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"We Will Let You Know": An Assessment of Digital vs. Face-to-Face Job Interviews via EEG Connectivity Analysis

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Abstract: We focused on job interviews as critical examples of complex social interaction in organizational contexts. We aimed at investigating the effect of face-to-face vs. computer-mediated interaction, of role (candidate, recruiter), and of the interview phase (introductory, attitudinal, technical, conclusive) on intra-brain and inter-brain connectivity measures and autonomic synchronization. Twenty expert recruiters and potential candidates took part in a hyperscanning investigation. Namely, electroencephalography (delta, theta, alpha, beta bands) and autonomic (skin-conductance, heart-rate) data were collected in candidate-recruiter dyads during a simulated job interview and then concurrently analyzed. Analyses highlighted a link between face-to-face condition and greater intra-/inter-brain connectivity indices in delta and theta bands. Furthermore, intra-brain and inter-brain connectivity measures were higher for delta and theta bands in the final interview phases compared to the first ones. Consistently, autonomic synchronization was higher during the final interview phases, specifically in the face-to-face condition. Finally, recruiters showed higher intra-brain connectivity in the delta range over frontal and temporoparietal areas, while candidates showed higher intra-brain connectivity in the theta range over frontal areas. Findings highlight the value of hyperscanning investigations in exploring social attunement in professional contexts and hint at their potential to foster neuroscience-informed practices in human resource management processes.

Keywords: job interview; remote vs. face-to-face; EEG hyperscanning; brain connectivity; autonomic synchronization

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1. Introduction

Social neuroscience investigates the neural mechanisms involved in the functioning of interpersonal behavior. The social brain comprehends the neurophysiological basis of interpersonal behavior and social cognition [1], mediated by certain neural networks that connect the limbic regions to the prefrontal cortex (PFC). For instance, the dorsal (DLPFC) and ventral portion of the lateral PFC support the components of social interaction and cooperative behavior [2–4]. These networks allow effective interpersonal interchanges.

In an organization, the social dimension appears critical for value and innovation developments, and in this light, cognitive neuroscience elicits the comprehension of the workers' cognitive and affective systems. Ongoing neuroscientific research refers to leadership, motivation, job assessment, and interviewing [5,6]. Its framework is referred to as neuromanagement, defined as that interdisciplinary approach that explores internal mechanisms of management by applying knowledge derived from neuroscience and cognitive sciences [7].

In this work, we focused on the job interview for the following reasons. First, psychologically, it represents the main social interaction between the organization and the candidate. Then, strategically, it was shown to be a good predictor of employability [8] and a value-maximizer, as it limits cases of bad hiring and loss of virtuous workers. Lastly, according to the authors, available studies have never properly considered its social complexity. A job interview represents a subcomponent of the selection process, where a candidate is invited to meet and interact with a company representative, who aims at selecting the best-fitting candidate for a position [9].

Dimensions such as anxiety, self-efficacy, its predictive validity, performance outcome, and the impact of age, accent, age, and gender, were previously investigated [10,11]. Moreover, it was shown that anchoring-and-adjuments heuristics and associated motivational mechanisms drive bias against stigmatized people in interview decisions [12]. Stigmatized applicants receive lower interview judgments and have a lower probability to be selected for the job.

Through methodological lenses, research has adopted psychometric methods, via questionnaires, qualitative-verbal methods (i.e., focus groups, in-depth interviews), or behavioral approaches [12]. These methods are extremely valuable for investigating associations of meaning, concepts, events, or complex attitudinal constructs on a general scale, but they present weaknesses if covert cognitive and affective processes are the research object. In fact, they are mediated by the person's language, cognitive bias, and self-awareness. Social neuroscience's interest in the job interview appears evident as it represents a pivotal social moment, which can be easily stressful and demanding [5].

