether they thought the face was shown for a duration akin to the short or long standard. A series of the four emotional expressions that elicit complex emotion was repeatedly displayed to participants for judgments, allowing the assessment of their time-perception responses. In fact, a dichotomy approach task like that is a means of ascertaining the influence of complex emotions on the tendency to overestimate or underestimate time intervals.

The entire experiment was estimated to take approximately 12 minutes per child. More specifically, the initial phase would include a detailed introduction and explanation of the experimental task, given approximately maximum of 5 minutes. In the test phase, for each emotion to be presented at each of the seven comparison durations to ensure a balanced and thorough assessment, the number of trials was calculated as follows: $4 \text{ emotions} \times 7 \text{ durations} = 28 \text{ trials per emotion set}$. Since we intend for each emotion to be tested across all durations for each child, and considering that each emotion's presentation should ideally be repeated to ensure reliability and account for variability in response we double the number of trials. So, if each emotion is to be presented ten times: $28 \text{ trials} \times 10 \text{ repetitions} = 280 \text{ trials for the complete set}$.

Emotional stimuli were selected and elaborated from the McGill Face Database (Schmidtman et al., 2020). Selecting complex emotions from this database

is aligned to the Emotion Signaling Theory by Izard (1971, 1994) which underscores the pivotal role of facial expressions in interpreting emotions, arguing that facial cues are a primary means through which emotional states are transmitted and understood. This “face-superiority” is particularly useful when dealing with the developmental abilities of preschool children, who largely rely on face cues for their interpretation of complex emotional contexts (Russell & Widen, 2002; Widen & Russell, 2010; Wiggers & van Lieshout, 1985). Furthermore, since our study also focuses on emotional valence, the McGill Face Database was again a powerful means as it offers a comprehensive array of facial expressions linked to mental state terms, enabling reliable classification according to valence and arousal (Schmidtman et al., 2020). So, the McGill Face Database served as a crucial resource in examining the nuanced aspects of emotional expression and perception. Thus, a diverse set of complex emotional expressions was offered tailored to the developmental level of preschoolers, ensuring that the stimuli are both challenging and comprehensible. In this sense, a total number of four (4) emotions balanced in valence (two positive and two negative) was presented in the experiment, depicting a female actor expressing different facial expressions. Following Parrott’s (2001) extended list of primary emotions, we include *gratitude*, *relief*, *embarrassment*, *worry* (see Appendix D) as complex/secondary emotions.

More specifically, *embarrassment* was chosen based on previous literature and its close relation to social interactions (Denham, 1998) included this emotion as part of a broader investigation into complex emotions and time perception. Although embarrassment itself may not have as extensive a literature base as primary emotions such as *happiness* or *fear*, evidence indicates that it affects time perception. (Droit-Volet & Meck, 2007; Gil & Droit-Volet, 2011).

Worry was also an input as it is the secondary emotion of *fear* (Parrott, 2001), a well investigated emotion in the literature so far, showing a temporal bias in children (Droit-Volet et al. (2004). The inclusion of *embarrassment* and *worry* also stems from their partial comprehension by children and evidence suggesting these emotions can induce temporal biases from as early as three (3) years of age (Droit-Volet & Meck, 2007; Droit-Volet et al., 2004; Gil & Droit-Volet, 2007).

Gratitude was chosen because preschoolers can easily recognize it (among other) through their association with specific sensations of pleasure (pertaining to the valence dimension of our interest) and the level of arousal they provoke. This

understanding among preschoolers is supported by findings from Bosacki and Moore (2004), Capps, Yirmiya and Sigman (1992), and Russell and Paris (1994), highlighting the capacity of young children to identify this complex emotion based on its experiential qualities. Also, *gratitude* is significant to our experiment as it requires a level of cognitive development related to understanding self and others, indicative of emerging social cognition and moral development in children. It would be important to see how this feeling emerge in early childhood, providing implications for social and emotional learning strategies in education. Consequently, incorporating emotional awareness into the curriculum can reinforce social and emotional learning, better interpersonal skills, and emotional regulation among students.

Finally, selecting *relief* as a complex emotion is justified by its universal expression across diverse cultures, as evidenced by Cordaro et al. (2017). This universality underlines *relief's* fundamental role in human emotional experience, making it a valuable focus for studying its impact on time perception in preschool children. Developing awareness of complex emotions such as *relief* can have a significant impact on therapies and education. In this sense, acknowledging and responding appropriately to such emotions may help educators build more supportive and empathetic learning environments.

