MASTER`S THESIS

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“EDA Based Detection of Emphatic Accuracy”

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Abstract

Empathic accuracy (EA), the ability to empathize with another person, often refers to the accurate judgments of the amount and kind of emotion experienced by another person (Ickes, 1993). A typical EA task involves participants (in similar studies known as perceivers) continuously judging the emotional experience of target individuals, where the targets describe their autobiographical experiences comprised of negatively and positively charged events (Zaki & Ochsner, 2011).

The present study aims to investigate if self-reported and electro-dermal-activity (EDA) synchronization differs between attentive and non-attentive listening. In the first phase of the study, two female targets were recorded discussing their positive and negative autobiographical events while having their EDA measured. Upon recording the stimulus videos, targets were instructed to use "Affect Dial" to continually rate the intensity of the affective valence they had felt while telling the stories. In the second phase of the study perceivers watched the recorded videos under a normal and distracted condition, while continuously rating them using "Affect Dial" system measured simultaneously with their EDA response (Levenson & Ruef, 1992). Our primary goal was to examine whether perceivers react differently and get a lower EDA and Affect Dial response in the case of distracted condition.

Our study results suggest that EDA activation patterns change in a synchronized way in a normal condition, but under distraction, those patterns become inconsistent through time between two individuals. Furthermore, low interpersonal accuracy in the experimental setting is behaviorally expressed through the perceiver`s affect dial rating system, where perceivers exhibit the effect of top-down regulatory processes (attention) over autonomic nervous system response patterns.

Keywords:

Emphatic accuracy, Affect Rating Dial, Cognitive Load, Electrodermal activity (EDA), Autonomic Nervous System (ANS), Perceiver, Target stimulus

Abstract (German)

Empathische Akkuratheit (EA), die Fähigkeit Gefühle einer anderen Person nachzuempfinden, bezieht sich meist auf die genaue Beurteilung der Intensität und Art von Emotion die von einer anderen Person empfunden wird (Ickes, 1993). Eine typische EA Aufgabe verlangt von StudienteilnehmerInnen kontinuierlich das emotionale Empfinden von Zielpersonen zu beurteilen. Dabei kategorisieren Zielpersonen autobiographische Erlebnisse als negativ oder positiv bewertete Ereignisse (Zaki and Ochsner, 2011).

Die aktuelle Studie soll untersuchen ob Synchronität von Selbst-Einschätzung und elektrodermaler Aktivität (EDA) zwischen aufmerksamem und nicht-aufmerksamem Zuhören unterscheiden kann. In der ersten Phase der Studie wurden zwei weibliche Zielpersonen gefilmt als diese positive und negative biographische Erlebnisse diskutieren, während ihre EDA gemessen wurden. Nach der Aufnahme der Stimulus-Videos wurden diese den Zielpersonen gezeigt, während sie dazu angewiesen wurden mit „Affect Dial" die während dem Erzählen der Geschichten gefühlte Intensität der affektiven Valenz kontinuierlich anzugeben. In der zweiten Phase wurden diese Videos ZuseherInnen unter normalen und abgelenkten Bedingungen vorgeführt, während diese die Zielpersonen ebenfalls mit „ Affect Dial" kontinuierlich einstuften, wobei auch deren EDA gemessen wurde (Levenson and Ruef, 1992). Unser primäres Ziel war sowohl zu untersuchen, ob ZuseherInnen unterschiedlich in den beidenSituationen auf die Videos reagieren als auch, im Fall der abgelenkten StudienteilnehmerInnen, eine niedrigere Synchronität von EDA und „Affect Dial" aufweisen.

Die Ergebnisse unserer Studie deuten darauf hin, dass sich EDA Muster unter normalen Bedingungen synchron verändern, aber mit der Zeit und bei kognitiver Belastung, zwischen zwei Individuen inkonsistent werden. Zusätzlich ist niedrige interpersonale Genauigkeit im experimentellen Aufbau durch das Verhalten der ZuseherInnen mit dem „Affect Dial" Bewertungssystem erkennbar. Das zeigt, dass der top-down Regulationsprozess (Aufmerksamkeit) die Antwortmuster des autonomen Nervensystems reguliert.

Keywords:

Emphatische Akkuratheit, Affect Rating Dial, kognitive Belastung, Elektrodermal Aktivität (EDA), autonomes Nervensystem (ANS), Wahrnehemder, Zielreiz

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Content

1. INTRODUCTION

Empathy, the capability to share and understand other people`s emotional states, is a complex phenomenon with no universally accepted definition. Interacting with our conspecifics, empathy allows us to effectively communicate, and more importantly, predict other people`s intentions and feelings.

The aim of this thesis is to explore the interpersonal aspects of physiological linkage between people, and their ability to accurately assess other people`s feelings. The primary goal is to delve into empathic accuracy of perceivers, specifically, the degree of correlation between perceiver`s judgments of a target`s feelings and the target`s assessment of their own affect. On the one hand, we plan to investigate physiological linkage and subjective measures of rating other people`s feelings in a typical scenario, in which perceivers watch and judge the target`s affect while the target discusses autobiographical experiences (Zaki, Weber & Ochsner, 2012). On the other hand, a different group of perceivers is exposed to the same target`s stories while watching videos in the distraction setting (i.e counting backwards). As such, our ultimate goal is to explore differences between these two groups of perceivers, and the possible influence of top-down processes (attention) on the regulation of their Autonomic Nervous System (ANS) response. .

Despite the notable progress in empathy research we still lack the exact knowledge on the interaction between cognitive and affective dimensions of empathy. In the beginning of this thesis (chapter 2), we plan to explore such questions, and look into the main concepts that underlie this phenomenon. Within the same introductory chapter, we will take a closer look into the meaning of interpersonal accuracy pertinent to our research design. Furthermore, we will delve into the patterning of ANS in emotion. We will focus on some of the core issues of EDA synchronized physiological responses to other people`s emotions. Of particular interest to our research, is the previous work of Levenson and Ruef (1992) and later work of Zaki and Ochsner (2011). However, before we explicitly state our research question, we will explore in more detail the empathic accuracy task and it`s corresponding ‘Affect Dial’ (AD) measure of people`s subjective emotional experience. Throughout the rest of the thesis we will keep a standardized form of research inquiry, further presenting our research question, methods in use and the findings we came across.

1.1 TOWARDS AN INTERDISCIPLINARY CONCEPTUALIZATION OF INTERPERSONAL ACCURACY

Researchers in the field of interpersonal relations and empathy claim that there is no universally accepted definition of what these two terms might mean. The growing interest in the field of interpersonal accuracy has led to research in many different fields, such as Affective Computing, Social Neuroscience, Phenomenology of Emotions and Cognitive Psychology. In the present study, our ultimate research goal revolves around further applications in Human-Computer-Interaction (HCI), and any possibilities that might emerge for training support in a clinical setting (e.g. psychotherapy). As such, our work starts with a critical approach of the concept of empathy, and the variety of distinct meanings that can be found in the literature. In the last two decades, social neuroscience has been able to differentiate between these distinct meanings and much of our work outlines recent neuroscientific efforts to conceptually define interpersonal aspects of such behavior. A potential approach to investigate interpersonal aspects of behavior may involve a combination of methods from psychology, social neuroscience and physiology. In our attempt to inspect interpersonal relations we used a measurement method from the field of physiology. However, despite the rising effort to use physiological measurements in real-world applications and due to the erosiveness of methods in hand, we added extra apparatus from the field of psychology. That said, we added one extra component to our physiological aspect of the experiment, an individual`s subjective experience, recognized through self-reported measurements of continuous rating of other people`s affect.

Equipped with both methods, our integrative model suggests the existence of a two-dimensional construct combining the affective and cognitive aspects of interpersonal accuracy. We believe that this can lead to a novel system-based approach of physiological synchrony, providing real-time cues relevant to further applications in the domain of HCI and training in a clinical setting. If used properly, it can lead to the development of specific training systems, drawing on findings of our multifaceted approach within the domain of interpersonal communication.

2. EMPATHY

In the last few decades there has been an increasing effort to understand the key components of interpersonal communication. One of the impressive accomplishments, is our capacity to understand other`s emotions, which has recently received much attention, especially in the field of social neuroscience. As such, empathy is one of the central aspects in social interactions, gathering many philosophers, psychologists and neuroscientists to investigate the hidden structure of empathy. Even though it has been 'popular' to investigate empathy, particularly in the last two decades, researchers are still reluctant to derive one representative model. Studying empathy at multiple levels has yielded conceptually different definitions of what this psychological state might represent (for a review, see Batson, 2009).

In its broadest sense, empathy represents a reaction to the observed experience of a target person (Davis, 1994). Furthermore, we can say that there are two qualitatively different notions of empathy. At the basic level we can say that empathy represents an ''affective response to the directly perceived, imagined, or inferred feeling state of another human being'' (Singer & Lamm, 2009, p.82). On the other hand, some scholars regard empathy as a cognitive phenomenon, drawing on the capacity to adopt different cognitive processes in assessing other people`s emotions (Shamay-Tsoory, 2009). More precisely, we can say that the former component of empathy refers to the inclination of perceivers to "take on someone's visceral, sensorimotor and affective states" (Zaki & Ochsner, 2016, p.871), while the latter refers to our ability to reason about target`s internal states (Gopnik & Wellman, 1992) correctly labeling and quantifying emotions felt by target persons (Zaki, Bolger, & Ochsner 2009; Levenson & Ruef, 1992).

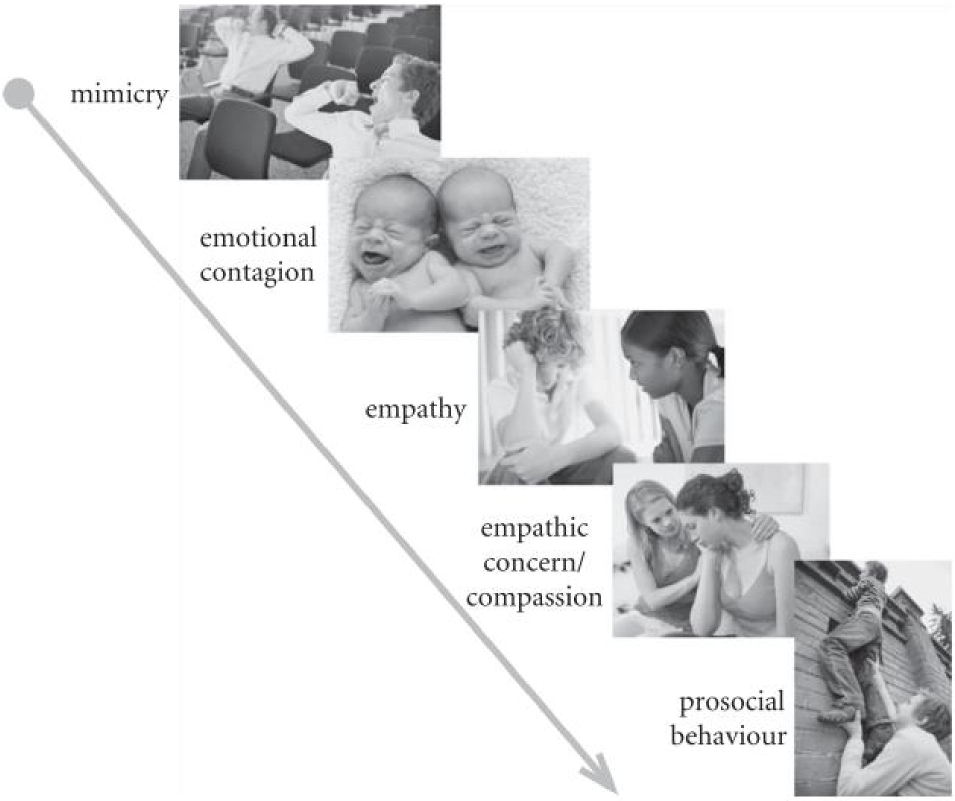
Early neuroscientific models of empathy emphasized the activation of "shared representations" in the perceiver, which were introduced through perception-action models of shared responses (Preston & De Waal, 2002). After almost two decades of intensive research, social neuroscience scholars have identified a distinctive point between bottom-up and top-down processes (Ochsner et al., 2010; Singer & Lamm 2009). In addition, the holistic notion of empathy most probably involves both processes intertwined, and as such we will take a closer look at both of these processes.

2.1 Top-down versus Bottom-up Processes

In the eighteenth century, economist and philosopher Adam Smith suggested how important subjective feelings and values of other people are; he described the experience of other people`s emotions as immensely important for moral judgments and actions (Smith, 1759). He further used the term ”imagination” to refer to the ability of people to form a mental concept and experience other people`s emotions. This mental potential has later been recognized by models of empathy that stress the significance of top-down processes (e.g. contextual appraisal, attention). For example, Decety and Lamm (2006) suggest that empathy is regulated through voluntary control (top-down) operating in combination with other neural mechanisms to promote empathy. According to this model, bottom-up refers to the direct exchange of experience (automatically activated), whereas through selective attention and self-adjusting behavior (top-down) we can further shape our empathic response, making it less dependent on external cues.

The vast amount of research provides evidence that people take on similar states to those they perceive in a specific similar state. For example, we mimic other`s bodily postures (Chartrand & Lakin, 2013), adopt facial expressions (Dimberg, Thunberg & Elmehed, 2000) and encounter synchronized autonomic arousals (Slovak, Tennent, Reeves, & Fitzpatrick, 2014; Levenson and Ruef, 1992). When perceiving target`s facial expressions, analogous facial muscles are activated in the observer (Dimberg and Oehman, 1996) further confirming our tendency to synchronize movements with those of targets. Such processes (motor mimicry) happen outside of our awareness, only later being susceptible to possible inhibition and control (Bargh, 1994). Similarly, emotional contagion (beside motor mimicry) is yet another strongly related empathic process (Hatfield, Rapson, & Lee, 2009). However, motor mimicry and emotional contagion are known not to be enough for a complete empathic response (Singer & Lamm, 2009). For that to happen, there should be an additional factor of self/other distinction which would direct our attention to a target`s emotional state. In their work, Silani and Lamm (2014) have identified five important concepts (figure 1) related to empathy; occurring in concert, related to each other (for a whole overview see, Lamm & Silani, 2014).

Figure 1. What is empathy?



Lamm & Silani (2014)

Thus far, contemporary neuroscientific findings suggest that “automaticity” cannot be a standalone component for the emergence of empathy. There is a significant reduction of empathy when subjects are given tasks that distract their attention from the emotional situation of target persons (Gu and Han, 2007). Furthermore, when perceivers are under the influence of time pressure, their empathic response further declines (Gilovich, Medvec & Savitsky, 2000). Nowadays, most models emphasize the importance of top-down control for the generation of empathy. Based on the available evidence, there are two possible ways to modify empathic response (Singer and Lamm, 2009). Individuals can either *inhibit* or *intensify* their automatic response (Bargh, 1994), or they can generate empathic response by means of *perspective taking*, by placing themselves into “another shoes” (Rolls, 2004).

Taken together, all these results suggest an important role for both top-down and bottom-up processes.