Furthermore, due to COVID-19, the employment of videoconferencing platforms proliferated. Therefore, the rise of digital forms is considered in this work. Historically telephone interviews were the first step toward technologized job interviews. Via the distribution of laptops, equipped with cameras, and a broadband internet connection, job interviews were firstly carried out in remote settings. In this sense, COVID-19 forced companies to switch to digitalized forms. Nowadays, many companies also include the use of machine learning approaches in the selection process, in particular for initial curricula screening purposes.

As many studies related to human-computer interaction have shown, a new medium generally determines different social responses, which are embodied at a neurophysiological and cognitive level. Communication platforms shape social relationships [13]. Unfortunately, existing evidence is ambiguous [14]. Computer-mediated interaction could act as a social connector or a separator. Remote communication has been linked to diminished levels of empathy [15], and factors such as age and technology habits are known to be significant mediators [14]. Conversely, face-to-face interaction is sometimes perceived as challenging and stressful [16].

Other approaches have focused on the behavioral dimension. The detection of nonverbal behaviors of the interviewee (gaze, facial expression, and posture) was investigated [17] aiming at signaling possible improvements to the candidate for training purposes [18]. Another study on job interviews found different gaze patterns between recruiters and candidates [19], in particular, the interviewer made more frequent and longer gaze contacts compared to the interviewee. Furthermore, automated video interview (AVI) analysis, via machine learning, using verbal, paraverbal, and nonverbal behavior from audio-video data was employed to assess personality traits [20]. Moreover, the positive effect of combined cognitive reappraisal (CCR) on stress levels, in terms of heart rate variability was considered, with the CCR group presenting less physiological stress, a speech better perceived by others, and more affiliative smile and hand gestures [21]. Besides these findings, it should be pointed out that the metrics used here are indirect proxies for cognitive and affective processes and only a few studies consider both interacting agents.

The complexity that arises in the social dimension can be efficiently approached only if all the agents are simultaneously considered [22]. For these reasons, among the available methods, hyperscanning is a proposed paradigm that allows the exploration of interpersonal brain mechanisms, generated by social interaction, via the consideration of inter-brain—besides intra-brain—connectivity [23]. In fact, hyperscanning consists of the simultaneous recording of cerebral activity of two or more subjects involved in a task.

EEG hyperscanning extends the research application in the domain of the social brain. Examples of applications were carried out and an electrophysiological synchronization occurs between the agents in terms of inter-brain connectivity [24] and intra-brain connectivity. Intra-brain connectivity refers to the synchronization and co-occurrence of neural activity between an individual's brain regions and is a proxy of the functional specialization of an individual's brain activity [25]. In contrast, inter-brain connectivity can be understood as functional connectivity between the individual's brain related to inter-personal coupling mechanisms during social exchanges [26]. The effects of increased inter-personal coupling could also result in a certain degree of synchronization of autonomic responses in interacting dyads [27].

Augmented portability, improved devices, and signal processing techniques are major factors that allowed the development of neuroscientific protocols for the organization [28]. Common techniques aim at assessing a stimulus (communication or advertising-related) or a medium (user experience of a product), training an individual (neuroempowering and neuro- and bio-feedback protocols), or assessing specific cognitive or affective dimensions within a group. An employed tool is non-invasive electroencephalography (EEG), which has been applied to investigate workers' mental workload [29], risk management [30], workers' trust [31], and emotion detection [32]. The power density data is extracted via Fourier's transformation [33] and then considered within specific spectral boundaries. The most commonly signal subcomponents are alpha (8–13 Hz), beta (13.5–30 Hz), delta (0.5–3.5 Hz), and theta (4–7.5 Hz). Each frequency wave is associated with a functional significance, which also depends on the activated cortical region where the pattern is detected. Concerning low-frequency waves, theta is considered correlated to long-term memory and emotional processing [34], and delta is linked to declarative, explicit memories, and other affective states [35]. Instead, alpha and beta are associated with attentional and conscious processing towards specific stimuli, or a general environment e.g., [36].