Digital stimuli consisted of high quality still images (see Appendix C), ideal for the short durations needed in a bisection task. This included only head photographs, emphasizing the facial expressions of the professional actor that mediate each complex emotion. Each emotion is depicted from the same female actor. The intervals between each stimulus are marked with the appearance of a small cross centered in the middle of a still black background on the screen frame.

Emotion Valence Assessment. In psychology there are widely used scales to assess self-reported experiences of emotion in the context of valence (pleasure or displeasure). Russell (1980) sees affect through a circumplex of bipolar and orthogonal dimensions employed in the Self-Assessment Manikin (SAM) based on pictures creating a universal instrument without the need of translation. Children are handed out worksheets with 4 rows depicting the nine-point scale of valence for each stimulus of the bisection task. Then, the researcher inquiries about the valence of specific facial expressions that have already been presented, with guidelines directly addressed to the participant (e.g., “*Look carefully at each photo with the lady. How does it make you feel? Happy or sad? Under each photo, color the little person in the*

box that shows how you feel when you look at her. You can use a different crayon each time. There is no right or wrong. Ready? Let's go."). Children indicate the emotions' valence by colouring the appropriate Manikin in a nine-point scale of the pictogram in front of them. These findings are pertinent for understanding whether time perception is differentially influenced by positive versus negative complex emotions. The experimenter collects the answer sheets and documents the children's selections on an individual digital form.

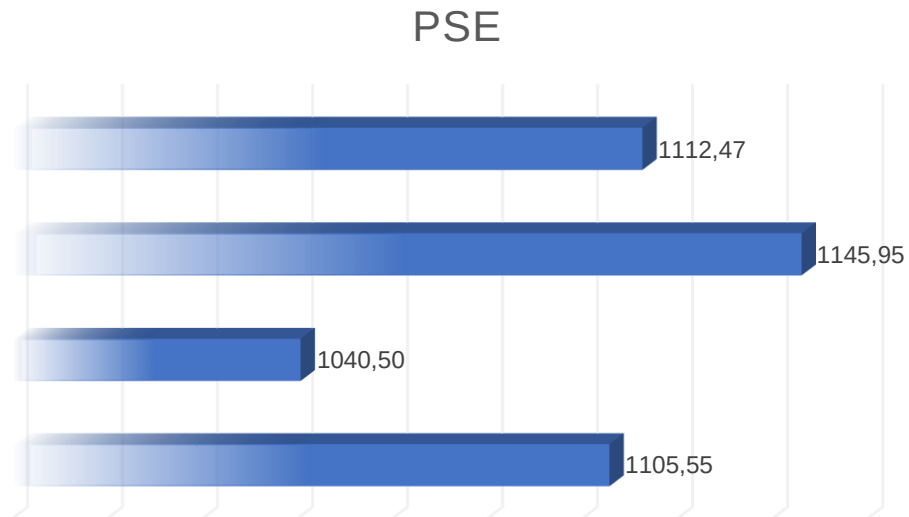
This task aims to evaluate preschool children's ability to differentiate between positive and negative emotions using visual cues. The assessment is conducted following the bisection task and utilizes the Self-Assessment Manikin (SAM) Test as its basis.

Results

Initially the Point of Subjective Equality (PSE) and Weber Ratio (WR) are presented as of the emotions. According to Figure 1, it seems that the participants present a higher mean of PSE during *worry* (1145.95), while a lower level of PSE during *gratitude* (1040.50). The emotions *embarrassment* and *relief* have scores that fall between these two extremes, with *embarrassment* being slightly higher than *relief*.