In what comes ahead, we will focus our attention on yet another cognitive and inferential aspect of empathy, that not only incorporates *affective sharing* as such, but heeds our ability to correctly categorize and infer target`s emotions.

2.2 Inferential Aspects of Empathy

With the discovery of mirror neurons, scientists have been able to demonstrate that people have an ability to engage in the understanding of motor intentions of targets (Rizzolatti & Sinigaglia, 2010). Whilst cognitive perspective taking, or theory of mind (ToM) led to the understanding of how people cognitively appreciate other people`s beliefs, desires and intentions. Even though fully-fledged empathy and action understanding are different concepts, they certainly occur simultaneously in everyday social cognition interactions.

In their work Zaki & Ochsner (2011) have operationalized a functional definition of empathy, taking into account two distinct notions, mentalizing (Mental State Attribution) and Experience Sharing (for more information on this topic, see Zaki & Ochsner, 2011). Perceivers observing targets responses, share their motor, sensory and affective states, exhibiting patterns of brain activations which are similar to those **as if** they are experiencing it themselves (Morelli, Sacchet, & Zaki, 2015; Zaki, Lopez, & Mitchell, 2013; Lamm, Decety, & Singer, 2011; Wicker et al., 2003). Experience sharing (ES) provides us with an efficient system to learn from others, yet lacks an intermediary function of interpersonal understanding; for example, in situations where nonverbal expression does not match the states targets are undergoing (e.g. *someone very close to a person just died and she is smiling while talking about that event)* (Ansfield, 2007; Ekman, Friesen, & O'Sullivan, 1997). Another possibility, given the limitation of experience sharing, is to rely on contextual information about targets states. Zaki & Ochsner (2011) refer to such processes as mental state attribution (MSA), in which perceivers reason through hypothesis building in order to resolve and assess other peoples states. Mentalizing is thus, a capacity to consign ourselves into a distant scenario, going beyond the present situation and imagining past and future perspectives. Furthermore, Zaki and his team often refer to both processes as "dissociable", in at least two ways. The MSA system appears when perceivers are encouraged to make accurate judgments and as such, the MSA system can only work if we are fully aware. On the other hand, the ES system takes place outside of our awareness (Dijksterhuis & Bargh, 2001), being engaged even when attention to social stimuli is restricted (Spunt & Liberman, 2011). Sometimes these two functionally defined systems have two distinct “neural signatures” competing for the guidance of behavior (Zaki & Ochsner, 2011). If the perceivers are directed towards low-level motor and sensory features of a target`s experience then the corresponding ES system is activated, whereas if directed towards “high” level intentions, it then relates to the engagement in brain areas associated with mentalizing.

On everyday occasions people are encountering situations in which they “read minds” of other people. Such inferences could be extended to a notion of empathic accuracy, if perceivers attempt to successively “read” other people minds (Ickes, 1993). In addition, accuracy in social situations can allow individuals to effectively react to others, increasing chances for more “predictive” and accurate responses. Brain regions accompanying the MSA system reveal an association with the complexity and accuracy of inferring other people`s states. Depending on the context, mentalizing or experience sharing are both involved in obtaining an accurate understanding of other`s emotional states (Zaki & Ochsner, 2011).

In our study we are interested in a target`s transient states through examining interpersonal synchrony between a perceiver and target person. Empathic accuracy (EA), later explained and explored in our study design, appears to be enclosed by both MSA and ES system processes (Zaki & Ochsner, 2011). From previous work, evidence shows that brain areas associated with mentalizing (MSA systems) follow the complexity (Hampton, Bossaerts, & O'Doherty, 2008), and accuracy (Zaki, Bolger, & Ochsner, 2009) of “reading through” people`s emotional states. Both, mentalizing and experience sharing provide support for empathic accuracy tasks, at times one system to a bigger extent than the other. In some cases, the ES system can be more efficient than the MSA system. For example, perceivers are able to rapidly undertake a target`s facial expressions, posture and moods. Our research goal is driven by this approach, targeting the interchangeability of both systems.

2.3. Interpersonal Accuracy

Human emotions have a structure that consists of both mental (cognitive) and bottom-up, “biological” layers. Interaction between top-down and bottom-up processes can be seen in daily context. Seeing a person under stress, yields facial-expressive, subjective and autonomic footprints of emotions in perceivers (Eisenberg et al., 1988; Stotland, 1969). There are many terms that have been used by researchers in regards to “feeling with” other people, that feeling in the stomach of being “united” with someone. Karvonen, Kykyri, Kaartinen, Penttonen, & Seikkula (2016) have adopted the term “embodied synchrony” to refer to this connectedness, whereas Feldman (2012) uses the term “bio–behavioral synchrony”. In a similar fashion, Damasio and Dolan (1999) refer to it as “background emotions”, suggesting that seeing emotional behavior in a target person, leads to associating emotions in the perceiver. Even though previous terminology mainly refers to physiological changes and synchrony in perceivers, at the same time, such response can be guided by the cognitive effort of an individual.

In the last decade, there has been a surge of studies inspecting psychophysiological synchrony in dyadic interactions. In one such recent attempt, Karvonen et al. (2016) examined the sympathetic nervous systems synchrony (manifested through EDA concordance index) during couple therapy with co-therapists where four-fifths of the dyads showed statistically significant synchrony. In a similar study, Marci, Ham, Moran, & Orr, (2007) showed that clients and therapists had considerably more positive social-emotional responses during high EDA concordance (correlation index) than during low EDA correlation. Making an effort to put such findings into use, Slovak et al. (2014) performed research outside highly regulated laboratory conditions, measuring the synchrony between friends in a natural pub setting. Both quantitative and qualitative analysis supports previous findings that consistent synchrony corresponds to high emotional engagement between friends, whilst low emotional engagement is coupled with “fluctuating synchrony”.

However, if one is interested in other components of the interpersonal synchrony, then there should be other measurements at hand. None of the foregoing studies investigated the accuracy of those emotional ratings; the degree to which a correlation exists between the perceiver`s judgment of a targets affect (Ickes, 1993). As such, the empathic accuracy task employs neural mechanisms accompanying the automatic sharing of emotional experience as well as brain regions involved in perspective-taking and MSA (Harvey, Zaki, Lee, Ochsner, & Green, 2013). Empathic accuracy effectively captures these specific neural signatures in connection with social adjustment and relationship satisfaction (Zaki and Ochsner, 2011).

In the next two sections, we will take a closer look at the relationship between the autonomic nervous system and emotions, further explaining the reasons for adding a subjective-measurement component to our research design. Once the physiological linkage has been explored, we will present prior work on empathic accuracy (EA) and explore a few additional grounding principles pertinent to our study design.

2.4 Autonomic Nervous System and Emotions

The Autonomic Nervous System`s (ANS) patterning of emotions is an area of great scientific interest. The autonomic specificity further refers to a notion that our emotions are associated with patters arising from the ANS. Using ANS variables in psychophysiological research has a long tradition of controversy, beginning with one of the very first ideas that originated from James and Lange`s theory of emotional arousal (Lange, 1887; James, 1884). According to the theory, our visual system delivers instructions to the somatic and ANS that later modifies our muscle and organ functions. Emotions that arise are the product of our bodily functions ("we are scared after you become aware of your heart beating and due to the tensed muscles in your body"). In short, emotion is elicited merely by a situation causing our body to change due to specific factors. By contrast, Cannon-Bard`s theory proposed yet another scenario, that emotional experience is independent of emotional expression. Cannon`s (1927) core argument was that emotion can be experienced in the absence of physiological change. Taken together, his evidence led to a divorce between the experience of emotion and physiological states of the body; how can one assume that fear can be accompanied by increased heart rate, inhibited digestion and increased sweating, when those same patterns of physical expression are to be found in states other than fear, for example fever (Bear, Connors, & Paradiso, 2015).

Humans are equipped with a very sophisticated emotional system, both psychological and physiological systems that sometimes have a role of preparing oneself for action (e.g. defense mechanism, attacking) or adjusting and regulating the behavior of conspecifics (e.g. social cooperation and social relationships). Often, if emotion assembles behavioral responses, it might as well mobilize the ANS to provide support for this set of behaviors (Fredrikson et al., 1998). It is hard to say that the ANS is not involved in emotional regulation. Consider everyday situations in which someone might say *"My heart wanted to explode" or "I am burning"* or *"He turned red".* Taken together these folk examples often refer to the ANS`s ubiquity in our culture of emotional expressivity. Linguist Lakoff (1987) has drawn attention to the synchrony between our use of language and empirical work referring to ANS expressivity of different emotional reactions. Ekman (1992) has gone a step further trying to differentiate autonomic specificity by employing a model that points to a specific set of emotions, as a response to a different ANS patterns. However, in recent years the question of ANS specificity has brought a lot of controversy over the "autonomic signature" of different emotions. ANS specificity became a very 'hot' and vast topic in the study of emotions, and as such we will go through few examples of ANS specificity and its coherence in terms of its connectedness with emotional expressivity and our study design.

In her exhaustive review of different concepts on the role of ANS in emotion Kreibig (2010) focuses on three conceptually different models (Table 1.). Researchers who endorse a "bottom up" view claim that emotions are seated in the structure and organization of the ANS. Furthermore, their model refutes "top-down" ('high-level' thought processes) influence on ANS and thus relies on a basic physiological level of emotional organization. In the literature, such models are sometimes labeled as evolutionary/functionalist models (see James, 1884; Levenson, 2003). The second group of models honor brain-behavioral systems in organizing autonomic response in emotions (Porges, 2007; Stemmler, 2003; Bandler, Keay, Floyd, & Price, 2000). The last class of models puts emphasis on the role of psychological appraisal as a general organizing principle of autonomic response in emotion (see Table 1.).

Table 1. Conceptual levels of autonomic response organization in emotion

Conceptual levels of autonomic response organization in emotion (Kreibig, in press).

Psychological level	
Functioning of appraisal modules	
Componential process model	Ellsworth (1994); Ellsworth and Scherer (2003); Scherer (1984, 1987, 2001, 2009)
Specific cardiovascular appraisal hypotheses	Blascovich and Katkin (1993); Blascovich et al. (2003); Gendolla (2004); Gendolla and Wright (2005); Wright (1996, 1998); Wright and Kirby (2001)
Functioning of Associative Networks	
Bio-informational theory of emotional imagery	Lang (1979, 1993); Miltner et al. (1986); Sartory (1993)
Brain–behavioral level	
Functioning of brain–behavioral systems	
Behavioral coping	Obrist (1981); Schneiderman and McCabe (1989)
Dual-system models	Bradley and Lang (2000); Cloninger (1987); Davidson (1998); Lang and Bradley (this issue); Lang et al. (1997)
Polyvagal theory	Porges (1995); Porges et al. (1996); Porges (2001, 2007)
Reinforcement sensitivity theory	Beauchaine (2001); Corr (2008); Fowles (1980); Gray (1982, 1987); Gray and McNaughton (2000)
Functioning of behavioral modes	
Basic modes of defensive coping	Folkow (2000); Stemmler (2009)
Modes of defensive coping and environmental demands	Bandler and Shipley (1994); Bandler et al. (2000); Bernard and Bandler (1998); Keay and Bandler (2001, 2002)
Predator imminence model	Bradley and Lang (2000); Craske (1999); Fanselow (1994); Lang et al. (1997)
Peripheral physiological level	
Functioning of autonomic systems	
Undifferentiated sympathetic activation	Cannon (1915, 1927)
Parasympathetic activation	Kling (1933); Vingerhoets (1985); Vingerhoets et al. (2000)
Sympathetic versus parasympathetic response dominance	Gellhorn (1964, 1965, 1970); Hess (1957)
Autonomic space	Berntson et al. (1991)
Functioning of transmitter substances	
Catecholamine hypothesis	Ax (1953); Funkenstein et al. (1954)
Receptor-types hypothesis	Stemmler (2003, 2004, 2009)

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Despite the fact that electrodermal (EDA) processes are insufficient for having a full scope of ANS emotional responses, our interest in ANS specificity has focused around this measure as it is quite easy to obtain and quantify. Moreover, we direct our attention to EDA measurements, summarizing previous attempts to quantify the strength and specificity of emotion by use of such EDA quantities.

2.5 EDA in Emotional States

The EDA is defined as a change in electrical proprieties of the skin in reaction to the secretion of sweat by the sweat glands. The glands are in control of the ANS in which three subsystems regulate EDA – limbic structures, the motor cortex and basal ganglia involved in locomotion and the reticular formation involved in the control of arousal (Boucsein, 2012). Consequently, it is believed that EDA response reflects pertinent events in the field of emotions (Dawson, Schell, & Courtney, 2011).

Since Ax (1953) tried to differentiate between the effects of anger and fear by means of ANS parameters, there has been a great body of research trying to obtain emotion-specific patterns of psychophysiological responses. For example, in his experiment, Ax showed a significant increase in skin conductance response frequency in a state of fear than in a state of anger. Four different studies have yielded similar results; elevated HR values in both states and SCL (skin conductance level) increase during a state of fear (Stemmler, 1984; 1989).

The hypothesis that facial expression is concurrent with emotions can be traced back to Darwin. In some cases, just by mobilizing facial muscles one is able to trigger central nervous circuits that further elicit ANS alterations in parallel with emotional experience (Izard, 1971). The Lanzetta group (1976) examined this influence by affecting subject`s facial expressions and giving instructions to *hide* or *intensify* their experienced discomfort by means of their facial expressions. The task was successful; the EDR amplitude was significantly lower when the subject tried to hide their discomfort as compared to the extensive facial expressions of pain. Similar patterns were shown in HR recordings (Vaughan & Lanzetta, 1981). Such evidence backs James-Lange`s theory, stating that different emotions are caused by muscular reafferents to the CNS (McFarland, 1981). Contrary to Lanzetta`s findings, Buck (1980) has come to a different conclusion, claiming it is more reasonable to say that facial expression serves as a “readout device” rather than a feedback device. As opposed to previous findings, Schachter and Singer`s (1962) theory of emotion alters the direction of emotional arousal by stating that cognition *per se* is a necessary condition to elicit an emotional state, especially its activation, intensity and duration. Therefore, patterning in ANS activation is not critical, which could be seen through the elevation of SCR amplitudes (being high) in synchrony with high self-report categories (Winton, Putnam, & Krauss, 1984). Similarly, Johnsen, Thayer and Hugdahl (1995) used EDA and HR together with participant`s subjective ratings to show that EDA is pertinent to arousal and that HR is indicative of valence characteristic of emotion (positive vs. negative).

For a very long time researchers have been trying to verify emotional stimuli through psychophysiological measurements. Thus far, neither of the aforementioned studies can confirm that any particular stimulus will lead to a particular emotion/s (Levenson, 2014). Careful study designs still cannot hold for a match between particular emotions and ANS activity. Therefore, in order to study the ANS specificity, verification must employ some other method to avoid "experimenter`s regress".[1] Self-report methods could provide a solution, but such emotionally scaled responses cannot be a part of the initial emotional response as they are constructed retroactively (Levenson, 2011).

To meet expectations and avoid this problem in our study design, we have included empathic inferential aspects in parallel with the ANS response.

