

Autobiographical narration and neuroscience: neurometric insights into work group dynamics

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ABSTRACT

This study explores the application of neurometric assessments, specifically electroencephalography (EEG) hyperscanning, in the context of autobiographical storytelling to enhance group dynamics and trust within teams. Social research has shown that collaborative activities like storytelling can foster synchronization among participants, increasing mutual understanding and group cohesion. Engaging in autobiographical storytelling allows individuals to reduce self-centered tendencies and encourages collaboration. Recent advancements in hyperscanning techniques, researchers can now study multiple individuals simultaneously, offering new perspectives on the topic. The goal of this research is to use EEG hyperscanning to investigate neural synchronization during autobiographical storytelling sessions. This approach has the potential to address the challenges faced by modern work environments, helping to create cohesive, inclusive, and high-performing teams. Ultimately, the aim is to develop a cutting-edge research protocol that explores how personal narratives create an emotional “force field” that strengthens collective social intelligence and fosters mutually beneficial relationships within teams.

Keywords: neuroscience; autobiographical narration; group dynamics; neurometrics; neural synchronization.

1. INTRODUCTION

Advances in neurometric measurements, alongside the progressive maturation of interpretative and analytical methodologies, open new horizons in the field of applied neuroscience within human sciences. Initially rooted in market research and marketing studies, these methodologies have evolved with the development of hyperscanning techniques to explore dual-subject interactions and, more recently, group interactions and organizational change processes (Santoro, 2017). This presents a significant opportunity to better understand the social dimension of individuals, enabling the measurement of their interactions and the identification of collective activation moments.

Social engagement generated within a workgroup, under specific conditions, leading to accelerated social efficacy has long been a subject of study. This trajectory extends from John Nash's reflections on game theory (Nash, 1950), through different applications of feedback in Group work (Fredrickson & Losada, 2005), to recent research on electroencephalography (EEG) applications on team performance (Reinero et al., 2021) and brain-to-brain coupling (Hasson et al., 2012).

Nash's classical illustration of the "prisoner's dilemma" exemplifies a game theory scenario where mutual cooperation yields better outcomes, yet the temptation to defect arises when anticipating betrayal by the other. The crucial factor in such scenarios is the information available to the parties within inherently unstable contexts where decisions often rely on incomplete or uncertain data. In repeated interactions (where players engage over time), game theory suggests cooperation becomes more likely as participants learn to predict each other's behaviors and build trust (Nowak & Sigmund, 1998). The possibility of transcending win/lose relationships depends fundamentally on fostering trust within the group. This requires clear intergroup communication and the establishment of an authentic climate of trust as key elements of collaborative settings (Axelrod, 2000). Empirical evidence, supported by extensive experience in organizational group dynamics, demonstrates that sharing personal stories within workgroups encourages openness and empathy, reducing the risk of "betrayal" (i.e., self-interested behavior) and fostering continuous and authentic cooperation (Gergen, 2009). As participants exchange their stories and experiences, a deeper mutual understanding develops, facilitating the prediction of future behaviors and the establishment of cooperative and reciprocal relationships.

2. NEUROMETRICS AND SOCIAL DYNAMICS

Research on social interactions through neurometric measurements spans various domains, from dyadic feedback interactions in professional contexts to group dynamics in technical or collaborative settings (Balconi & Vanutelli, 2017). While functional Magnetic Resonance Imaging (fMRI) provides high spatial accuracy for brain activity localization, empirical studies show that EEG is equally effective for analyzing central nervous system mechanisms (Tagliazucchi et al., 2012; Montague et al., 2002; Giroladini et al., 2015; Grootjans et al., 2024). EEG's high temporal resolution and non-invasiveness make it well-suited for studies in naturalistic settings. Portable devices such as "MuseTM" headbands have simplified neurometric data collection in complex contexts like storytelling labs, where maintaining task focus and allowing free movement and emotional interaction among participants are essential (Babiloni & Astolfi, 2014). In collaborative settings, EEG facilitates the synchronous recording of brainwaves from defined groups of individuals, engaged in activities like autobiographical storytelling. This approach makes it possible to analyze brain synchronization and activation across different cortical areas based on group dynamics. Hyperscanning technology, which enables simultaneous monitoring of multiple individuals, is particularly valuable for studying brain synchronization during social interactions involving several people. Research demonstrates that collaborative activities enhance brainwave synchronization among participants, underscoring EEG's utility in dynamic contexts (Liu et al., 2017; Chuang et al., 2024), such as collaborative storytelling.

Other recent studies help us define various fields of investigation, such as:

- Identifying neural coupling profiles that distinguish high-creative group dynamics using functional Near-Infrared Spectroscopy (fNIRS) (Lu et al., 2023)
- Emotional contagion in dyadic interactions under stereotype-based stress using hyperscanning EEG and functional graph contrastive learning (Chuang et al., 2024)
- Functional dynamic connectivity between brains during real-world social interactions (TenHouten et al., 2023).