Together with central electrophysiological activity, peripheral autonomic parameters have been employed to determine the positive and negative emotional activation, the arousal, and the stress response in individuals and therefore they proved to be valuable in the assessment of cognitive-affective dimensions in social interactions [37]. Electrodermal activity (EDA) corresponds to the resistance and electrodermal potential that provoke alteration in the electrical characteristics of the skin and reflects a person's autonomic responses to internal and external stimuli. EDA is composed of skin conductance level (SCL) and skin conductance response (SCR). While the latter reflects short-lasting fluctuations, associated with attentional processing e.g., [38] SCL corresponds to the tonic activity of EDA and is linked to workload and arousal [39].

Given the methodological issues we underlined, and the known synergetic interaction between brain, body, and behaviors, composed of complex feedback and feedforward processes, we advocate and propose an integrated multi-method approach to study social dynamics during a job interview, adopting a dual hyperscanning paradigm [40]. Thus, central and peripheral parameters were applied to a qualitative evaluation of the job interview session to address set questions, where role (recruiter, candidate), setting (face-to-face vs. remote), and job interview phases (introductory, attitudinal, technical, and conclusive) are together considered.

Therefore, the following research questions were set. Is there a difference in intrapersonal and interpersonal connectivity levels depending on the face-to-face vs. computer-mediated setting of the job interview? Is electrophysiological connectivity in the dyads detected during a job interview? Does the connectivity emerge in specific interview phases?

Electrophysiological and autonomic parameters are simultaneously gathered during the task, in both participants. We hypothesized to observe specific patterns in the EEG and autonomic correlates, based on the considered factors. First, we expected to observe higher intra-brain connectivity in those job interview phases, which presented particular cognitive and emotional relevance such as the attitudinal and technical phases, where soft and hard skills are tested on the candidate. Conversely, regarding inter-brain connectivity, we expected to detect significantly increased activity in the last phases of the job interview process, due to a deeper social understanding within the dyad. Furthermore, we conjectured that the face-to-face condition might be an eliciting factor for both these predicted patterns we just introduced. Ultimately, as for the synchronization of autonomic indices (electrodermal activity and heart rate), we believed that it could mirror the trend expected for central activity, thus increasing during the final phases of the interview, resulting in it being higher in the face-to-face condition.

2. Method

2.1. Participants

Participants joined the experiment after signing the written informed consent. The research was carried out following the principles of the Helsinki Declaration and was further approved by the Ethical Committee, where the work was designed. The populations of interest were, on one side, human resource professionals, on the other, potential candidates who were actively seeking a job. A total of 20 subjects ($n = 20$, $M_{age} = 27.3$, SD = 9.17), 10 recruiters and 10 candidates, were successfully recruited. All subjects were right-handed, presenting normal/corrected-to-normal visual acuity. For all participants, the following exclusion criteria were considered: (i) history of neurology or psychiatry disorders; (ii) being involved in therapies with psychoactive drugs; (iii) presenting clinically relevant distress or burnout history.

Participants were then randomly divided into dyads while considering their role, and then randomly assigned to the condition (face-to-face vs. remote). For ethical reasons, the candidates were not real contenders, and have not been involved in other previous job interviews for this position. The following ad hoc inclusion criteria were considered: (i) being older than 18 years old; (ii) proficiency in online communication technologies; (iii) currently looking for a similar/equal job position in the experiment. For human resource professionals, the following ad hoc inclusion criteria were also considered: (a) being employed; (b) being regularly involved in the recruitment process and personally carrying out job interviews; (c) five or more years of professional experience in job interviewing.

2.2. Procedure

For the data acquisition, a dual-EEGs and autonomic activity hyperscanning paradigm was designed. In this work, simulated job interviews were carried out by participants. Every subject signed the written informed consent and was randomly assigned to one of the two experimental conditions: remote vs. face-to-face. Every dyad, composed of one recruiter and one candidate, underwent one interview. Every interview presented four different phases. Participants, one recruiter, and one candidate were introduced in a laboratory room by a researcher.