Figure 1

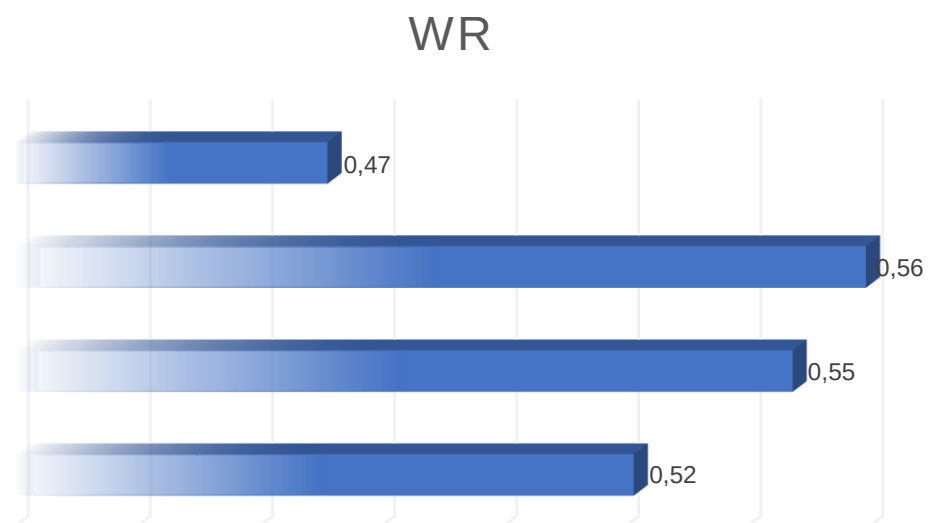
Means of PSE as of the emotions



In Figure 2, it is evident that participants exhibit a higher level of WR during *worry* (0.56), with a slightly lower level during *gratitude* (0.55). Conversely, the lowest level of WR is observed during *embarrassment* (0.47).

Figure 2

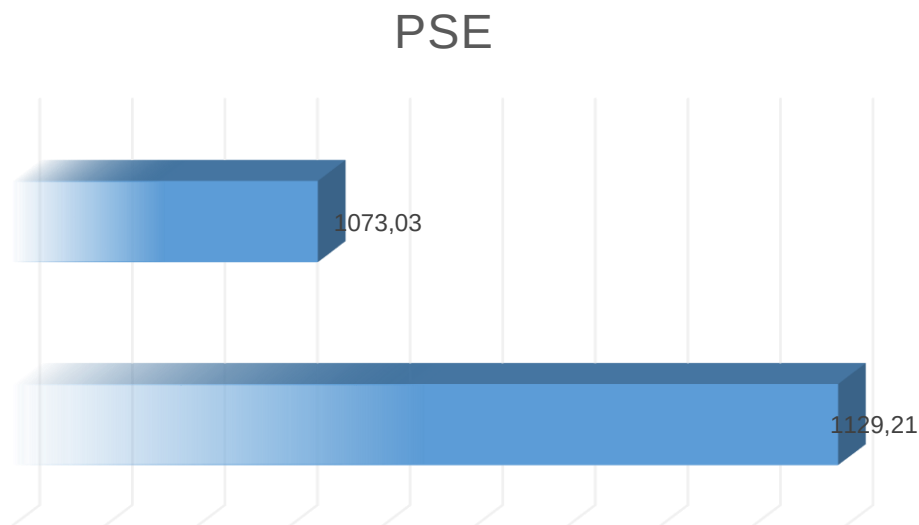
Means of WR as of the emotions



Furthermore, the means of PSE and WR regarding the valence of emotions are also analyzed. Figure 3 shows that the mean of PSE on negative valence is higher (1129.21) compared to the positive valence (1073.03).

Figure 3

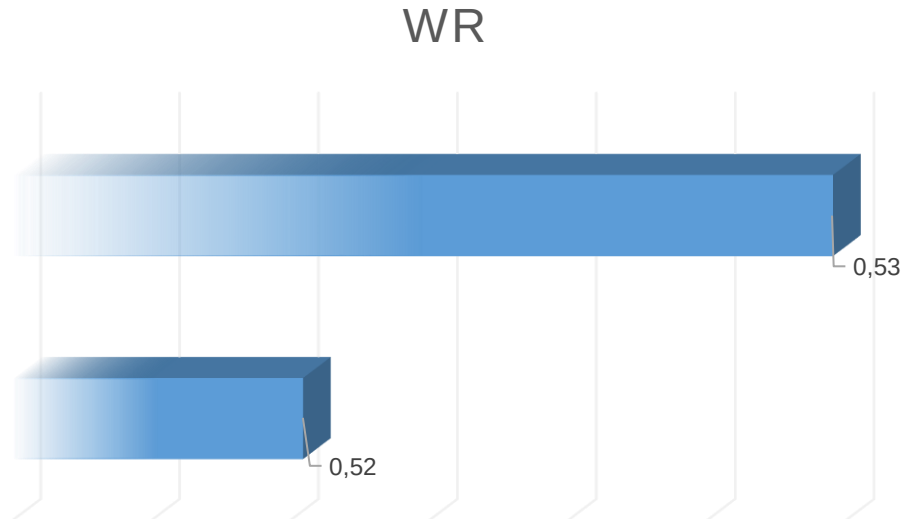
Means of PSE as of the valence



From Figure 4, it can be observed that the mean of WR is higher on positive valence emotions (0.53), compared to the mean of WR in the negative valence emotions (0.52).