2.6 Empathic Accuracy Paradigm

During the beginning of the 1990s, Levenson and Ruef (1992) called for a more advanced (integrative) model. Based on their studies of marital interaction, they marked the grounding principles for measuring the extent of physiological linkage between targets and perceivers.

The first principle heeds to the need-based judgments of perceivers on continuous streams of emotional expressive behavior, rather than on the single report judgments of behavior. Furthermore, as emotional content swiftly changes, it is better to use video streams of information, rather than "static displays (photographs) or short behavioral extracts". The second principle includes an experimental design in which the multimodal content is typically presented to perceivers. The third principle suggests that target persons should retell

[1] In philosophy of science this term has been used by a prominent sociologist of science, Collins (1992). In order to know if the experimental result is correct a researcher has to see if the apparatus employed is reliable. However, the research cannot know if the apparatus is reliable unless she knows that it produces correct results in the first place so on and so on, *ad infinitum.*

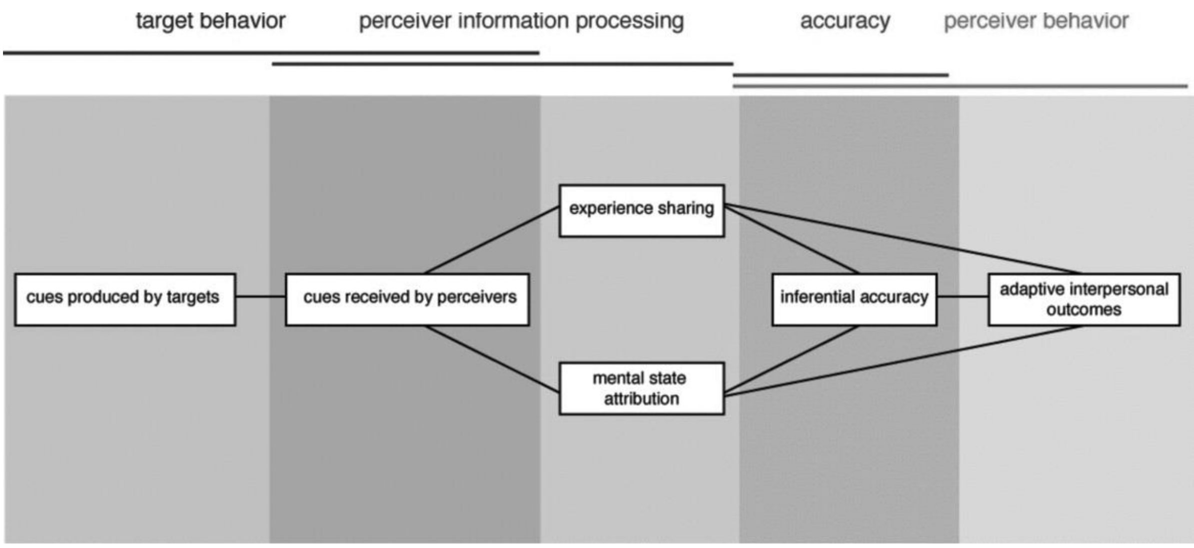
their real personal stories corresponding to a more natural than staged context. The fourth principle, outlined by Levenson and Ruef (1997), conveys that in order for emotions to be judged, they should appear in an interpersonal context. The fifth principle signifies the valence of stories being told, targeting the perceiver`s capacity to detect both positive and negative emotions. Finally, accuracy is then to be determined by taking subjective emotional ratings of perceivers and comparing them with target`s subjective ratings (e.g. Affect Dial System).

The empathic accuracy (EA) research paradigm revolves around these six grounding principles. In general, the EA paradigm inspects the perceiver`s ability to infer target`s thoughts and feelings (from videotaped recordings) while the target person is retelling their autobiographical story. Furthermore, by using the special built in self-report scale, perceivers are able to continuously report actual thoughts and feelings while watching the target`s video. In the literature, variations of this procedure are commonly recognized through the lens of an EA research paradigm (Decety and Ickes, 2009, p.58).

The idea behind this approach amounts to an attempt to explore processes underlying experience sharing (ES) and mental state attribution (MSA), that otherwise cannot be tested without a strategy to outline patterns on a social and neural level. Those patterns are unable to be directly measured, and as such, a proper framework has to be employed that contains behavioral and neuroscientific measures for drawing inferences of how interpersonal accuracy can be assessed. Combining multiple domains, Zaki and Ochsner (2011) proposed a model in which the empathic accuracy design has to employ many quantifiable factors that this cognitive phenomena leaves out (figure 2.) For example, the activity in perceiver`s neural systems is equally important as perceiver`s self-reports on their own affect. It is not only that the mind-perception accuracy is pertinent to interpersonal accuracy, but even perceiver`s transient states can be assessed by employing measures of weighing emotions over time unlike the traditional approach of just inferring other people`s stable dispositions. For instance, one can compute correlation between perceiver`s judgments about target's responses along two dimensions, the physiological and social/behavioral (Levenson & Ruef, 1992; Vaughan & Lanzetta, 1981).

In figure 2, social interactions are dynamic with many feedback loops engaged. Perceivers are able to shift their accuracy task, either changing the content they relate to (Spunt, Satpute & Lieberman, 2011) or changing the process in which they perceive target persons (e.g. perspective taking; Lamm, Batson and Decety, 2007). There is still a lack of evidence on how the feedback loops work together (for a full overview, see Zaki and Ochsner, 2011) but in our study we address patterns of inferential judgment, from left to right *(see figure 2.)*

Figure 2. Some of many contextual factors constraining the relationship between mind perception phenomena



*Jamil Zaki and Kevin Ochsner, 2011 (*http://dx.doi.org/10.1080/1047840X.2011.551743)

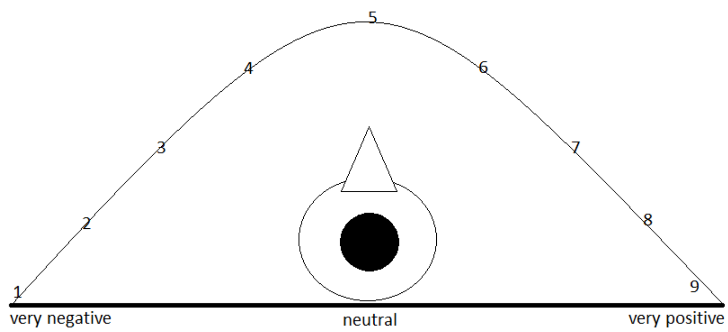
2.7 Affect Dial Response

Researchers in the field of psychology and social neuroscience have developed a range of methods to assess perceiver`s subjective emotional experience and interpersonal accuracy. One such example, often used in EA standard paradigm research, signifies a method to continuously measure self-reported emotions across time, reflecting natural conditions in social interactions. Therefore, the affect dial system (AD) represents a method of measurement allowing for a continuous time course assessment of an emotional experience (Levenson & Ruef, 1992). Earlier, traditional methods of self-report inquiry required researchers to repetitively stop the conversation and ask perceivers how they were feeling whilst watching other people tell their autobiographical stories (Markman, 1979). They would then report their feelings on a Likert (5-point) scale making the inquest process invasive and subsequently less time-synchronized and accurate.

Often, the affect dial system is used to match a perceiver's accuracy response to a target`s (Levenson & Ruef, 2007). In such settings, targets are first invited to come to the lab for a short 5-15 minute conversation. Using video recording equipment, they are asked to retell one of their personal stories in front of a camera. Once the story has been recorded, targets have the opportunity to watch the videos of themselves talking and with the help of the affect dial device, continuously rate how they had felt during the story telling. Soon after, perceivers are called to come to the lab with a similar task. Watching target`s videos, perceivers are able to continuously rate how they think a target person had felt while discussing the salient event. Accuracy scores of perceivers are correlated with the scores of target persons, yielding a final measure of overall interpersonal synchronized accuracy (Levenson & Ruef, 2007).

In empathy studies, the AD system (figure 3.) as depicted below, is the usual way of representing the self-report measuring system. The faceplate consists of a 180 degree arc drawn on a black and white background. For every 20 degrees along the arc, there are 9 thick marks representing numbers (labeled from 1-9). At the end of the arc, *very negative* is anchored at the left side and on the right side lies *very positive,* with *neutral* to the middle of the arc (Levenson & Ruef, 2007).

Figure 3. Affect Dial System



Levenson & Ruef (2007)

Since the 1990s, this sort of device (traditionally measured using Joystick) has been used in empathy related studies. One such research that set the stage for later similar study-designs, involved the investigation of physiological linkage of empathy between targets and perceivers. Levenson and Ruef (1992) tried to correlate the perceiver's accuracy rates with the one of targets. Perceivers were asked to watch a 15-minute videotaped interaction of marital couples paying attention to the story of a designated spouse, and using the rating dial to continuously indicate how they thought that the spouse was feeling. These scores were correlated with the target spouse`s self-ratings, obtained previously to get the final score of empathic accuracy. Later on, these accuracy scores were correlated with measures of physiological linkage (along four dimensions; *for a detailed procedure see*, Levenson & Ruef, 1992). In our study design we adopted this concept, together with some of Zaki, Weber, Bolger, & Ochsner`s (2009) minor modifications.

3. RESEARCH QUESTION

Relatively little is known about how empathic processes are affected by the manipulation of different attentional conditions, and even less is known in regard to the interpersonal accuracy of individuals in a more natural setting. There are many factors contributing to the rise of empathy (e.g. contextual appraisal, motivation of participants to participate, attention etc.) which have already been discussed in previous sections. Interacting with different individuals, we might respond empathically or we may fail to empathize. Past studies have examined such issues yielding somewhat ambiguous results. In the literature, clinical examples of studying therapeutic relationships are used to explore if client-therapeutic relations (empathy, rapport) could be accurately accessed from 2-5 minute segments of observation (‘thin slices of behavior’; for more information see, Ambady, 2010; Ambady & Rosenthal, 1992). Furthermore, the process of accurate judgments of other people`s behavior is thought to be based on tacit, implicit knowledge (Polanyi, 1966), suggesting that evaluative judgments occur automatically without cognitive effort (Ambady, 2010). The Interpersonal Perception Task (IPT), a test used to measure the accuracy of judgments, has been employed by some researchers to explore the effect of cognitive load on our judgment behavior. Costanzo and Archer (1989) have shown that perceivers do not appear to exhibit a reduction in accuracy under conditions of distraction. As such, those accurate judgments are efficient even when perceivers are asked to process information along with other tasks (Ambady, 2010). To some extent this corresponds to Preston and De Waal`s (2002) theory of empathy in which perceivers instantaneously recognize another`s persons emotional state, even in the condition of cognitive occupation. By contrast, other researchers claim that in everyday interactions empathy can be disturbed by cognitive load effects (Hiraoka & Nomura, 2016; Morelli & Lieberman, 2013; Rameson, Morelli, & Lieberman, 2012; Gu & Han, 2007). For example, Hiraoka and Nomura showed that cognitive load reduces attention to provide care, and leads to a completely different scenario, in which subjects for example, neglect infants who are in need of help, decreasing caretakers empathic concern to provide support. In a similar fashion, Morelli and Lieberman (2013) showed that cognitive load decreases participant`s subjective experience of empathy, demonstrating a decline in the neural response of core-empathy-related regions. With these findings, they challenged the assumption that empathy is mainly automatic.

The goal of the present study is to investigate **if** self-reported (AD) and EDA synchronization is disrupted in the condition of cognitive load (distraction). A typical EA task is employed simultaneously measuring EDA response in 31 healthy individuals. The 31 participants are divided into two groups, the control group and the experimental group. Both groups watch targets telling one autobiographical negative and positive story, however the experimental group watches the videos under the cognitive load condition.

The current study investigates the role of automaticity, attention and cognitive effort in everyday personal interactions. Furthermore, we want to explore **how cognitive load impacts the empathic accuracy task along the physiological and self-regulating (cognitive) dimension.** Therefore, we posited that perceiver`s affect dial (AD) response becomes obstructed under cognitive load instructions. Additionally, we hypothesize that physiological and behavioral synchrony between individuals will be disrupted over time, leading to a lower level of synchrony between the perceiver`s and target`s EDA and AD response.

3.1 Hypothesis Testing

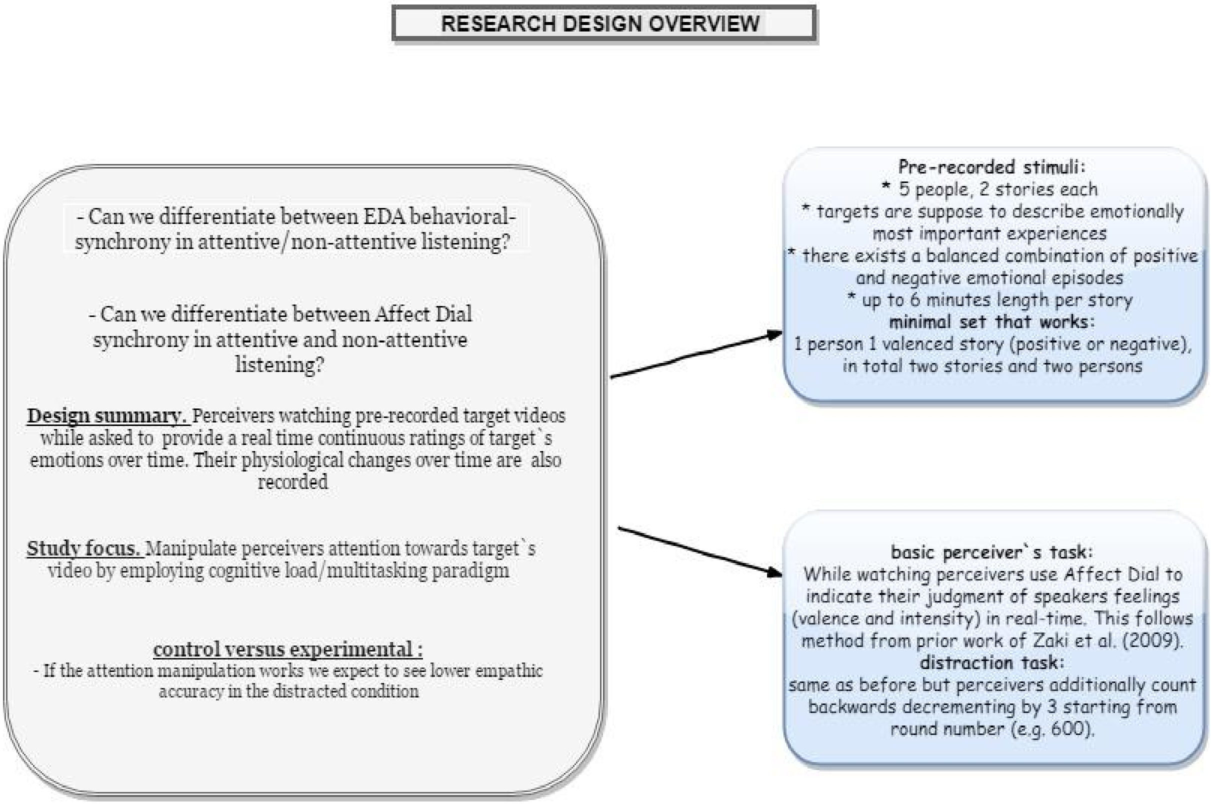
After we compare and correlate the perceiver`s EDA and behavioral response with the target`s EDA and behavioral response in the control and experimental group separately, we further expect to see if:

H1(0): Perceiver`s physiological (EDA) response in the group under distraction exhibits no significant difference in EDA synchrony in comparison to the control group of perceivers.
H1(a): Perceiver`s physiological (EDA) response in the group under distraction leads to a decrease in EDA synchrony in comparison to the control group of perceivers.