The foundations have been laid for a new social anthropology in which human interactions, cultural relationships, and complex social networks can become phenomena that are not only observable but also measurable and detectable at the cerebral and neuromotor levels.

These observations highlight the importance of well-designed

experimental setups to isolate genuine neural synchronization between interacting individuals. In educational settings, studies on the neurophysiological correlates of classroom interactions have identified two key metrics in EEG hyperscanning designs: intracerebral and inter-cerebral connectivity. The former refers to neural synchronization within a single participant, while the latter pertains to functional connectivity between different individuals during social interactions. Both indicators are significant predictors of collective performance (Gola et al., 2022).

3. NEUROSCIENCES AND NARRATIVE

Jerome Bruner's research on autobiographical storytelling demonstrates that narrative is a primary mode of human thought, as humans construct meaning through stories, which in turn influence social behavior (Bruner, 1990). Through narrative, individuals experience a sense of connection with others and function within a social framework. Building on these concepts, along with theories developed during the 20th century by social psychologists such as David Kolb (1984), Carl Rogers (1961), Abraham Maslow (1943), and Daniel Goleman (1995), group autobiographical storytelling has emerged as a key practice for fostering trust among team members and significantly enhancing collaborative group development. The act of sharing personal stories nurtures empathy, which is a central concept in Goleman's work on emotional intelligence. Furthermore, research by Paul Zak reveals that storytelling activates profound neurobiological mechanisms. Zak (2015) demonstrated that telling and listening to stories increases oxytocin levels, a neurotransmitter associated with empathy and social bonding. This physiological response strengthens connections among group members, promoting cooperation and mutual trust.

Neuroscientists like Richard Davidson (2003) and Matthew Lieberman (2013) have highlighted the link between brain function and social behavior, showing that sharing experiences and emotions through storytelling not only strengthens interpersonal bonds but also alters brain structure and activity. These studies have been recently confirmed by EEG studies on how the brain's bio-electrical activity can predict prosocial behavior. Using EEG measurements during decision-making tasks, researchers found distinct patterns associated with cooperative choices, suggesting that neural activity can serve as an indicator of an individual's propensity for prosocial actions. Together, these studies enhance our understanding of the neural mechanisms underlying social

behavior, offering potential avenues for interventions to improve social functioning and mental health (Kunavin et al., 2021).

Storytelling creates a neurochemical environment that stimulates brain regions associated with empathy and autobiographical memory. In essence, emotional regulation and social awareness are closely linked to specific patterns of brain activity. Hasson's (2008) and Gallese's (2015) research demonstrated that listening to stories synchronizes brain waves among participants, fostering emotional and cognitive alignment that facilitates mutual understanding and collaboration. The storytelling experience also generates narrative coherence, intertwining personal stories into a collective framework that guides the group toward shared understanding and common goals. This process aligns with Daniel Siegel's (2007) concept of "social coherence", which emphasizes how shared narratives create a "common map" of the world, improving communication and collaboration within the group.

In our research-intervention practice (within our company's research group, in Gruppo Prospecta s.r.l.), we have implemented group dynamics through autobiographical storytelling workshops. Participants share significant life moments, and through active listening and collective reflection, group cohesion and communication are significantly improved (Rogers, 1961). The outcomes are consistently remarkable: participant commitment, development of collective thought, mutual recognition in each other's stories, and establishment of trust within the team (Dumas et al., 2010; Rolls et al., 2022). During these storytelling workshops, we observed the emergence of a "collective force field", a narrative synchronization that enhances the group's social intelligence. This empirical observation aligns with Dikker's (2017) research findings.

Some well-documented neurological mechanisms help explain this phenomenon:

- Brain synchronization: Uri Hasson showed that shared listening to a story synchronizes participants' brain waves (Hasson et al., 2008; 2016)
- Mirror neurons: Discovered by Giacomo Rizzolatti, these neurons underlie empathy and emotional connection, activating during storytelling (Rizzolatti & Arbib, 1998; Rizzolatti & Craighero, 2004)
- Field theory: Kurt Lewin (1951) theorized that groups create force fields influencing individual behavior. In storytelling workshops, this theory suggests that change occurs when the group reflects collectively, breaking old patterns and fostering new ways of thinking and acting

- Coherence effect: Storytelling creates a structure that orients the group toward shared objectives (Siegel, 2007)
- Narrative neuroscience: Paul Zak (2015) emphasized that oxytocin released during storytelling fosters empathetic connections and creates a collaborative environment
- Social Field Theory: Otto Scharmer (2009) explored the influence of shared intentions on collective behavior (2009).