In the remote condition, two independent rooms were used. In one condition a face-to-face job interview was carried out, while in the other condition the task was conducted via the video teleconferencing software program *Microsoft Teams*, through personal computers.

A member of the research team previously verified that every subject was familiar with the software. EEG and autonomic system devices were installed on both the subjects and a 2-min resting-state baseline was recorded. Data were simultaneously gathered from both agents. The research team previously briefed the recruiters regarding the conduction of the job interview to limit the impact of the interviewing style and maximize the standardization. All candidates were motivated to participate in the research protocol, as it represented a learning occasion for their professional future.

In line with the interviewers' experience, four phases were established, each one with an approximate duration of ~5 min. The interview lasted about 25 min, with the following phases: (i) introductory; (ii) attitudinal; (iii) technical; and (iv) conclusive. In the *introductory* phase, both actors shortly described themselves. The candidate's curriculum is discussed. Recruiters presented the company's profile, the aim of the process, and the job offer. In the *attitudinal* phase, candidates were questioned regarding their motivation and attitude.

A description of their soft skills was discussed. In the *technical* stage, recruiters investigated the candidate's hard skills, discussing how they would fit the job position and the overall company needs. Finally, in the *conclusive* phase, feedback was furnished, eliciting strengths and weaknesses. Once the job interview was concluded, tools were detached. A debriefing phase was conducted to assure that participants understood the research aim. Job interview phases are reported in Figure 1.

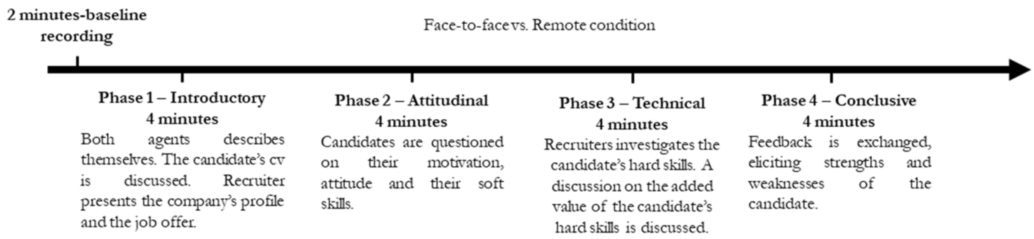

Figure 1. The four phases of the job interview. The four phases carried out during the experiment task by the dyads: introductory, attitudinal, technical, and conclusive.

To maximize the relevancy of the social interactions we checked each session to highlight not-pertinent time intervals, using audio-visual materials.

2.3. Signal Recording and Processing

2.3.1. EEG Signal

Recruiters' and candidates' EEG activity was recorded, according to the hyperscanning specifics, via two lean 15-channels EEG systems. Electrodes were placed in correspondence to F7, F3, Fz, F4, F8, T7, C3, Cz, C4, T8, P3, Pz, P4, O1, and O2 electrode sites (SI10) [41], using Ag/AgCl sensors with physical reference in the two earlobes. vEOG was monitored for subsequent signal processing. Electrodes impedance was kept below 5 kΩ. Data were sampled at 1000 Hz, with a 0.01–200 Hz bandpass input filter and a 50 Hz notch filter. During offline processing, a 0.5–50 Hz bandpass filter was applied to the raw data. Average reference was computed to limit the effect of situational biases on recorded data and improve the comparability between EEGs. Furthermore, to lower ocular movements and blinks noise, a regression-based ocular correction algorithm was applied. Data were then segmented according to the internal structure of the assessment interview (four phases) and manually screened for residual ocular and movement artifacts. Finally, power spectra were computed, via Fast Fourier Transform algorithm (resolution: 0.5 Hz; window length: 2 s) to extract power density data for the standard EEG bands, defined as follows: delta (0.5–3.5 Hz), theta (4–7.5 Hz), alpha (8–13 Hz), and beta (13.5–30 Hz). The average EEG power profile was computed and extracted for both resting and for each of the four phases (introductory, attitudinal, technical, and conclusive) of the interview plot, normalized based on the time lengths, and considering four main Regions of Interest (ROI): frontal (F7, F3, F4, F8), central (C3, C4), temporoparietal (T7, T8, P3, P4), and occipital (O1, O2).