H2(0): Perceiver`s accuracy of rating target`s emotions in the group under distraction exhibits no significant difference in comparison to perceiver` accuracy of rating target`s emotions in the control group
H2(a): Perceiver`s accuracy of rating target`s emotions in the group under distraction leads to a decrease of perceiver`s accuracy of rating target`s emotions in the control group

For further clarifications of our research study, we have graphically depicted the experimental design deployed (figure 4.)

Figure 4.



4. METHOD

Participants completed a version of the empathic accuracy (EA) task replicated from Zaki et al. (2009) with minor modifications.

The study was performed in two phases. In the first phase, stimulus videos were collected in which participants (targets) discussed autobiographical positive and negative emotional events, while simultaneously measuring their EDA response patterns. In the second phase, physiological activity in perceivers was also recorded while perceivers were watching target`s videos, in which they had the opportunity to rate the affect they believed targets were feeling at each moment. Each phase is described separately in our procedural design.

Procedure. In the *first phase* (target), 4 targets (1 male and 3 females, mean age = 23.75) participated for no exchange in monetary compensation. All participants were college students whose mother tongue is English. Before the laboratory sessions even started, targets had completed a 16-item Berkeley Expressivity Questionnaire (BEQ; Gross, 2000), a highly reliable and validated measure of emotional expressivity. All participants scored above 50% in general expressivity. Soon after, targets were asked to recall and list 4 positive and 4 negative autobiographical episodes. Next, the experimenter asked them to rate every story on the 9-point Likert scale. The stories with a score above the threshold (scale`s middle point) were included in the following procedure. Targets were then seated in front of the camera to discuss their chosen positive and negative events. The instructions that had been given stated that the stories should not exceed 6 minutes, for both positive and negative episodes. Before the recordings started, targets were asked to spend one minute calling to mind those relevant episodes. Once they had restored the affect, they were asked to describe their positive and negative event in a successive manner, in front of the camera. The window frame captured targets from shoulders up, facing the camera directly. Typically, targets evoked events such as the death of a close relative, a break-up with a boyfriend or discussing positive episodes such as ecstatic feelings after some achievements and hard work. The events discussed, had a duration on average of 4 minutes per target`s positive or negative story.

After discussing each event in front of the camera, we asked targets to come back after two days and use the affect dial rating system (see subsection 2.7), instructing them to continuously rate the affective valence they had felt while watching their own video. In this segment, it is of "great importance that targets concentrate on the affect they had felt while discussing events, and **not** during the events themselves" (Zaki et al., 2009, p.11385) After watching the videos we asked our participants for their informed consent to use the videos in the next phase of our study.

Before the videos were prepared for the second phase of the study we had recruited a group of 4 people (external raters) to give their qualitative impressions of the target`s session videos. All the raters were female, psychology students, not involved in the central study design. They had been asked to compare all stories (positive and negative) and select those they could agree upon as the most emotionally engaging. External raters judged the perceived engagement and expressivity of targets, the importance of the issue being discussed, the context relevant matters of the issue being discussed, and the logical structure and "flow" of the story. From the corpus of 4 people and 8 positive and negative autobiographical stories being recorded, two target videos had been chosen to be presented to perceivers.

In the *second phase* of the study, 31 perceivers (11 females, 20 males) participated in exchange for no monetary compensation. Just before the session started, every participant got precise instructions on the following 6 different blocks (see *figure*. 5). Prior to the first block of information, perceivers were prepared for electrodermal (EDA) recordings.

Figure 5. Study design scenario

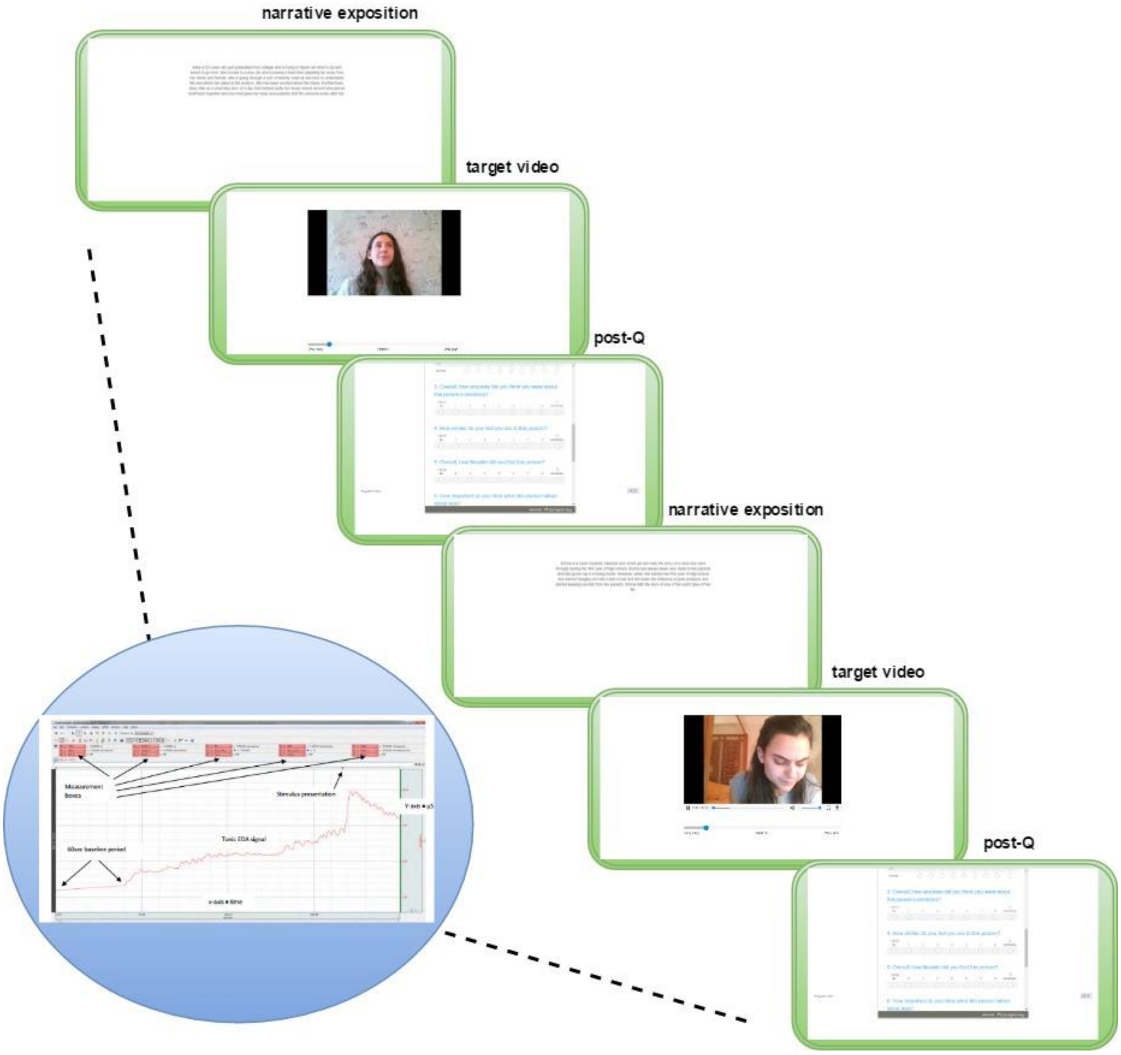


Figure 5.EA sequence design. At first, perceivers are attached to the EDA measuring device (Biopac sys.) continuously recording their physiological response from block_1 (narrative exposition) to block_6 (post-Q).

The first block consisted of a narrative exposition revealing the background information of a story (see *figure* 5.) Specifically, information is presented about the setting of the story, the context and relevant details. Subsequently, target`s positive video example is presented in the second block. Perceivers were instructed that, when the video appears they should continuously rate how positive or how negative they believed the target felt at each moment while discussing the event, **not** how they felt when the events discussed on camera had occurred. Below every target`s video, the affect dial system had been embedded, helping perceivers continuously rate and report target`s feelings (see *figure* 6.)

Figure 6. Affect dial system

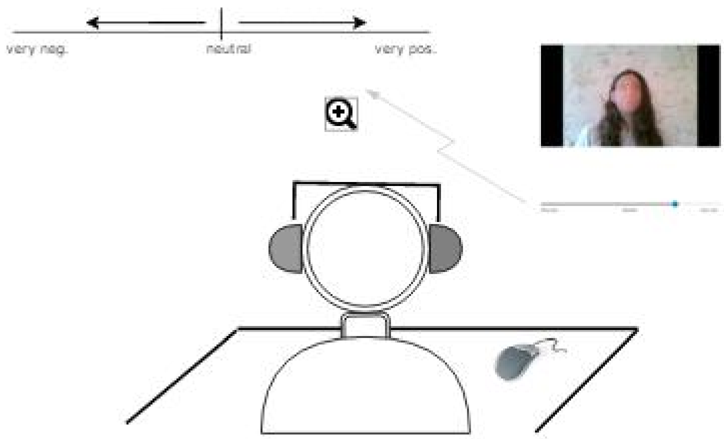


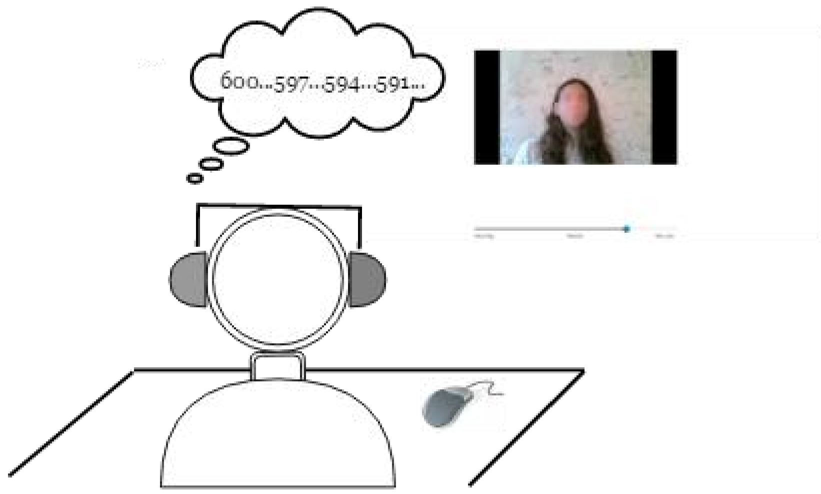
Figure 6. The affect dial system, embedded just below the target video. Perceivers are able to continuously rate target`s feelings by sliding left and right from neutral point on the scale. The scale is anchored very negative at left, and very positive at the right.

After each video, perceivers are asked to respond to a series of items. This set of questions is adopted from Morrison et al. (2016), and slightly changed, examining the perceiver's opinion on the intensity of emotions targets had felt, with a set of 10 different emotional reactions offered. More important is the global affective response to the videos, assessed through perceivers apparent accuracy when rating target`s emotions. The last three items weighed interpersonal perceptions of the targets, their similarity to the target, degree of "liking" the target person and the observed importance of the target`s narrative (see Appendix 8.2). All post-video questions are rated on a scale from 1 to 9 (*not at all,* to *extremely*).

Participants (perceivers) in the second phase were randomly assigned to one of two conditions:

1. In the control condition, 15 perceivers watched each clip making their rating while their EDA was simultaneously measured.
2. In the cognitive load condition, 16 participants were given a standard distraction task (Posner & Rothbart, 1989; van den Hout, 2010) while their EDA was simultaneously measured (see *figure* 7).

Figure 7. Standard distraction task



As in figure 6, the EA task is the same in both conditions. Perceivers are seated in front of the computer screen using the AD system to rate target`s affect valence. While watching the video their EDA response is recorded. Unlike in control trials, perceivers in the experimental condition have one additional task; they are instructed to count backwards from 600s decrementing by 3 units (e.g. 600,597,594 …) while completing the AD task. In the second video perceivers are instructed to count backwards but this time starting from 900s decrementing by 3 unit measures (e.g. 900,897, 894, 891…).

4.1 Cognitive Load Task

Perceivers during the cognitive load task are asked to count backwards decrementing by 3 unit measures (e.g. 600,597, 594, 591 etc.). When exposed to the first target`s story (positive), they were asked to count backwards from 600. In the consecutive block design, when listening to the target`s negative story, the same group of perceivers were asked to shift and change the range of counting backwards, but this time starting at 900 and decrementing by 3 unit measures (e.g. 900, 897, 894, 891 etc.). In the pilot phase, when this test was conducted on two random videos from *youtube*, three university students warned us to keep the range of numbers different. Additionally, they have reported easier retrieval of numbers if we keep the range the same (counting from 600) for both the positive and negative videos. However, if we change the range and start from 900, it then becomes harder for students to remember the series of numbers in the prior condition (counting from 600). Thus, in the second target`s story, perceivers in the pilot phase reported the same issue. It was much easier for them to recall numbers if we keep the counting range the same. Consequently, when this task is conducted in the experimental group of perceivers, they had been asked to tell us the number they reached after they had finished with listening to the positive and to the negative target`s story.

In the experimental group of perceivers who listened to the negative story, all perceivers reached the range of numbers from 750 to 770 (counting started at 900). The perceivers who listened to the positive story reached the range from 370 to 400 (counting started at 600).

4.2 Materials

Block design environment. For the preparation of the block design environment we used four different program technologies; HTML/CSS, Javascript/jQuery, CSS/js bootstrap library and php. For block 3 and block 6 we used embedded Survey monkey questionnaire. The whole environment is a plain html/css page with an integrated html5 player. Below the video player (*figure 6)* an interactive slider is embedded, for values ranging (1-100; from 1 to 50 are values in the negative affect range, and from 50 to 100 in the positive affect range).When perceivers press play, the button on the video player javascript 'play' event is triggered. While the video is playing, values from the interactive slider are collected, once per second in json array. Once the video is finished, collected affect dial system data is sent to the server (server, php file) via ajax protocol, where it is further transformed to excel (csv) file, ready for use and further analysis. Survey (post-Q) has been made via survey monkey web page with a provided embedded code on their webpage.