Figure 4

Means of WR as of the valence



To investigate our hypotheses (Supporting that there is a statistically significant difference between the PSE and WR results as of the emotions and therefore, there is a statistically significant difference between the PSE and WR results as of the valence of the emotions) data was analyzed in the Statistical Package for Social Sciences (SPSS).

First, two repeated-measures ANOVA models were applied to analyze the effect of the different emotions on the participants' PSE and WR levels. Starting with the PSE, the multivariate test presented in Table 1, indicates that the effect of the four different emotions on the PSE is not statistically significant $F(3, 19) = 2.198, p = .122$. Furthermore, the Mauchly's test of sphericity in Table 2 reveals that the sphericity assumption is rejected ($\chi^2(5)=23.139, p<0.001$) and based on that the Greenhouse-Geisser index is taken into consideration in the tests of within-subject effect. However, according to the results in Table 3, the effect of the different emotions to the participants' PSE, once again is not statistically significant $F(2, 149) = 45.127, p = .407$.

Table 1

Multivariate Tests of emotions and PSE

		Hypothesis				
Effect		Value	<i>F</i>	df	Error df	Sig.
Emotions	Pillai's Trace	.258	2.198 ^b	3.000	19.000	.122

Wilks' Lambda	.742	2.198 ^b	3.000	19.000	.122
Hotelling's Trace	.347	2.198 ^b	3.000	19.000	.122
Roy's Largest Root	.347	2.198 ^b	3.000	19.000	.122

a. Design: Intercept

Within Subjects Design: Emotions

b. Exact statistic

Table 2

Mauchly's Test of Sphericity of emotions and PSE

Within Subjects Effect	Mauchly's W	Approx. Chi- Square	df	Sig.	Epsilon ^b		
					Greenhouse- Geisser	Huynh- Feldt	Lower- bound
Emotions	.309	23.139	5	.000	.716	.801	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept, Within Subjects Design: Emotions

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Table 3

Tests of Within-Subjects Effects of emotions and PSE

Source		Type III Sum				
		of Squares	df	MS	F	Sig.
Emotions	Sphericity Assumed	128322.725	3	42774.242	.932	.431
	Greenhouse-Geisser	128322.725	2.149	59714.999	.932	.407
	Huynh-Feldt	128322.725	2.402	53428.081	.932	.415
	Lower-bound	128322.725	1.000	128322.725	.932	.345
Error(Emotions)	Sphericity Assumed	2892906.763	63	45919.155		
	Greenhouse-Geisser	2892906.763	45.127	64105.456		
	Huynh-Feldt	2892906.763	50.437	57356.302		
	Lower-bound	2892906.763	21.000	137757.465		

Additionally, a repeated-measures ANOVA was applied to investigate the effect of the four different emotions on the participants' results regarding their WR. In Table 4, the multivariate test indicates that the effect of emotions on the dependent variables is not statistically significant ($F(3,19)=0.396, p=0.757$). As for the Mauchly's test of sphericity it indicates that the assumption of sphericity is once again rejected ($\chi^2(5)=24.454, p < .001$) (Table 5). Therefore, the Greenhouse-Geisser measurements within-subjects effect is taken into consideration. According to this index, which is presented in Table 6, it seems that the effect of emotions on WR is not statistically significant ($F(3, 63) = 0.492, p = .689$). According to the above results, the first hypothesis is not confirmed.