A well-structured storytelling workshop creates conditions for activating a social “force field” through:

- Shared empathy: Stories generate deep emotional connections
- Collective synchronization: Storytelling harmonizes the group
- Common goals: Interpreting stories channels group energy.

Key factors for success include the facilitator’s empathy, group willingness, and a protected setting. Under these conditions, storytelling workshops stimulate thought, emotion, and interpersonal connections that can be interpreted as a social “energy field” supported by neuroscience, psychology, and speculative theories in physics.

4. A NEUROMETRIC RESEARCH PROTOCOL

The systematic use of such techniques in storytelling contexts significantly illuminates the activation of a group’s “force field”, particularly in autobiographical settings. Storytelling workshops not only stimulate thought and emotion but also create a network of interpersonal connections that can be interpreted as a social “energy field” (Zak, 2015). This phenomenon is supported by neuroscience research and neuro-social psychology (TenHouten et al., 2023): empirical findings indicate that in autobiographical storytelling contexts, brain synchronization and activation of specific neural circuits contribute to collective success and the creation of a collaborative and highly motivating work environment (Hasson et al., 2012).

With the aim of better understanding the level of well-being synchronization among the participants, we propose conducting a large-scale investigation using neurometric hyperscanning techniques (EEG devices like Muse™) to measure participant activation levels, synchronization, primary interactions, and enhanced interaction abilities following such activities. Workshops should involve 8 participants and one facilitator per session,

conducted in a physical setting for a total of 4 hours. Participants would prepare autobiographical narrative posters, which they would subsequently present to the group in a free sequence. Each participant, along with the facilitator, would wear a Muse™ device connected to their mobile phones. Minimal emphasis would be placed on neurometric monitoring to ensure emotional engagement with the storytelling process. Data interpretation following the workshops would enable analysis of participant interaction and collective engagement levels. Multiple objectives can be pursued on various levels:

- Measure Inter-Brain synchronization during storytelling: utilize hyperscanning EEG to assess neural synchronization between participants while engaging in autobiographical storytelling compared to control conditions (e.g., factual discussions)
- Evaluate the impact of synchronization on cooperation: analyze whether higher levels of inter-brain synchrony during storytelling predict enhanced cooperative behaviors in subsequent group tasks
- Investigate the role of emotional and cognitive engagement: assess how emotional intensity and personal relevance of stories influence neural coupling and group cohesion
- Determine which modality fosters the highest inter-brain synchrony and group cohesion
- Identify predictors of effective storytelling for teamwork: determine whether individual factors (e.g., empathy, prior social bonds, communication style) influence the degree of neural synchrony and cooperation
- Develop a neuro-cognitive model of storytelling in teams: integrate EEG findings with psychological theories of social bonding and cooperation to propose a framework for how storytelling enhances team dynamics.

Papers published in recent years (2018-2024) have increasingly focused on measuring neurometrical relevance in social interactions, reflecting a growing interest in the neural underpinnings of human connectivity. Among these works, Czeszmusky et al. (2020) provides a comprehensive analysis of various approaches to studying the neural inter-brain mechanisms that facilitate social interaction. However, the analysis and interpretation of hyperscanning data present significant challenges, necessitating a rigorous comparison between intra-brain and inter-brain data to establish accurate correlations between participants. Furthermore, biofeedback validation is crucial to confirm emerging evidence and ensure the reliability of findings (Ebrahimzadeh &

Soltanian-Zadeh, 2024). Establishing an affordable research protocol requires careful consideration of specific objectives and settings. To guide the development of this protocol, we draw upon the framework employed by International research center for Cognitive Applied Neuroscience (IrcCAN) researchers in 2022, which examined brain activity during remote versus face-to-face learning in managerial contexts (Balconi et al., 2023; Cassioli & Balconi, 2022). This framework provides a valuable model for designing hyperscanning studies that effectively capture and analyze neural synchronization during social interactions.

Our potential research should recruit 2 work groups of 8 participants each. The sample size will be determined based on power analysis and previous literature.

Participants could be recruited between consolidated training courses, or online advertisements. All participants will provide informed consent, ensuring they understand the study's purpose and procedures. Expert trainers with at least five years of experience in training and educational settings, particularly in managing storytelling laboratories, will facilitate the storytelling tasks. Multiple Muse™ Headbands version 2 (InteraXon Inc.) will be used for EEG recording. Data will be acquired at a sampling rate of 256 Hz, with a 50 Hz notch filter applied. The Mind Monitor app will be used for data acquisition, and Lab Streaming Layer (LSL) will enable real-time synchronization of EEG data across participants. The validity of the Muse™ headbands will be established through reference to previous validation studies. A within-subjects experimental design will be employed, comparing brain activity during an individual task (Phase 3) to a group collaboration task (Phase 4). The independent variable is task type (individual vs. group), and the dependent variables are inter-brain synchronization (Phase Locking Value, PLV; Cross-Frequency Coupling, CFC; Granger Causality) and subjective ratings of cooperation, engagement, and group cohesion. Phase 2 will serve as a baseline measurement. The experimental procedure should consist of five phases.