Electrodermal data acquisition. The recording phase was conducted in a laboratory room. The room temperature was kept constant (M= 23°C) with enough light and fresh air. The stimulus video was shown on the computer screen (Lenovo G50-70, 19 in.). Ag-AgCl electrodes (Biopac system) were placed on the upper phalanges of the index and middle fingers of the non-dominant hand. In accordance with standard procedure, electrodes were previously prepared with isotonic gel (for a detailed procedure see, Fowles et al., 1981). The electrodes were connected to a preamplifier (Biopac GSR100C), and the signal was transmitted to a 16-bit AD converter (MP150). Raw tonic skin conductance signal was recorded, and no filter was applied during the acquisition of the EDA signals. The acquisition rate for all participants was set to 1000 kHz. This ensures 1-ms accuracy between the target stimulus video and the trigger sent to the computer recording the EDA signals.

4.3 Data Reduction Analysis

To estimate the level of synchrony between participants, we used *Acknowledge 4.1 (AK)* signal-processing software, together with *Minitab 17(MT)* statistical software. Other supporting analysis has been done in *MS Excel 2010.*

There are two main components of the EDA signal. One component is phasic (skin conductance level, SCL) reflecting general changes in our autonomic arousal. The second one is the phasic component (skin conductance response, SCR), and it refers to the faster changing elements of the signal. They are both important (Dawson et al., 2001) and as such they have both been derived and analyzed. In the preprocessing phase, AK is used for the first, initial visual inspection. During visual analysis we were able to discover potentially important periodic shifts in the tonic background. In the phase of initial visual processing, we "cleaned" the signal from its artifacts, due to either poor contact or other artificial agents interfering with the SCL signal. Such artifacts were down-sampled using the mean value smoothing algorithm, at the rate of 2000 samples per second.

In the next phase, every participant`s phasic signal was derived from tonic. To correctly identify discrete and significant short-term changes in the tonic signal, this transformation included high pass filtering, applying a digital IIR high pass filter (f=0.05 Hz, Q=0.707) to the tonic signal. The estimate of the baseline was generated using median value smoothing, set to 8 seconds with a threshold detection level set to 0.02 microsiemens. After the derivation was calculated, *Locate SCR (Acknowledge 4.1)* routine was conducted in order to identify skin conductance response and score the waveform. SCR occurrences were detected executing threshold positive peak detection on the phasic EDA channel of every participant. Further data reduction analysis led to counting the number of events of a particular type, as well as the sum of the amplitude peaks and the mean amplitude of events that had been selected as significant (for a more detailed procedure see, Braithwaite, Watson, Jones, & Rowe, 2013).

When the preprocessing phase was finished, results were exported to an Excel spreadsheet for further statistical exploration. Perceivers were divided into two groups, experimental and control, those who had just watched the video without distraction (control) and perceivers exposed to the cognitive load of counting backwards (experimental). Each perceiver had been assigned with particular features previously determined as relevant (see *Table* 2).

Table 2 . Overall preliminary results

participants	**TONIC r-pos.**	**TONIC r-neg.**	**Ev_cnt Neg.**	**Ev_cnt Pos.**	**Post-Q (pos)**	**Post-Q (neg)**	**AD r-pos.**	**AD r-neg.**
Cnt_ID_1	0.01	0.7	22	59	no match (1<x<5)	**match (5<x<9)**	0.6	0.16
Cnt_ID_2	0.22	0.66	26	38	**match (5<x<9)**	**match (5<x<9)**	0.38	0.2
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
Exp_ID_1	0.28	0.08	14	26	**match (5<x<9)**	no match (1<x<5)	0.2	0.4
Exp_ID_1	0.1	0.4	12	30	no match (1<x<5)	no match (1<x<5)	0.4	0.6

Table 2 . **Tonic r-pos.** refers to the Pearson correlation coefficient between the perceiver`s and target`s response; **Ev_cnt** is derived from the phasic signal and it stands for the number of located SCR events; Post-Q shows final results of the matched response between the perceiver`s and target`s response. Bolded examples are assigned with the status **relevant** and are further included into analysis; AD r-pos. refers to the degree of correlation between the perceiver`s and target`s response when listening to the positive target`s story.

Previous studies have emphasized the importance of contextual appraisal demonstrating that empathy is highly dependent on situational factors (Lamm, Batson & Decety, 2007; Bernhardt & Singer, 2012; Zaki, 2014). To ensure that we have a control group of perceivers who will empathize, we used a post-questionnaire (see Table 2) to control for contextually relevant variables. Perceivers who rated their degree of similarity to target or to target`s story above 5 (*not at all (1) - extremely (9))* on the Likert scale (5<x<9) were included in the final analysis. To control for contextually relevant target stories, each perceiver had been categorized as ***match or no-match.*** The table is additionally reduced to 12 perceivers in both the experimental and control groups listening to the negative story, 4 in the positive control group, and 6 perceivers in the experimental positive group.

As noted in table 2, columns (*Tonic r-pos., Tonic r-neg., AD-r pos., AD r-neg.*) represent the EDA and AD of two individuals (target`s signal superimposed against perceiver`s) expressed by *Pearson`s* product moment correlation coefficient ( r ) during the video. To illustrate such results, below we have a case of EDA synchrony between a perceiver listening to the negative target`s story in the control condition, and the negative target telling the story. In *figure* 8, we depicted (r = .7) degree of synchrony, derived in *AK 4.1,* and between Cnt_ID_1 and negative target stimulus.

Figure 8. Tonic EDA high degree of synchrony

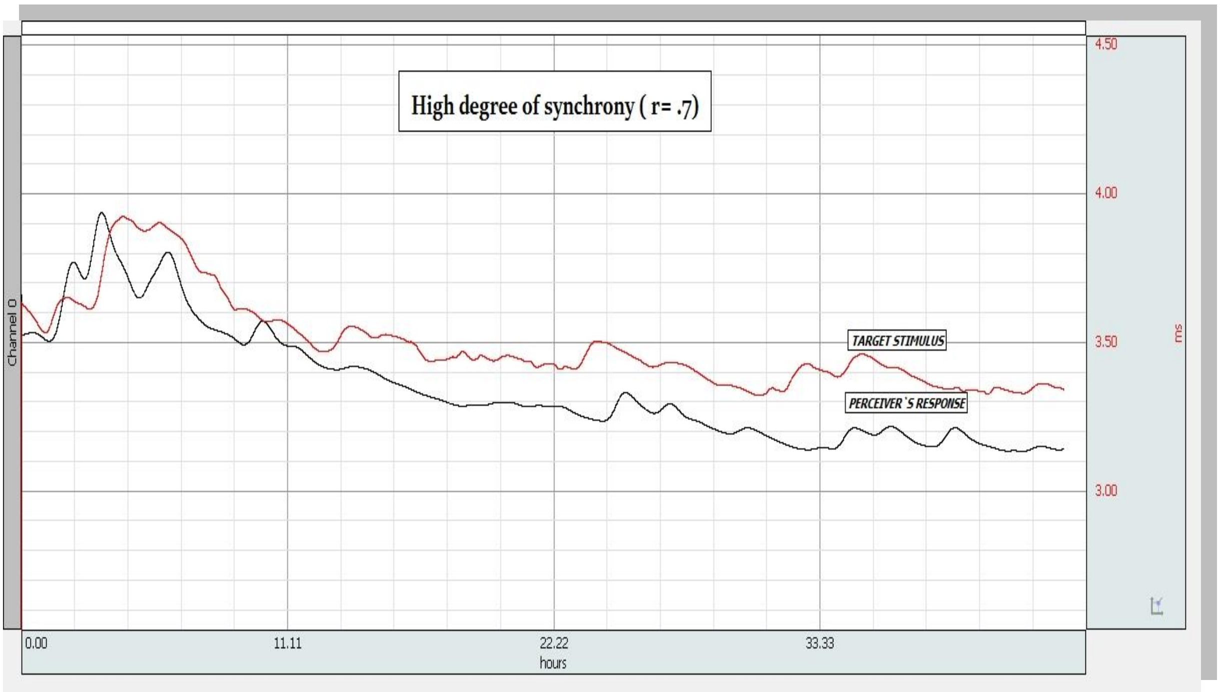


Figure 8. Control condition (perceivers are just watching target`s video without distraction). In this case we have a high degree of EDA (tonic) synchrony between perceiver and target.

Time-course correlation in the case of empathic accuracy task between the target`s own AD ratings, and the perceiver`s AD ratings of target`s negative story are depicted in *figure* 9 and 10.

Figure 9. Low correlation accuracy score (*r =.-41*)

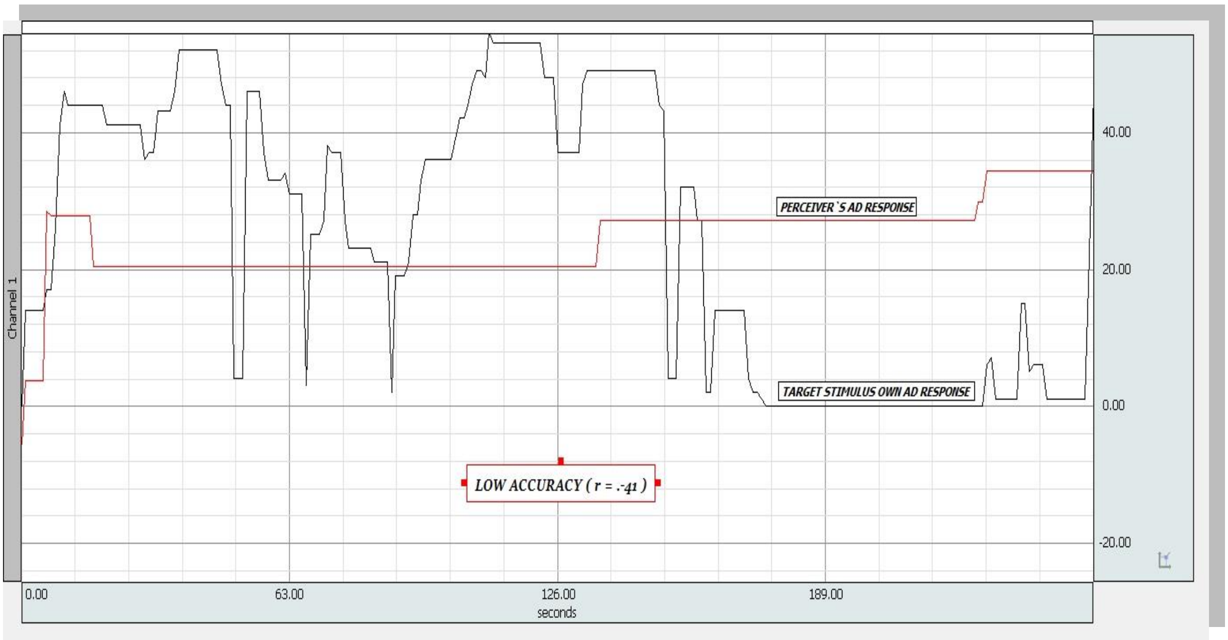


Figure 9. *Experimental condition* – The perceiver is rating the target`s negative story counting backwards from 600, decrementing by 3-unit numbers.

Figure 10 . High correlation accuracy AD score (*r=.49)*

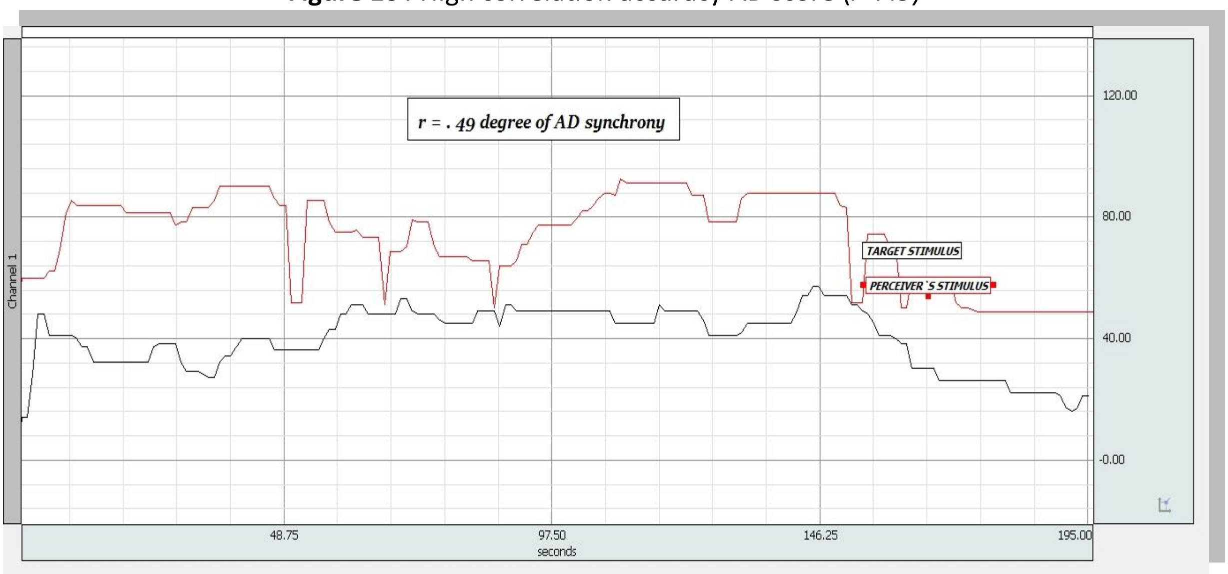


Figure 10. *Control condition* – The perceiver is rating target`s negative story without distraction.

In order to precisely determine discrete changes in the tonic signal (SCR), we generated phasic (red) signal and its corresponding SCRs (blue water droplets) depicted in *figure* 11. Zooming into the blue signal, each SCR is marked with open and closed brackets (open brackets = SCR onset; water droplet = peak SCR response; closed bracket = SCR offset). Blue water droplets represent an SCR that is significant from its background, but not particularly coupled with certain stimulus, and as such we refer to it as, a Non-specific-SCR (NS-SCR). In *table* 2, under column E*v_cnt* each perceiver`s selected phasic signal characterizes a number of SCR events in reaction to the target stimulus.

Figure 11. Perceiver`s phasic signal

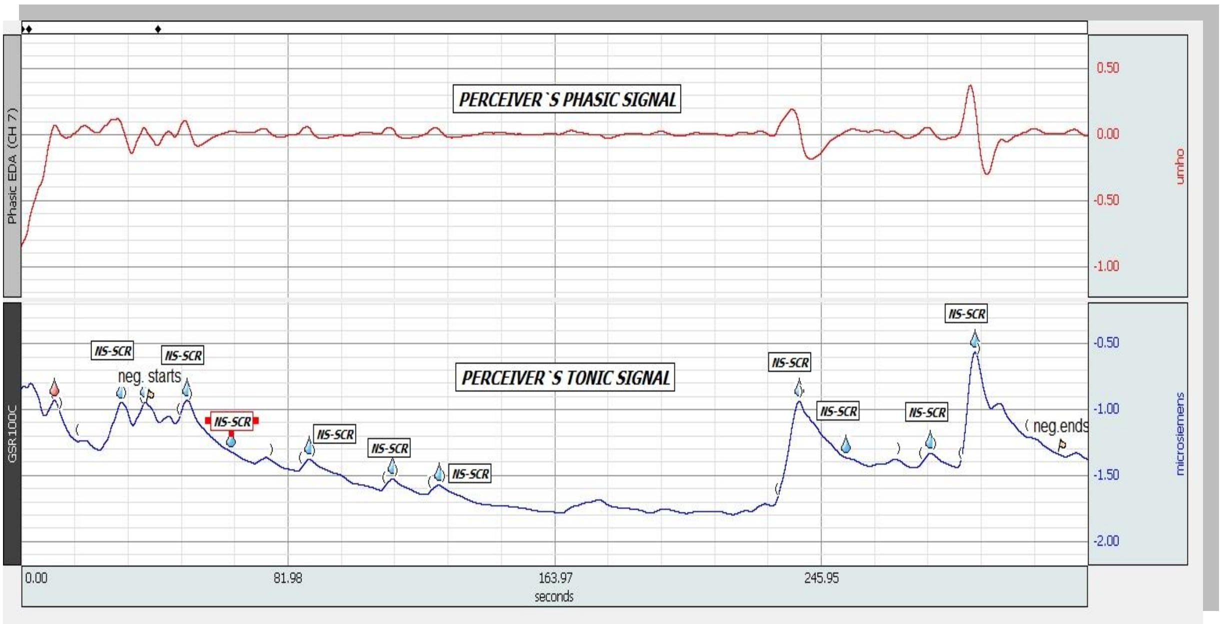


Figure 11. The phasic signal derived from tonic. Each perceiver`s NS-SCR is counted, and later compared with the target`s SCR response. When gathered, the mean average of the perceiver`s SCR in the experimental and control group is further compared.