Table 4

Multivariate Tests of emotions and WR

		Hypothesis				
Effect		Value	<i>F</i>	df	Error df	Sig.
Emotions	Pillai's Trace	.059	.396 ^b	3.000	19.000	.757
	Wilks' Lambda	.941	.396 ^b	3.000	19.000	.757
	Hotelling's Trace	.063	.396 ^b	3.000	19.000	.757
	Roy's Largest Root	.063	.396 ^b	3.000	19.000	.757

a. Design: Intercept

Within Subjects Design: Emotions

b. Exact statistic

Table 5

Mauchly's Test of Sphericity of emotions and WR

					Epsilon ^b		
Within Subjects					Greenhouse-	Huynh-	Lower-
Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Geisser	Feldt	bound
Emotions	.289	24.454	5	.000	.553	.594	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

Table 6

Tests of Within-Subjects Effects of emotions and WR

		Type III Sum				
Source		of Squares	df	MS	<i>F</i>	Sig.
Emotions	Sphericity Assumed	.101	3	.034	.492	.689
	Greenhouse-Geisser	.101	1.658	.061	.492	.581
	Huynh-Feldt	.101	1.782	.057	.492	.594
	Lower-bound	.101	1.000	.101	.492	.491
Error(Emotions)	Sphericity Assumed	4.316	63	.069		
	Greenhouse-Geisser	4.316	34.818	.124		
	Huynh-Feldt	4.316	37.432	.115		
	Lower-bound	4.316	21.000	.206		

a. Design: Intercept

Within Subjects Design: Emotions

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

As for the second hypothesis, the paired sample t-test was applied, to compare the PSE and WR between the positive and negative valence of emotions. In Table 7, it seems that the positive correlation between the PSE for negative and positive valence is statistically significant ($r(44)=0.609$, $p<0.001$), while the correlation between the negative and positive valence for WR is not statistically significant ($r(44)=0.025$, $p=0.873$). Continuing, in Table 8, it becomes clear that there are no statistically significant differences between the level of negative valence and positive valence regarding the participants' PSE ($t(43)=1.332$, $p=0.190$) nor their WR's level ($t(43)=-0.333$, $p=0.741$). So, the second hypothesis is once again not confirmed.

Table 7*Paired Samples Correlations as of the valences*

		<i>N</i>	Correlation	Sig.
Pair 1	PSE negative valence & PSE positive valence	44	.609	.000
Pair 2	WR negative valence & WR positive valence	44	.025	.873

Table 8.*Paired Samples Test*

		Paired Differences							
		95% CI of the Difference						Sig. (2- tailed)	
		Mean	SD	SEM	Lower	Upper	t	df	
Pair 1	PSE - VAR00001	56.18666536364	279.72220062741	42.16970840971	-28.85665662992	141.22998735720	1.332	43	.190
Pair 2	WR - VAR00002	-.01907868273	.38018650785	.05731527259	-.13466594585	.09650858039	-.333	43	.741

Discussion

In the present research on how complex emotions affect time perception in preschool children, findings have emerged suggesting that complex emotional expressions do not notably modify how time is perceived. However, this conclusion warrants a closer examination. Even if those findings were not statistically important, many researchers indicate a statistically significant correlation and effect of emotions to PSE and WR of children. More specifically, through some research it was revealed that emotions like *worry* and *embarrassment*, which are quite complex due to their relation to social and cognitive aspects, can significantly affect the perception of time. This is confirmed by the researchers Droit-Volet and Meck (2007), who investigated the way and the depth in which emotions affected time perception in participants from different age groups. Their research reveals that intense emotions, and especially those that present a negative valence such as *anger* or *fear*, affect time intervals and seem to speed them up.

Continuing, the present research also presents similarities on its goals with Gil's et al. (2007) study, which focused on the regulation of time perception by *anger* in young children. Their study demonstrated that when the young children were exposed to negative emotions it consistently led to an overestimation of the duration and the time perception. This indicates that there is a strong pattern in the way that the emotions influence the perception of time and time judgement, even from an early developmental stage, where the depth of emotions is not yet fully received and associated with social rules. So, both studies confirm that strong negative emotions surely lead to an overestimation of the time.

These corroborative findings highlight a significant aspect of emotional impact on time perception, reinforcing the notion that negative emotions lead to an overestimation of time. However, the discrepancy between the present research and the existing literature necessitates further exploration. One potential explanation for the lack of statistical significance in our findings could be the variability in the intensity and type of emotional expressions evaluated. Additionally, the methodological differences, such as the duration of exposure to emotional stimuli and the age range of participants, might have contributed to these variations.

Additionally, this research is in align with the findings from Tipples (2008), who focused on analyzing the effect of emotional content of stimuli on time perception. His study revealed that both simpler emotions with negative valance such as *fear* and *anger* and also more complex emotions that involve and are related to social interactions and cognitive appraisals, like *embarrassment* and *worry*, affected children's time perception and actually led to overestimating the time. This reveals the existence of a complex interplay between emotional interaction and cognitive processes in the understanding and view of time perception.