Phase 1 (Settings, 15 minutes): participants will be introduced to the classroom and the EEG equipment, receive training on its use, and have the opportunity to ask questions. All participants will provide informed consent, ensuring they understand the study's purpose, procedures, and potential risks. Participant data will be stored securely and anonymized to protect privacy and confidentiality. Issues related to data sharing and publication will be addressed. Potential risks, such as discomfort from the EEG equipment, will be mitigated. The potential benefits of the research for understanding and improving social collaboration will be highlighted.

Phase 2 (Baseline, 5 minutes): participants will sit quietly with their eyes open for two minutes and their eyes closed for two minutes, during which individual resting-state EEG will be recorded.

Phase 3 (Individual Task, 30 minutes): each participant will prepare a storytelling flip chart with key elements of their biography, guided by the trainer, and individual EEG will be recorded.

Phase 4 (Group Collaboration Task, 90 minutes): participants will engage in collaborative storytelling, presenting their biographies to the group, facilitated by the trainer, and hyperscanning EEG will record brain activity simultaneously across all group members.

Phase 5 (Post-task Reflection, 10 minutes): participants will complete a questionnaire on perceived cooperation, engagement, and group cohesion, followed by an open discussion on task performance and group dynamics. Subjective ratings of cooperation, engagement, and group cohesion will be collected using validated questionnaires.

EEG data will be preprocessed using Independent Component Analysis (ICA) to remove artifacts such as eye blinks and muscle noise. The specific ICA algorithm and software used will be detailed. Any additional filtering procedures will also be described. Inter-brain synchronization will be quantified using PLV, CFC, and Granger Causality. The specific methods used to calculate each of these measurements will be provided. Between-group comparisons (high vs. low cooperation, based on questionnaire data) will be conducted using independent t-tests. Correlation analysis will be used to examine the relationship between neural synchrony and subjective ratings. Appropriate methods will be employed to address multiple comparisons.

We expect to identify brain regions involved in social coordination, such as frontal-parietal networks. We hypothesize that inter-brain synchronization will be increased during the collaborative storytelling task compared to the individual task. We also expect higher inter-brain synchronization in groups with higher perceived cooperation, engagement, and group cohesion. Furthermore, we predict a positive correlation between neural synchrony and subjective ratings of engagement. The data will be visualized using appropriate graphs to illustrate these findings.

5. CONCLUSIONS

This protocol's implementation could potentially provide neurometrical evidence suggesting that personal storytelling extends beyond trust-building, possibly reflecting a process rooted in quantifiable cognitive and emotional responses. By exploring how personal narratives might induce neural synchronization, emotional alignment, and interpersonal connections, we may gain insights into the efficacy of storytelling through neuroscientific observation. This approach could offer a data-driven framework for understanding team dynamics, potentially enhancing cohesion, inclusion, and performance. We aim to investigate whether sharing meaningful life stories within teams might activate neurological mechanisms that influence communication and understanding. Group storytelling, therefore, might not simply be an interpersonal exercise; it could potentially be a neurometrically validated method for fostering empathy, active listening, and collaboration – factors possibly critical for high-functioning teams. Furthermore, if storytelling's impact is reflected in neurophysiological evidence of synchronized brain activity and emotional resonance, it may suggest its efficacy in facilitating teamwork, even in high-stakes environments such as negotiations or competitive settings. This neuroscientific validation could potentially position storytelling as a methodology for addressing challenges in the modern workplace and optimizing team dynamics.

We envision the possibility that organizations might leverage these insights to create environments that foster deeper connection and more effective collaboration. The hope is that further research will expand our understanding of these phenomena, potentially providing new tools for applications in organizational, educational, and therapeutic contexts. By exploring the neural underpinnings of storytelling, we may develop targeted interventions that could promote positive social change and enhance individual and collective well-being. The fusion of neuroscience and storytelling has the potential to influence how we approach team building, leadership development, and conflict resolution. We are not merely measuring brain activity; we are attempting to understand the mechanisms of human connection. By investigating the effects of narrative through neurometrics, we hope to contribute to a future where collaborative intelligence is more than a concept, a future where storytelling might serve as a bridge to deeper understanding, empathy, and collective success.

Competing interests

The authors declare that they have no competing interests.

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Author Contributions

The order of the authors reflects their contribution. All authors equally contributed to the conception and development of the work.

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