2.3.2. Autonomic Activity

The autonomic activity was recorded in the dyads during the task through multi-use units. Recording sensors were positioned on subjects in correspondence with the distal phalanx of the second finger, on the non-dominant hand. The sensor monitored electrodermal and cardiovascular activity, in terms of skin conductance level (SCL), skin conductance response (SCR), and heart rate (HR). An accommodation phase took place before the recording session began. Data were sampled at 40 Hz. Moreover, to maximize accuracy, artifact rejection and data filtering were offline applied when needed. Heart Rate (HR, measured as beats per minute) was extracted via photoplethysmography, detecting blood volume changes in the microvascular tissues. Phasic SCR was computed using tonic EDA activity, via moving average. Mean HR, mean SCL, and SCR count were computed for each of the four phases of the job interview plot (introductory, attitudinal, technical, and conclusive).

2.4. Data Analysis

Here we described the data analysis process for the considered variables. For all ANOVA models, degrees of freedom were corrected by Greenhouse–Geisser epsilon when needed. No outliers were observed in that sample or subgroup. Post-hoc analysis (contrast analysis for ANOVA, with Bonferroni corrections for multiple comparisons) was successively applied. The size of statistically significant effects has been estimated via partial eta squared (η^2) indices.

2.4.1. EEG

In the first part of the analysis, we calculated the intra-brain and inter-brain connectivity index for every dependent variable (delta, theta, beta, and alpha power). The phase synchronization approach was not implemented in the preliminary analysis as it does not allow the further computation of correlation coefficients. Specifically, for the calculation of the functional intra-and inter-brain connectivity indices, the partial correlation coefficient Π_{ij} was computed, by normalizing the inverse of the covariance matrix $\Gamma = \Sigma^{-1}$:

$$\Pi ij = \vdash (\boxslash \{-\Gamma ij)\} \left\{ \sqrt{} \{\vdash (\Gamma ii \Gamma jj \dashv)\} \right\} \dashv) \text{ Partial correlation matrix}$$

$$\Gamma = (\Gamma ij) = \Sigma - 1 \text{ Inverse of the covariance matrix}$$

This procedure [42] can quantify the relationship between two independent signals (i, j), for example within a dyad, known as inter-brain connectivity, and the neural connectivity between an individual's brain regions, defined as intra-brain connectivity.

For intra-brain connectivity, we applied a set of four ANOVA, one per every frequency band intra-brain connectivity index, considering the following factors: Role (2: recruiter, candidate) and Condition (2: face-to-face, remote) as between factors, and Interview phase (4: introductory, attitudinal, technical, and conclusive) and Region of Interest (ROI; 4: frontal, central, temporoparietal and occipital) as within factors.

Similarly, for inter-brain connectivity, we applied a set of four ANOVA, one per every frequency range inter-brain connectivity index, considering Condition (2: face-to-face, remote) as between factor, and Interview phase (4: introductory, attitudinal, technical, and conclusive) and Region of Interest (ROI; 4: frontal, central, temporoparietal and occipital) as within factors.

2.4.2. Autonomic Activity

In the first step of the analysis, we computed the synchronization indices using Pearson correlation coefficients [43] for each autonomic measure (HR, SCL, and SCR), with the same mathematical procedure previously described in the EEG section.

Then a set of three repeated-measures ANOVAs, one per each dependent variable, was run considering Condition (2: face-to-face, remote) as between factor and Interview phase (4: introductory, attitudinal, technical, and conclusive) as within factor.