Additionally, a study by Qu et al. (2021), analyzed and investigated the development of time perception in young children. Through the research it became clear that the age significantly influences how children perceive time, and mostly in the context of emotional placement. In the same way, our sample was too homogeneous (e.g., similar age, socioeconomic status) and therefore this could limit the variability needed to detect significant effects. The research seems to be also highlighting the profound impact emotions and their context in children as young as preschoolers. Even if Qu et al. (2021) focus mostly on the way in which emotional placement and whether emotions are presented centrally or peripherally in the children's visual field, affects their time perception, the current study deeper analyzes the influence and impact of the complex emotions themselves. Despite their differences both those studies reveal a sensitivity of young children's time perception when it comes to their exposure to emotions, both negative and positive.

The present study's findings both corroborate and challenge existing literature. While our research did not yield statistically significant results, the broader body of work, including studies by Tipples (2008) and Qu et al. (2021) consistently demonstrates that emotions do affect time perception in children. One potential explanation for the discrepancy could be the variation in the emotional stimuli used. For example, the intensity and uni-sensory nature of emotional exposure in the images of our study may not have been sufficient to elicit the same level of perceptual distortion observed in other research. Also, the final sample size ($N=22$) in the present study might have been too small to detect nuanced effects. So, individual differences in emotional sensitivity and cognitive development were may not fully accounted for. Future research should consider larger, more diverse samples and longitudinal designs to better capture developmental trajectories. Another point to consider, might be the fact that even though the pre-test of our study seemed successful for all children, in

general, preschool children are still developing their emotional understanding and may not fully grasp complex emotions. Their ability to infer meaning from stories and understand causal factors of emotional states may be still limited. Moreover, exploring neural and physiological correlates could provide insight into how emotional states alter temporal processing. Of course, working with young children requires equipment and methodologies that are non-invasive, adaptable, and child-friendly. For example, a follow up study within the school environment could use portable electroencephalogram (EEG) systems that indeed allow for more naturalistic and flexible testing environments. This can help reduce anxiety and increase compliance. Examining the role of different types of emotions beyond negative/positive valence, including high or low arousal or neutral emotions, will also offer a more comprehensive view. Considering such additional factors, may mediate the relationship between complex emotions and time perception.

Concluding, all the mentioned research revealed that indeed there is a significant correlation between the emotion and the time perception, specially at children. Those results enrich the understanding of the valence of emotions and their affect, on time perception but also create a solid foundation for further future researchers. Specially professionals in the educational field and psychologists would benefit in developing strategies and interventions to support the growth and development of children. Using the results in practical applications could surely transform the educational approaches and create a more effective environment and activities.

Our findings carry several implications. At first, they imply that specific interventions aimed at tackling time perception issues in children should consider the cognitive complexity of emotions, rather than merely the valence. This is supported by the findings of Tipples (2008) and Qu et al. (2021) already mentioned, who demonstrated that both simple and complex emotions significantly affect time perception. Our results align with these studies, indicating that emotions with social and cognitive components, such as *embarrassment* and *worry*, can lead to an overestimation of time. Future work could possibly benefit from a more in-depth exploration of how certain elements of complex emotions for example, social context and self-awareness, affect time perception. In addition, examining such effects across different age groups would also provide insights into the developmental aspects of emotional processing and time perception. In terms of methodological advantages and considerations, our study used robust experimental designs and suitable quantitative

analyses, to enhance the reliability of the findings. However, as mentioned it is possible that the sample size could be increased in a follow-up study to improve statistical validity and allow for broader generalization of the findings. Furthermore, the inclusion of a wider range of emotional stimuli or the idea of modifying task parameters may provide deeper insights into the underlying mechanisms of emotion-time interactions in preschool children. Additionally, the temporal bisection task employed durations between 400 and 1600 milliseconds. Future studies could look at varying these durations or utilizing different measures to assess time perception, such as temporal reproduction tasks, to validate and extend these findings. Moreover, no explicit measures of attentional focus that could possibly moderate the relationship between emotions and time perception, were included in the study. Leveraging technology could provide valuable data on how these factors interact with emotional states to influence time perception. For example, a possible idea could be the use of systems designed for children that are less restrictive and can be incorporated into tablet-based tasks or interactive screens, such as child-friendly eye-tracking systems.