Finally, each group was separately checked for the normality assumption (see example *Plot* 1) before any of the group's pairs were separately checked for the statistically significant difference between their means (two-sample independent t-test was applied separately across varying groups) (see *figure 12).*

Plot 1. Probability Plot

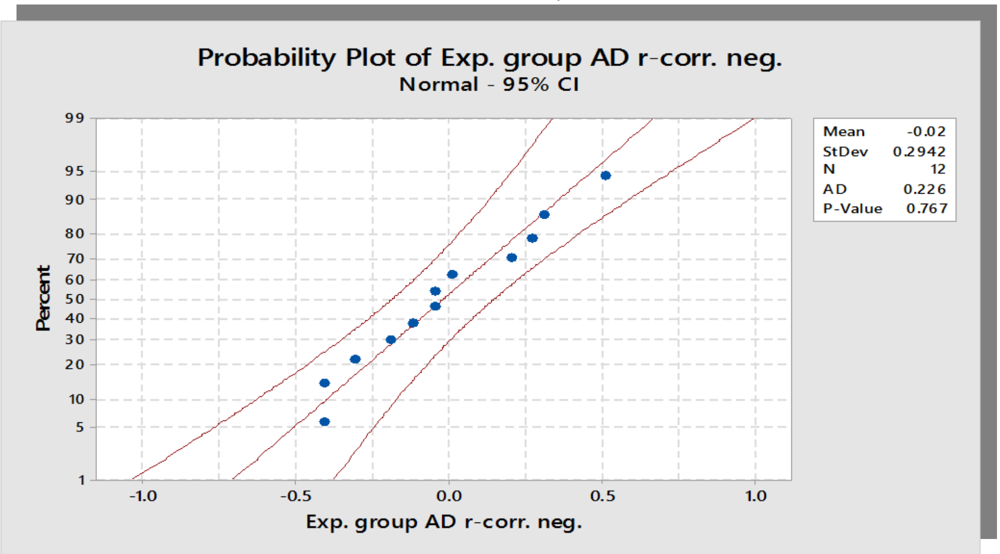


Figure 12. Data reduction analysis

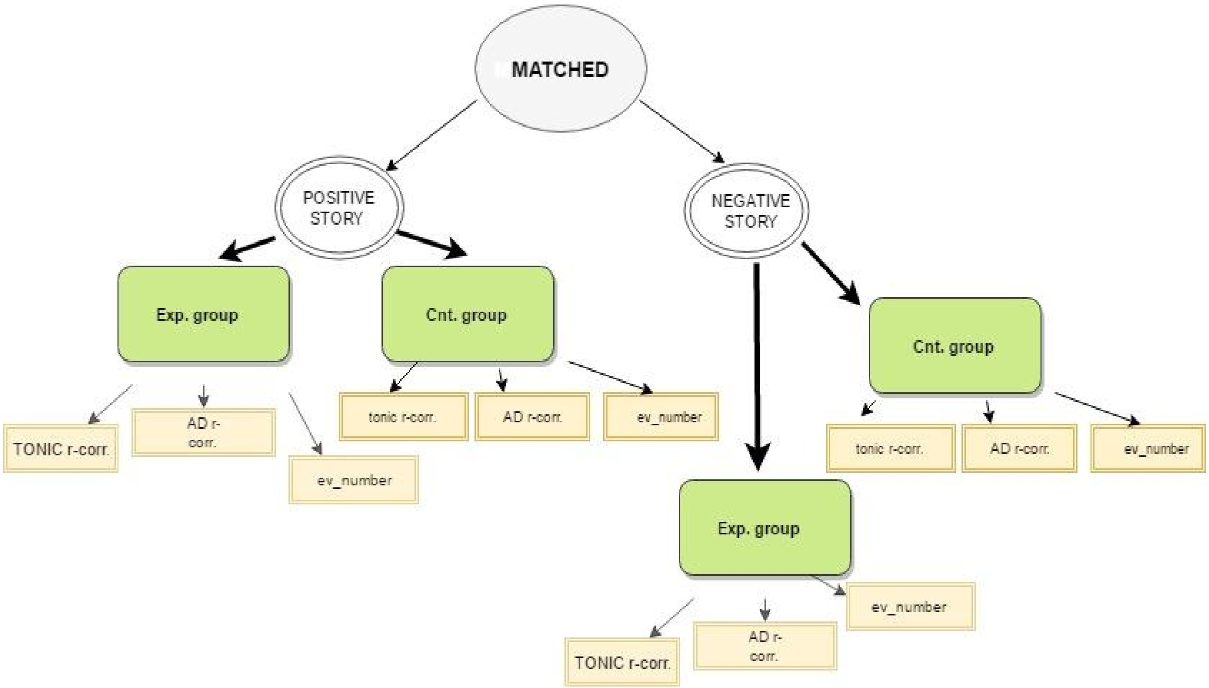


Figure 12. The figure above demonstrates the final results after the experiment had been controlled for the contextually relevant variable (match or no-match). For example, the same perceiver can be a **match with the target stimulus** in regards to the positive target story, but **no-match** in regards to the negative target story. As such, in regards to the positive target stimulus we have further separation into two groups (experimental and control). It is the same in regard to the negative target story. In the positive story the scenario we have as an example, 4 perceivers in the control group and 6 different perceivers in the experimental group. In the positive group (Exp.group and Cnt.group) measurements are conducted across three different variables (TONIC r-corr., AD r-corr., and the number of SCRs- (ev_number)). Next, we compared means between positive exp. and positive cnt. group of their TONIC r-corr. coefficient numbers. A comparison was also made between perceiver`s AD r-corr. coefficients in exp. and cnt. group, and in their number of SCRs. The same method was applied to the negative target story. Unlike the positive target stimulus, perceivers in this group were equally distributed (12 in exp. and 12 in exp. negative story group). The comparison of their means (e.g. TONIC r-corr. in experimental vs. tonic r-corr. in control group) was performed for all three dimensions separately (tonic, AD and SCR).

5. RESULTS

For all the following calculations *Acknowledge* 4.1 and *Minitab* 17 were used. The data from the Tonic and SCR signal of each participant was exported to .csv files, and further used for analysis in *Minitab* 17.

Participants. The participants taking part in our study were recruited in two phases. There were two excluding criteria for the initial phase, one was the knowledge of English language (preferably native English speakers) and the second, was the level of general emotional expressivity (BEQ questionnaire). If both were mutually satisfied we included target subjects in our study. In the initial phase, four targets were recorded, all four whose mother tongue is English. External raters included in the research design (4 psychology students) had the task of rating positive and negative stories (previously explained in the procedural design, see p.20). Selected stories were included in the final research design and were presented to perceivers as target stimulus. In the second phase, 31 subjects were recruited from the University of Ljubljana. They were all undergraduate or graduate level students, from the Faculty of Informatics, Faculty of Physics and Faculty of Arts. This resulted in 20 male and 11 female participants (*N=31*). 90 % of perceivers belonged to the group of 24-32 year old students. 10% of them were in the group of 18-42 year old students. They had all participated without monetary compensation. In the preprocessing phase, we detected 3 EDA Non-responders (9.6%) from the total number of 31, and they have been excluded from further analysis. One perceiver`s data had been corrupted and he was excluded as well.

Questionnaires. Overall, two questionnaires were applied. One of them was the **Berkeley Expressivity Questionnaire (BEQ)** (Gross, 2000) which is a 16-item scale designed to measure an individual`s emotional expressivity divided into three facets (Negative and Positive expressivity, and Impulse strength). Each facet consists of a 7-point Likert-scale, ranging from 1 (*strongly disagree)* to 7 (*strongly agree).* We decided to combine all facets together to form an overall emotional expressivity scale. Results in percentages are presented in *Table* 3.

Table 3. Target`s expressivity

Target	BEQ			
	Negative expressivity	Positive expressivity	Impulse strength	General expressivity
T1	62%	72%	57%	64%
T2	80%	65%	76%	74%
T3	77%	65%	72%	72%
T4	65%	70%	77%	70%

The second questionnaire was adapted from Morrison et al., (2016), and it serves as a mean to control for contextually relevant variables. It consists of 8 items (see *Appendix 8.2)*, of which the first two are oriented towards the perceiver`s specific emotions while watching the video clip. The next three items (see *Table* 4) are important as they contributed to the final score of who would be involved in further data analysis. Those three items follow interpersonal perceptions of the targets. Perceivers rated the degree of "liking that person", similarity to the target person, importance of target`s narrative and perceived self-accuracy of the task being done. All post-items are rated from 1(*not at all)* to 9 (*extremely).* Participants who had scored above average ($5<x<9$) on the last three items were taken into consideration for the final data reduction analysis (e.g. **match,** see Table 2, p. 26**)**. Those were the perceivers, who showed an increased degree of "liking", similarity and importance to the target`s narrative.

Table 4. Post-Q

Questions	Likert-scale
4. How similar do you feel to this person?	***not at all*** (1) to ***extremely*** (9)
5. Overall, how likeable did you find this person?	***not at all*** (1) to ***extremely*** (9)
6. How important do you think what this person talked about was to you?	***not at all*** (1) to ***extremely*** (9)

5.1 Physiological Synchrony

To check for the physiological linkage, second-by-second *Pearson* correlation analysis was performed over the selected area of previously recorded tonic EDA signals. Following a previously determined scenario (see figure 12, p.31) the tonic EDA signal of each selected perceiver was compared to the target stimulus. Table 5 below reveals all selected degrees of correlation reflecting the extent of linear relationships between the perceiver and the targets negative stimulus in both control and experimental conditions.

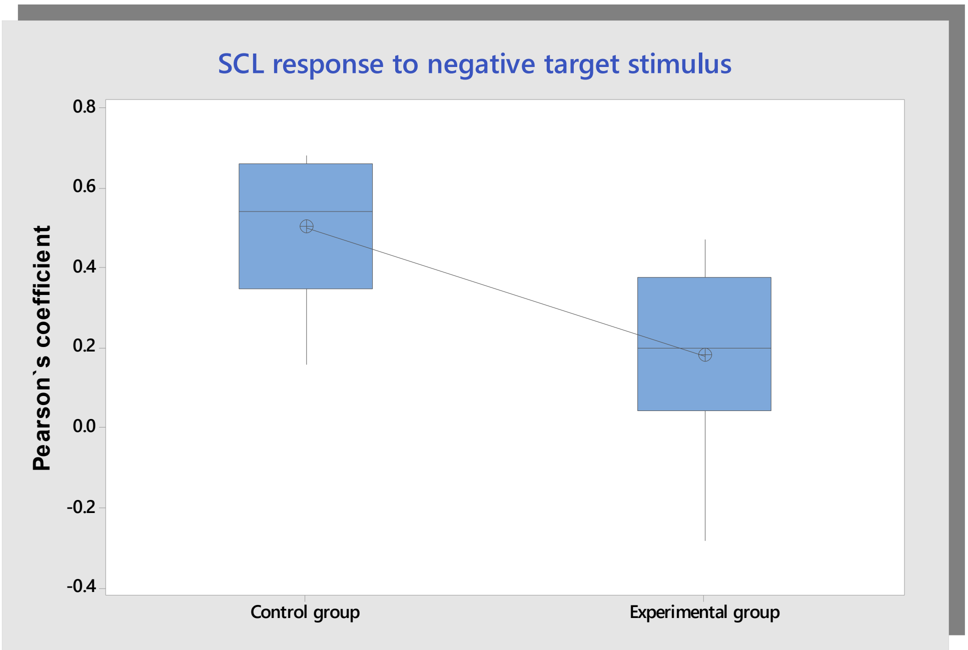
Table 5*. Tonic EDA correlation.*

Control group		Experimental group	
John	.68	Nancy	.38
Marry	.6	Helen	.43
Linda	.4	Dolma	.18
Barbara	.67	Carol	-.28
Maria	.66	Sarah	-.26
Susan	.5	David	.15
Margaret	.16	Joseph	.2
Donald	.33	Thomas	.01
Kevin	.66	Richard	.32
Jason	.55	Elisabeth	.37
George	.53	Sharon	.47
Sandra	.28	Deborah	.2

Table 5. Perceivers are watching negative target stimulus video. All 12 perceivers were different in both groups (experimental. and control group). Average response of the control group is (*r=.5*), and the average response of the experimental group is (*r=.18*). ***Note****: Names in the table have been changed to protect the anonymity of the participants in the study*

As expected, the tonic signal (SCL) of selected perceivers listening to the negative target stimulus in the experimental group significantly differs from the control group (*t(22)=3.67, p= 0.001; right-tailed; level of significance: p<.05) (see boxplot 1.).*

Boxplot 1. Tonic difference (negative target stimulus)



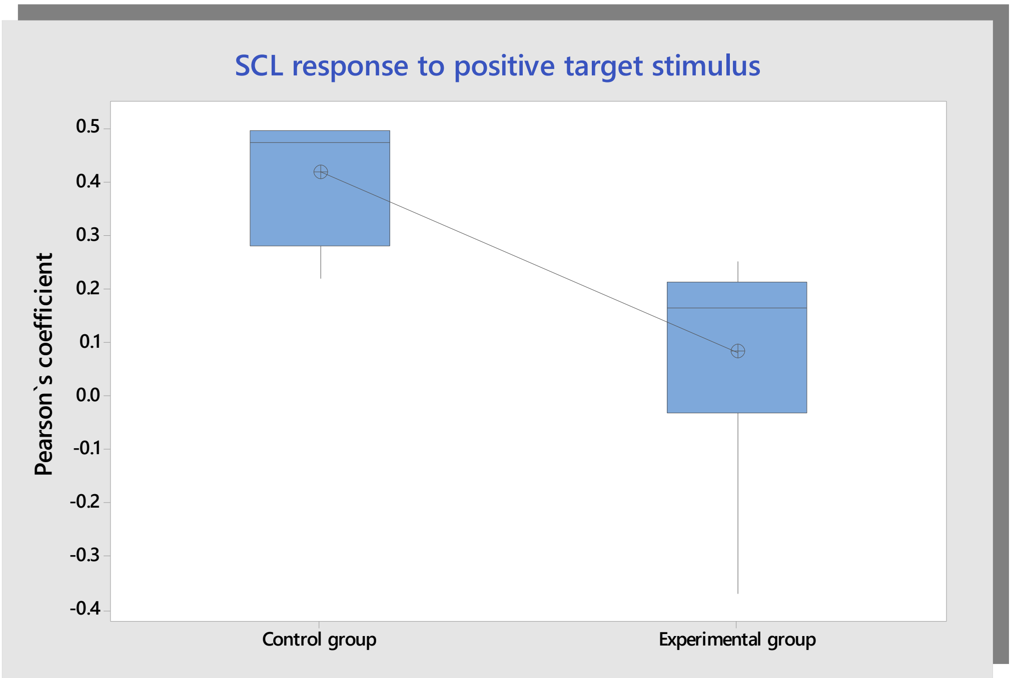
The same procedure was repeated in the case of the positive target stimulus, and *Table 6* reveals the results from that study.

Table 6*. Tonic EDA correlation***.**

Control group		Experimental group	
John	.22	Nancy	.18
Marry	.49	Helen	.08
Linda	.5	Dolma	-.37
Barbara	.46	Carol	.25
		Sarah	.2
		David	.15

Table 6. *Perceivers are watching negative target stimulus video.* Average response of the control group is (*r=.41),* and the average response of the experimental group is (*r=.08).* ***Note****: Names in the table have been changed to protect the anonymity of the participants in the study.*

In the situation where selected perceivers watched the positive target stimulus we found a significant difference between the experimental and control group (*t(8)=2.63, p=0.015; right-tailed; level of significance: p<.05)* (see *Boxplot 2).*



Boxplot 2. Tonic difference (positive target stimulus).

These findings provide support for our initial theoretical assumption, namely, we can demonstrate the rejection of $H1_0$ hypothesis indicating an asynchronous linkage between perceivers and targets response in the setting where perceivers, under distraction, are exposed to the target`s positive and negative story stimulus.

Additionally, a pair of individuals (perceivers & targets) who had been assigned to **no-match group** showed results backing up the weight given to the contextually relevant variables. In the control **no-match** group, 9 perceivers watching the positive video displayed no linear relationship with the target`s story. Moreover, their EDA tonic response was close to 0 (*M=-0.09, SD=0.24*). Similarly, in the experimental group of 8 perceivers, their ability to empathize was also affected by contextual constraints (*M= -0.02, SD=0.15*). The situation in the control and experimental **no-match** group of perceivers who watched the negative video is somewhat different. To begin with, we only had 1 perceiver in the control no-match group (*r=0.05*). On the other hand, in the experimental **no-match group** we had 2 perceivers illustrating no linear coherence with the target`s negative story (*r=0.04 & r=0.1*).

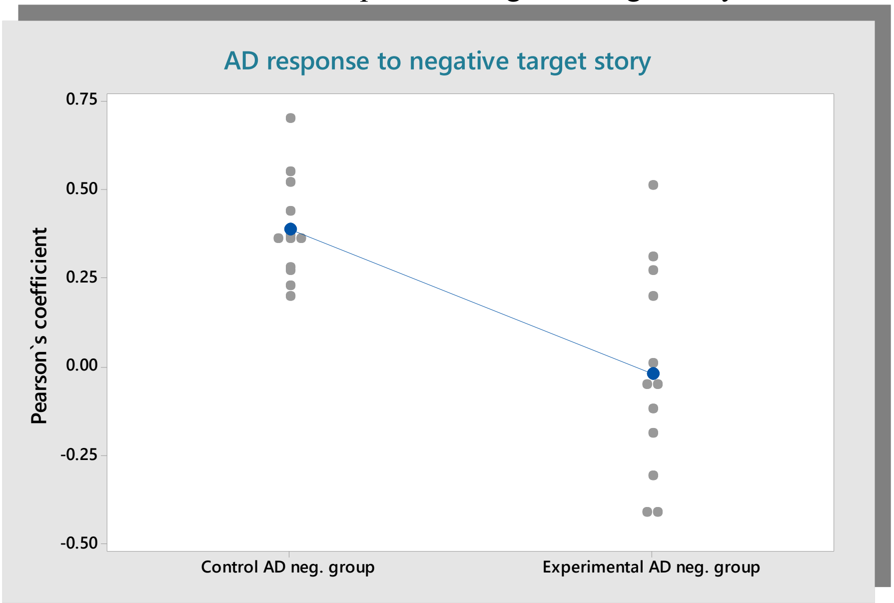
5.1.1 Additional EDA Component – SCR Response

Regarding the EDA phasic component of the signal (SCR), the female target who told the negative story showed 21 discrete SCRs over the course of 4 minutes. If you look at the mean average of the perceivers in the negative control group, the SCR mean response is weaker with (*M=12.25, SD=4.15*), which met our expectations as perceiver`s SCRs can hardly equate to the number of SCRs in people who are telling the story themselves. However, perceivers in the experimental group who listened to the negative story (*M= 19.41, SD=8.33*) differ both from the target`s SCR response, and when compared to the SCR response in the control group they show a statistically significant SCR difference between their means (*t(22)=-2.66, p=.01, two-tailed; level of significance: p<.05).* On the other hand, the female target who told the positive story showed 39 discrete SCR over the course of 6 minutes. When perceivers in the control group *(M=17.16, SD=10.32)* are compared to the experimental group *(M=37, SD=11.48)* of perceivers who are listening to the positive story, the comparison between their means yielded statistically significant difference (*t(8)=-2.85, p=0.021; two-tailed; level of significance: p<.05).*

5.2 Affect Dial Synchrony (self-reported scale)

In terms of the AD ratings, a comparison of the control and experimental groups exhibited a statistically significant difference when perceivers were exposed to a negative target stimulus (*t(22)=4.29, p=0.00; right-tailed; level of significance: p<.05).* It was already noted during the experiment that perceivers had barely moved the affect dial slider due to the already demanding cognitive task of counting backwards (see *Boxplot* 3.).

Plot 3. AD response to negative target story



Plot 3. AD r-coef. difference between control and experimental condition in perceiver`s response to the negative target stimulus. An equal number of 12 different perceivers has been selected for the control and experimental group.

When comparing means between the selected perceiver`s AD rating score in the experimental group and the control group of perceivers listening to the positive story, we did find significant difference (*t(8)=2.16, p=.03; right-tailed; level of significance: p<.05)*. The mean average over Pearson`s correlation coefficients still exhibits a decrease in the control group response (*r=.39),* compared to the experimental group (*r=.08).*

Table 7*. Affect Dial Pearson`s coefficient*

Positive target stimulus

Control group of perceivers		Experimental group of Perceivers	
John	.38	Nancy	.25
Marry	.46	Helen	-.45
Linda	.34	Dolma	.13
Barbara	.38	Carol	.2
		Sarah	.29
		David	.1

Table 7. Affect dial ratings between the perceivers and female targets during the positive story condition. Average response of the control group is (*r=.39),* and the average response of the experimental group is (*r=.08).*

Similar to the indicative asynchronous physiological linkage in the experimental state, perceivers who are distracted also demonstrate a considerable amount of decline in the AD rating score. Therefore, our primary assumption has been confirmed; the perceiver`s AD rating score in the experimental condition leads to the rejection of the $H2_0$ in both experimental conditions (positive & negative target`s video).

Finally, our evidence suggest that empathy is dependent on situational factors. In the control and in the experimental **no-match** group the average response shows no-relationship with the target`s positive video stimulus. The control group of 9 perceivers exhibited the mean response of (*M=0.06, SD=0.04*). Likewise, the experimental group of 8 perceivers watching the positive video demonstrated the same patterning (*M=0.02, SD=0.05*). Furthermore, the perceiver who watched the negative video story in the control no-match group does not show a connection with the target`s negative story (*r=0.07*), and in the experimental no-match group affect dial response is again skewed towards no-relationship with the target`s negative video (*r=-0.09 & r=0.06*). Our results indicate that certain contextual factors may alter the empathic accuracy task, the way people assess and infer other people`s emotions.

6. DISCUSSION

Many recent studies have revealed a considerable amount of physiological synchrony in interpersonal interactions. In most cases, those were paired dyads and combinations of marital couples, friends and client-therapist relations (Karvonen et al., 2016; Slovak et al., 2014; Marci et al., 2007). In accord with similar empathy-related studies, they expose a key factor of interpersonal accuracy and its dependence on the contextually relevant variables. The perceivers, who are generally similar to the observed targets, show a higher degree of understanding with elevated inferential accuracy of other people`s emotions (Zaki & Ochsner, 2016; Hodges, Kiel, Kramer, Veach, & Villanueva, 2010).

6.1 EDA Patterning

The present study, previously accounting for the aforementioned contextually relevant variables, presented similar results. EDA physiological synchrony indicates that changes in the tonic (SCL) signal occur synchronously when perceivers are watching targets telling autobiographical negative and positive stories. As an indicator of a more general level of arousal, the SCL trend in the control group of perceivers who are watching target`s negative story confirms previous findings (Levenson and Ruef, 1992), and presents a slightly higher degree of correlation than in the positive case. That is to say, the perceiver`s mean average response ($r=.5$) when listening to the negative story is higher than in the case of the perceivers who are listening to the positive target story ($r=.41$). Even though the sample in the negative scenario is double the size than in the positive one, it still exhibits a trend consistent with established theories. For example, it could be the case that people who are more emotionally expressive display more negative affect in an interpersonal setting (King & Emmons, 1990; Zaki, Bolger, & Ochsner, 2009) and thus, we can probably see a higher level of accuracy when perceivers are exposed to negative than to positive stories. However, there could be a more intuitive explanation that perceivers experiencing positive affect engage their ANS less, as EDA patterns of activation can appear separately across two independent dimensions, positive and negative, respectively. If we go beyond interpersonal linkage and further explore empathic response in general, Morelli et al. (2014) point out different neural patterns of valence activation (i.e. positive vs. negative), in which positive affect engages the ventromedial prefrontal cortex, and negative affect engages the anterior insula and dorsal cingulate cortex. In addition, we can justify our results in terms of duration of the videos. In the case of the female target person, the video lasts for 4 minutes, while in the positive scenario the story goes for 6 minutes. Therefore, it can be argued that even if we consider prior arguments, perceiver`s attention to the stimulus (and loss of interest in case story) can lead to less physiological synchrony with the target`s positive story example. As only one autobiographic event is considered, it can still mean that the story itself is less interesting than maybe some other more positively valenced story. Nevertheless, the present study shows that the physiological tonic linkage between perceivers and targets, replicates previous findings of synchronized changes in general EDA arousal of two individuals, who happen to share similar emotionally arousing patterns of ANS activation.

The main research question and the far more interesting part of this study comes from the setting in which perceivers are now exposed to target`s stories in the cognitive load condition (counting backwards), superimposed on the usual EA task in hand. It was previously assumed that top-down regulatory process (attention) can disrupt empathy in general, but to date it was never confirmed how such constraint can interfere with interpersonal accuracy within the EA paradigm. In a study done by Gu and Han (2007) fMRI results showed that empathy related regions (ACC/paracingulate area, insula, and the frontal cortex) are active only when the perceiver pays attention to, in this case, the pain aspect of a target`s stimulus. Furthermore, contextual appraisal and attention are important factors that by top-down regulation can inhibit or amplify our empathic response (Singer & Lamm, 2009). In some cases, time can be a limiting factor, altering the odds that perceivers will empathize (Shaw, Batson & Todd, 1994). Under time pressure, we can change the prospect of someone who is about to empathize with another person. Having said that, in the present study we outlined this probability through a design in which cognitive load plays an important interfering task. In our experimental group, perceivers were counting backwards while watching targets telling one positive and one negative story. When these two groups of perceivers are compared, we can see a more asynchronous SCL response pattern of activation across the entire video. Namely, in the experimental condition we have 2 out of 12 perceivers who watched the target`s negative story and who exhibited a negative correlation pattern ($r = -.28$ & $r = -.26$). One of the subjects showed no correlation pattern with the target at all ($r = .01$). In the control group, no perceivers showed this divergent SCL pattern. If the alpha level is marked as salient ($p<.05$) we can see a statistically significant pattern of correlation between the experimental and control group of perceivers.

In the experimental group, in which perceivers are watching a target`s positive video, we observed a different pattern of occurrence. One subject is completely diverging from the target`s general arousal (*r = -.37)* and one shows no correlation pattern *(r=.08)*. The result is probably affected by methodological constraints making it difficult to define how much weight we can give to these outcomes. Specifically, the explanation can probably be found in the group sample size, which was relatively small.

The phasic channel is an equally important measurement. In some cases, researches give more importance to this part of the EDA signal. Throughout this study we focused on the measurement of SCRs per unit time, reflecting faster changing elements of the signal. In the case of a resource demanding task, such as counting backwards, subjects should show an increased number of SCRs. When compared between groups, the number of SCRs is greater in the group where perceivers are exposed to the task of counting backwards. On average, that number is statistically significant and in both groups, perceivers exhibit an increase of SCRs, more than in the control group. It should also be noted that the average number of SCRs across all perceiver`s recorded signals is quite close to the number of the target`s. This leads to the conclusion that perceivers produce elevated levels of EDA signals, confirming previous findings that attention processing and cognitive demanding tasks can evoke an increase in EDA responses (Braithwaite et al., 2013).

6.2 Affect Dial Patterning

When rating the target`s negative story, we see a strong decline in comparison with the control group. Perceiver`s accuracy is estimated by matching their inferences with those of target`s, that is to say, what the perceiver`s thoughts and feelings were, to what the target registered as their thoughts and feelings. Out of 12 perceivers, 7 of them exhibit negative correlation coefficients, whereas in the control no perceiver displayed such patterns. When coupled together (experimental vs. control), they display a strong divergent pattern in their AD response (*p=.00*). By contrast, those numbers are not the same when perceivers are rating a target`s positive story. Only one perceiver showed a negative correlation pattern (*r=.-45)*; yet the results in the case of experimental group listening to the positive story demonstrate a statistically significant pattern of activation of (*p=.03*). Following the previous line of reasoning, the negative story does have an influence on perceivers who seem to be more emotionally engaged with the negative story. If we look into patterns of AD negative ratings, they barely move the slider. By contrast, perceivers listening to the positive story, and counting at the same time, appear to have less biased responses and show more accurate judgment on the positive slider as opposed to the *p-value* in AD negative ratings ($p=.00$). So far, the only theory accounting for these results can come from an intuitive idea of length of the video. As the positive video is longer than the negative one there can be more time to correct for the error that exists in the results, and adapt more to the cognitive task of counting. Once the perceivers finish with watching the target`s video in the experimental condition, they were asked to report the counting-number they had reached (to control the task at hand), whilst also asked to say a few words about counting strategies being employed. In most cases, they reported that it was easier for them to count backwards when listening to the target`s positive story. However, it should be noted that there still exists a disruption and the decrease in the AD response signal between the experimental and control group of perceivers who listened to the target`s positive story. In the experimental positive group of perceivers mean response of ($r= .08$) shows a decrease from previously calculated correlation coefficient in the control group ($r= .39$).