Taken together, the present study contributes to a more sophisticated comprehension regarding the relation between complex emotions and time perception in early developmental stages. By questioning valence-based models and emphasizing the importance of other cognitive factors. Our findings suggest that a more nuanced approach is necessary to fully understand how complex emotions affect time perception. This extends the work of previous researchers, highlighting the need for future studies to explore the multifaceted nature of this relationship. By doing so, we can develop more effective interventions and strategies to support the growth and development of children in both educational and psychological contexts

Conclusion

The present thesis offered a deep exploration of the complex interaction between emotional and cognitive development in young children. It achieved to analyze and investigate the way in which complex emotions can possibly influence young children's perception of time. The study and its results extend the already existing literature by analyzing the effect of emotional stimulation of situations to preschool children on the way they perceive time. Also, the study focused on four (4) emotions: *embarrassment*, *worry*, *gratitude* and *relief*.

The findings of the study seem to come to an agreement with previous theories and research indicating that emotions can influence and alter time perception using

other cognitive mechanisms rather than valence, like the children's attention and memory since it did not reveal any statistically significant results. More specifically, complex negative emotions, which in the present research were *worry* and *embarrassment*, seem to be associated and related to a higher Point of Subjective Equality, even if not statistically important in the research. This reveals that emotions with negative valence may make the time seem slower to children. The results are quite important when it comes to expanding the traditional understanding, which was based on primarily or basic emotions like *fear* and *anger*. It suggests that emotions that are more complex and are affected by society rules could indeed have a more complex relation with time perception.

Continuing, the study also focused on the Weber Ratio of the children's response. It seemed that the ratio did not differ strongly between negative and positive valence. Through other researchers though it was indicated that social discomfort and its perspective influence the way in which children perceive time, which also enhances the hypothesis that negative emotions can make time seem slower to young children at preschool age.

However, the above findings seem to be in correspondence with the plethora of research that focused on the effect of emotions to time perception. The importance of these results lies mostly on educational and psychological practices and assessments. They reveal the significant importance of the possible adoption of strategies that take into consideration the effect of the emotional influence on children's perception regarding the time. In that way, new educational strategies and therapeutic approaches can be used, allowing for the developmental stages and the importance of cognitive and emotional intelligence that children present, but also the huge effect it has on them. Understanding how complex emotions affect the perception of time in preschool children is not just a theoretical pursuit that I look forward to developing. It carries practical implications even in clinical settings. The development of this research can inform targeted treatments and interventions for children with developmental or emotional disorders, such as ADHD and ASD and help tackle issues related to temporal processing, time estimation, motor timing and synchronization, covering challenges in their daily routines and social interaction.

So, the outcomes of the study surely indicate the need of a reassessment regarding the role of complex emotions in developmental psychology, especially on aspects and fields where the perception of time is of importance.

In conclusion, this thesis is an attempt to foster a deeper understanding of this topic, paving new avenues for research that consider the rich array of emotional and cognitive interactions together. Longitudinal studies could observe developmental changes in the way young children conceive time as their emotional and cognitive skills mature, bringing insights into the dynamic nature of affect-cognition associations over time.

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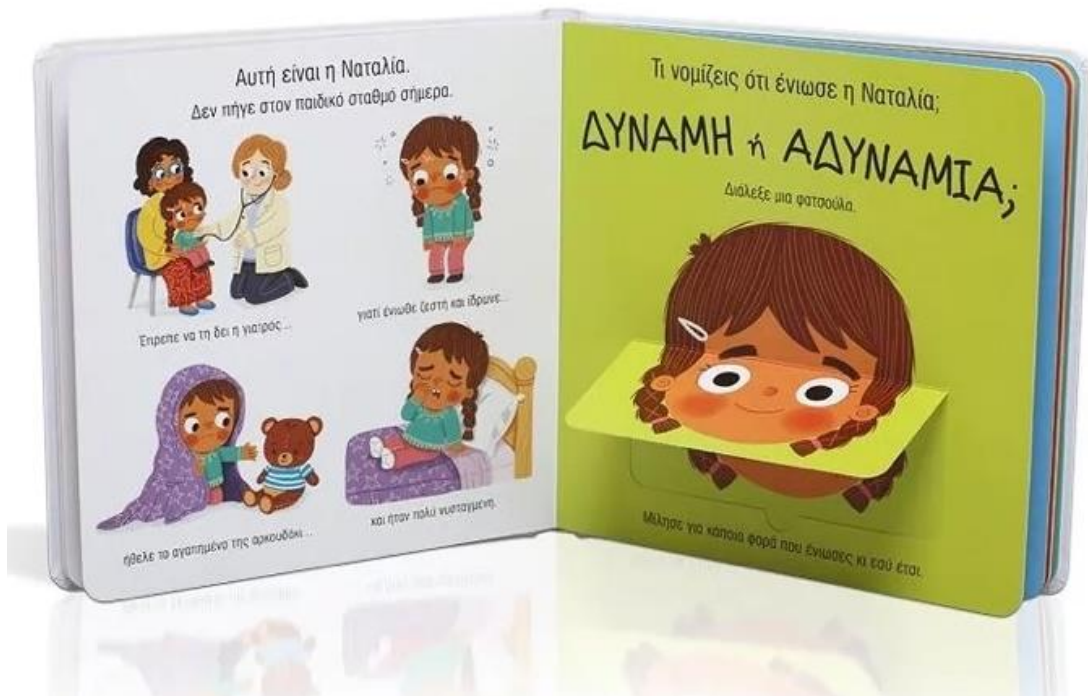
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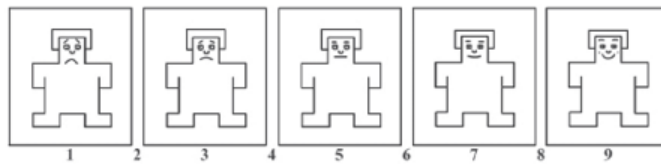
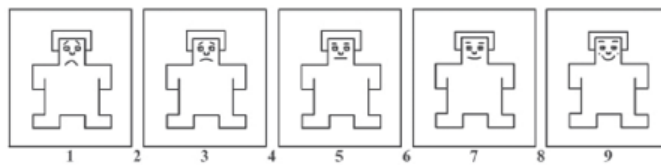
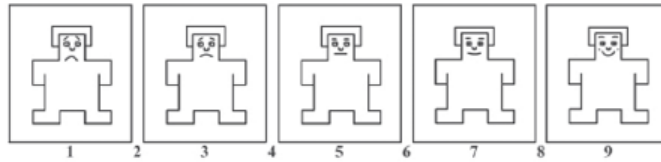
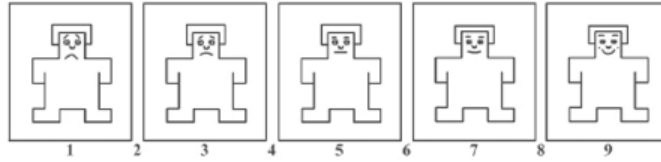
Appendix A

Emotion Understanding Test Picture Book



Appendix B

SAM answer sheets



Appendix C

The McGill Face Database – Complex emotions examples (*relief*, *gratitude*, *worry*, *embarrassment*) which were used as stimuli in the temporal bisection task presented from left to right respectively.



Appendix D

Parrott's (2001) Emotional Framework

Primary emotions	Secondary emotions	Tertiary emotions
love	Affection	Compassion, Sentimentality, Liking, Caring, ...
	Lust/Sexual desire	Desire, Passion, Infatuation
	Longing	
Joy	Cheerfulness	Amusement, Enjoyment, Happiness, Satisfaction, ...
	Zest	Enthusiasm, Zeal, Excitement, Thrill, Exhilaration
	Contentment	Pleasure
	Optimism	Eagerness, Hope
	Pride	Triumph
	Enthrallment	Enthrallment, Rapture
Surprise	Surprise	Amazement, Astonishment
Anger	Irritability	Aggravation, Agitation, Annoyance, Grumpy, ...
	Exasperation	Frustration
	Rage	Outrage, Fury, Hostility, Bitter, Hatred, Dislike, ...
	Disgust	Revulsion, Contempt, Loathing
	Envy	Jealousy
	Torment	Torment
Sadness	Suffering	Agony, Anguish, Hurt
	Sadness	Depression, Despair, Unhappy, Grief, Melancholy, ...
	Disappointment	Dismay, Displeasure
	Shame	Guilt, Regret, Remorse
	Neglect	Embarrassment, Humiliation, Insecurity, Insult, ...
	Sympathy	Pity, Sympathy
Fear	Horror	Alarm, Shock, Fright, Horror, Panic, Hysteria, ...
	Nervousness	Suspense, Uneasiness, Worry, Distress, Dread, ...