6.3 Key Findings

Over the course of the last 20 years, many related studies have been conducted, most of them aiming to document different interpersonal factors under which physiological concordance occurs. Comparably to other related studies, the present one indicates the synchrony between two individuals in the control condition; two individuals display changes in their arousal that happen to be consistent over a longer period of time, changing in a similar recurring way. Although it might be that the correlations are a result of chance, in the experimental condition the length of video secures stable asynchronous concordance in the state of distraction. In addition, low emotional engagement is further backed up through low interpersonal accuracy of rating target`s emotional valence.

Finally, the present study confirms our previous theoretical assumptions. There has to be some interference with EDA patterns of activation when people are engaged in cognitively demanding tasks in a setting where they are asked to judge other people`s emotions. Moreover, the empathic patterning is not entirely automatic, mentalizing can become crucial too, and lead to yet, an altered empathic state (Morelli & Lieberman, 2013). Therefore, effortful empathic control (Eisenberg & Eggum, 2009, as cited in Decety&Ickes, 2009) and top-down regulatory processes have to be assigned equal status as to bottom-up (sensory) driven empathic models (Decety & Lamm, 2006). Both information processes (top-down vs. bottom-up) are intertwined and they tend to generate a fully-blown empathic response. When perceivers take the advantage of top-down regulatory mechanisms, they reveal the potential of, for example, the supremacy of attention over lower levels of empathic organization, and hence make the perceiver less dependent on external cues. Taken together, these initial results stress the significance of high-level processes, demonstrating that consistent interpersonal physiological synchrony and self-reported emotions may become disrupted by cognitive load.

6.4 Limitations

The present study has a number of strengths. To the best of our knowledge, this is the first EA study exploring the effect of cognitive load on physiological and self-reported synchrony. Many studies are performed under highly controlled settings, yet in our study we used short videos that were made by non-actors, and in which targets were retelling real emotional situations. Having said that, the relationship between perceivers and targets closely approximated discourse from real-world interpersonal interactions due to similar age, status (mostly students) and cultural embeddedness. Furthermore, the affect dial system deployed allowed perceivers to effectively rate other people`s feelings without interruption, further letting perceivers change their choice (*intensity and valence of the affect) whilst viewing the video.* This allows the experimenter to calculate accuracy for the time-changing dynamics examining the correlation between the perceiver`s inferences of the target`s feelings and the target`s self-rating over a period of time.

However, in our study there are several limitations. First, our sample size is relatively small, especially in the case of perceivers who have listened to the target`s positive story. Before the final analysis was conducted, the number of matched samples had been reduced to 6 in the negative, and only 4 in the positive group. Such group size can hardly hold for the necessary generalizability criteria. Second, the AD system uses a one-dimensional valence component (positive vs. negative) and for instance, a perceiver cannot express their opinion in case of ambiguous feelings. It is not possible for participants to specify positive and negative feelings (sadness and affection) in parallel, on the scale (Morrison et al., 2016). As such, perceivers are forced to indicate a neutral position which does not correspond to the complexity of the relevant emotion. Additional limitations come from the fact that previous fMRI studies show that acute stress can affect neural mechanisms essential to automatic and regulatory components of empathy during pain (Tomova et al., 2016). Stressed perceivers could show stronger activation in empathy than controls who are not exposed to such stress. No prior battery of tests in our study has been applied to reveal such momentary factors.

In similar video-taped studies, often times, researchers would use a larger number of target videos. It lets them extrapolate better results due to the variability of people, emotional valence and diversity of stories displayed. That said, researchers have the opportunity to correct for indefinite findings. Furthermore, it enables them to assign and test other variables in the experimental condition. Take cognitive load as an example; perceivers could easily adjust to counting backwards deploying less demanding cognitive task (decrementing by 1). Although such instances can lead to very interesting discoveries, they have not been taken due to practical and technical reasons.

One additionally useful approach could include emotional coding as such. Getting more precise insight into the emotional 'footprint' of target's videos can be comprised of a search for critical interpersonal aspects of those videos. Trained raters could look for distinct bits of behavior on the basis of verbal content, voice tone, gestures, motor and body movements. Annotated videos marked through time-stamped logs could result in more complete emotional reflections; other than drawing an average from the whole EDA and AD signal, we could detect critical moments in the target`s video, and further get more relevant parts of the story and therefore more precise results for comparison.

Our findings build on previous research and match the latest psychophysiological discoveries on synchrony between perceiver`s and target`s responses. However, no current model offers an accepted and standardized analytical procedure of physiological and AD synchrony. Consequently, our model belongs to this group as well. We are aware that other more complex and sophisticated statistical models exists, and as such future follow-up studies could deploy such procedures. For example, the bivariate time series correlation (Levenson & Gottman, 1983) or SC-concordance index (Marci et al., 2007) proposed by these researchers could, more closely estimate the level of synchrony in interpersonal interactions. Other phasic changes in the signal such as the area under the curve (Boucsein, 2012; Benedek & Kaernbach, 2010) could serve as a better statistic of the perceiver`s expressive arousal.

Correspondingly, recent studies have revealed that units such as the sum of amplitude peaks (Figner & Murphy, 2011; Groeppel-Klein, 2005) can evaluate the level of emotional activation.

Finally, to generalize our findings and link psychophysiological synchrony between perceivers and targets, it is necessary to include measurements other than EDA. Even in combination with cardiovascular response, it is insufficient to say that electrodermal and cardiovascular processes can generate and represent a full-blown ANS response (Levenson, 2014). There are other important ANS specific quantities such as respiration or the activity of the gastrointestinal system. Probably the most important limitation of them all comes from the methods of assessing particular emotional ANS responses. No matter how cautious researchers are, there is still no guarantee that the target stimulus generates any particular emotion in question. Different patterns of ANS activity must have other means of real-time verification other than the existing methods in use.

6.5 Future Implications

It is worth mentioning that several limitations explored in the previous subsection offer potential for further investigation. However, the EDA ability to distinguish between some emotional patterns of activation can play a key role in the field of HCI. As such, the EDA synchrony can be extended outside the setting in which our research project took place. Feedback from the EDA synchrony and other related means of inquiry can, together, lead to novel EDA systems where real-time feedback responses can be provided. Furthermore, such systems could specify real time signals and further connect them to, for example, wearable technologies designed to address stress management issues and reflect positive and negative patterns of people`s behavior and emotions (Sanches et al., 2010). In a setting where we experience other people`s emotions, we can trace their response patterns employing research strategies such as the one in our study. Moreover, we can see factors contributing to such real-time responses considering our previous assumption that attention can play a critical role in our empathic understanding of a person. We further see an influence in the future design of technologies that can catch such complex phenomena, at least in the realm of general differentiability of positive and negative emotions.

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8. Appendix

8.1 Berkley Expressivity Questionnaire

****** For each statement below, please indicate your agreement or disagreement. Do so by**

filling in the

blank in front of <u>each</u> item with the appropriate number from the following rating scale:

--

1	2	3	4	5	6	7
strongly <u>disagree</u>			**neutral**			**strongly <u>agree</u>**

--

____ 1. Whenever I feel positive emotions, people can easily see exactly what I am feeling.

____ 2. I sometimes cry during sad movies.

____ 3. People often do not know what I am feeling.

____ 4. I laugh out loud when someone tells me a joke that I think is funny.

____ 5. It is difficult for me to hide my fear.

____ 6. When I'm happy, my feelings show.

____ 7. My body reacts very strongly to emotional situations.

____ 8. I've learned it is better to suppress my anger than to show it.

____ 9. No matter how nervous or upset I am, I tend to keep a calm exterior.

____10. I am an emotionally expressive person.

____11. I have strong emotions.

____12. I am sometimes unable to hide my feelings, even though I would like to.

____13. Whenever I feel negative emotions, people can easily see exactly what I am feeling.

____14. There have been times when I have not been able to stop crying even though I tried to stop.

____15. I experience my emotions very strongly.

____16. What I'm feeling is written all over my face.

Items 3, 8, and 9 are reverse scored.

Items 3, 5, 8, 9, 13, 16 make up the Negative Emotionality facet

Items 1, 4, 6, 10 make up the Positive Emotionality facet

Items 2, 7, 11, 12, 14, 15 make up the Impulse Strength facet

- Scoring is kept continuous. Researchers can either keep the 3 facets as separate scores or can combine them together to form an overall Emotional Expressivity scale.

8.2 Post-video Questionnaire

1. Overall, how did this person seem while they were talking?

		not at all								**extremely**
a.	Pleasure	1	2	3	4	5	6	7	8	9
b.	amused	1	2	3	4	5	6	7	8	9
c.	pride	1	2	3	4	5	6	7	8	9
d.	relived	1	2	3	4	5	6	7	8	9
e.	desperate	1	2	3	4	5	6	7	8	9
f.	angry	1	2	3	4	5	6	7	8	9
g.	surprised	1	2	3	4	5	6	7	8	9
h.	irritated	1	2	3	4	5	6	7	8	9
i.	sad	1	2	3	4	5	6	7	8	9
j.	anxious	1	2	3	4	5	6	7	8	9

2. Overall, how did you feel while watching this video?

		not at all								**extremely**
a.	Pleasure	1	2	3	4	5	6	7	8	9
b.	amused	1	2	3	4	5	6	7	8	9
c.	pride	1	2	3	4	5	6	7	8	9
d.	relived	1	2	3	4	5	6	7	8	9
e.	desperate	1	2	3	4	5	6	7	8	9
f.	angry	1	2	3	4	5	6	7	8	9
g.	surprised	1	2	3	4	5	6	7	8	9
h.	irritated	1	2	3	4	5	6	7	8	9
i.	sad	1	2	3	4	5	6	7	8	9
j.	anxious	1	2	3	4	5	6	7	8	9

3. Overall, how accurate did you think you were about this person`s emotions?

	not at all								**extremely**
a.	1	2	3	4	5	6	7	8	9

4. How similar do you feel are to this person?

	not at all								**extremely**
a.	1	2	3	4	5	6	7	8	9

5. Overall, how likeable did you find this person?

	not at all								**extremely**
a.	1	2	3	4	5	6	7	8	9

6. How important do you think what this person talked about was to you?

	not at all								**extremely**
a.	1	2	3	4	5	6	7	8	9

7. What is your gender?

    a. Female
    b. Male

8. What is your age?
    a. ___

8.3 Curriculum Vitae

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Academic Qualifications

| Master of Arts in Social Work |	|University of Belgrade http://www.fpn.bg.ac.rs/en/|	|2009 – 2012|
| Special Pedagogue, BA |	|University of Belgrade http://www.fasper.bg.ac.rs/|	|2003-2009|
| Associate Fellow Qualified Therapist |	|REBT Affiliated Center, NY,USA, http://albertellis.org/|	|2008-2012|

Research-related employment

| **Research Assistant** Internship position |	| TU Vienna, HCI lab Project contact: PhD Petr Slovak petr@igw.tuwien.ac.at |	|2015-2016|

- *Project name*: EDA Based Detection of Emphatic Accuracy ; *Responsibilities*: Experimental Design, Data Collection & Data Analysis MEI:CogSci Conference Presentation
  Conf. Abstract - https://goo.gl/s7FasE

| **Research assistant** |	| International Management Group http://www.img-int.org/- Beneficiary country → Serbia. Project contact: prof. Tamara Dzamonja tamdzam@eunet.rs |	|2013-2014|

- *Responsibilities*: Design&Implementation of (evidence- based) integrative treatment program for juvenile offenders; Evaluation of the program effects and activities – development&design of questionnaires and interviews for children and experts; Data entry and analysis. Paper published (in Serbian).

| **Researcher** on the project: Advancing Social Welfare for Vulnerable Groups of Children and Their Families |	| Center for Research-Faculty of Political Science, Belgrade-funded by UNICEF Project contact: prof. Tamara Dzamonja tamdzam@eunet.rs |	| 2011-2014|

- *Responsibilities***:** Semi-structured interviews with children and their families; In-depth analysis of social caseworker`s documented case folders; Focus group facilitation with experts in the field (design &facilitation); Qualitative focus group analysis (children and experts);

| **Researcher** on the project: Child Begging in Southeast Europe: Serbia Report | | Ombudsman of Serbia and Save the Children, Norway| Project contact: Natasa Jovic natasa.jovic@ombudsman.rs | |2010-2011|

- *Responsibilities:* In-depth interviews (design&data collection) with children and their families; Focus group (design&facilitation) with experts in the field; Questionnaires (design&data collection); Qualitative analysis – as a result, national report has been written and published (link below).

| **Young undergrad student Researcher** on the project : Trafficking Risk and Resilience in Southeast Europe | | Save the Children UK| Project contact: prof. Nevenka Zegarac, nzegarac@eunet.rs |2007|

- *Responsibilities*: In-depth semi-structured interviews with children and youth; Focus group facilitation with children and youth; Semi-structured observation of children and youth.

Publications

Bircanin, F., Brereton, M. Information sharing between family members of children with Intellectual Disability: Future perspectives of ICT. OzCHI. ACM (2016)

**accepted as double-blind peer reviewed two page paper for poster presentation* (OzCHI conference, 2016).

Bircanin, F., Jovic, N., Nesic, S., Colic, G. Prevention of Child Exploitation In Southeast Europe: Child Begging in Serbia. Ombudsman Serbia, Belgrade, (2011) https://goo.gl/n54IVO - ISBN: 978-86-87945-07-4

**parts of the report translated in English have been used in the regional report which can be found following this link* https://goo.gl/ubGdKe

Bircanin, F., Djordjevic, M., Vasilijic, M. We know best: Outreach Work of the Centre for Youth Integration. Save the Children&CYI, Belgrade, (2011). https://goo.gl/g7w7hC - no cited ref. ISBN: 978-86-912679-2-6

**this report does not present a research publication, it is a report based upon the experiential learning and underlying theoretical research on the Outreach work with street children. It is written as a national guidebook in this field.*

Dzamonja, T., Bircanin, F. Integrative Treatment Program: Implementation of Diversionary Measures. Social Policy (2), Institute of Political Studies, Belgrade pp. 67-91. (2014) https://goo.gl/VE3DdL - cited only in Serbian

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Other relevant information

- AWARDS: QUTPRA scholarship award (2017)
- Machine Learning Specialization (Sep.2016-Feb 2017) , University of Washington, online course
- Virtual Reality Theater Production (Apr 2016 – Aug 2016), contact details: igor_bozovic@eg.rs
- Internship position, AI lab., University of Ljubljana (Nov 2015 – Feb 2016), contact details: domen.soberl@fri.uni-lj.si
- Conferences: MEI:CogSci conference presentation 2016 (An EDA study); National Serbian Psychotherapeutic Congress, invited talk on Integrative Treatments of Juvenile Offenders

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