3. Results

3.1. EEG

3.1.1. Intra-Brain Connectivity

Delta. Interview was found to be significant (F[3,57] = 7.09, $p \leq 0.05$, $\eta^2 = 0.43$). From post hoc analyses, higher intra-brain connectivity was found in the attitudinal phase compared to introductory phase (F[1,19] = 7.13, $p \leq 0.05$, $\eta^2 = 0.43$), and in the technical phase compared to the introductory phase (F[1,19] = 8.07, $p \leq 0.05$, $\eta^2 = 0.44$). Data is reported in Figure 2a. Moreover, Condition was found significant (F[1,19] = 9.33, $p \leq 0.05$, $\eta^2 = 0.48$), with higher intra-brain connectivity in the face-to-face compared to the remote condition. Data is reported in Figure 2b. Finally, the interaction effect Role*ROI resulted significant (F[3,54] = 6.78, $p \leq 0.05$, $\eta^2 = 0.40$). Post hoc analyses highlighted higher intra-brain connectivity for recruiters compared to candidates in the frontal region (F[1,19] = 6.70, $p \leq 0.05$, $\eta^2 = 0.40$) and in the temporoparietal region (F[1,19] = 6.78, $p \leq 0.05$, $\eta^2 = 0.40$). Data is reported in Figure 2c.

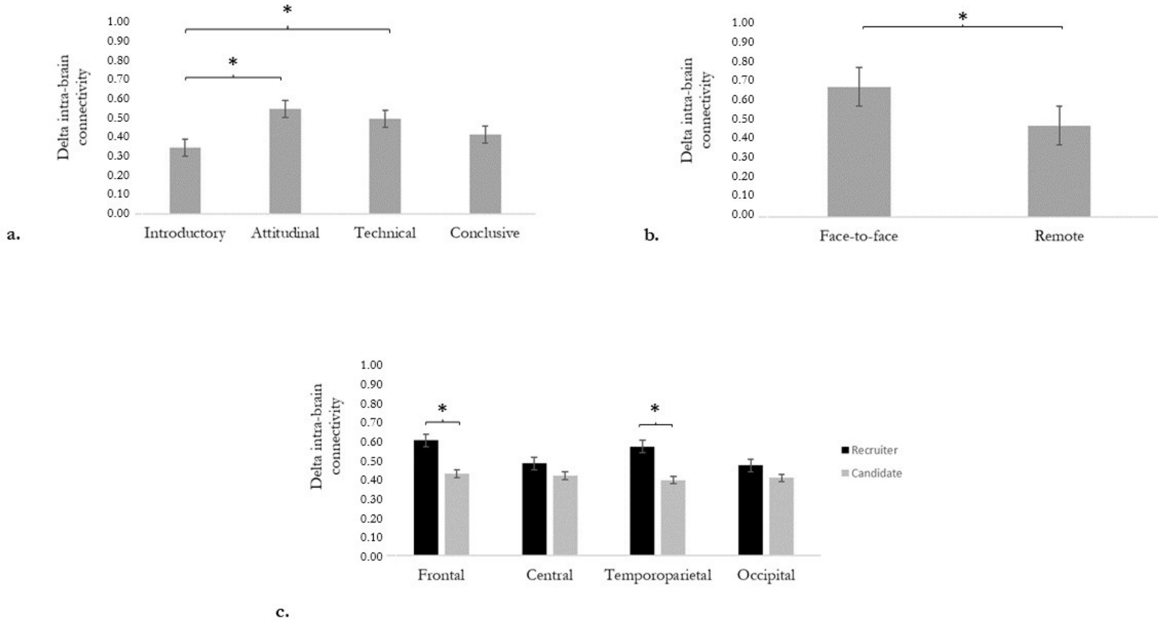

Figure 2. Delta intra-brain connectivity results. (**a**) Bar graph shows differences in Interview. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons. (**b**) Bar graph shows differences for Condition. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons. (**c**) Bar graph shows differences for Condition*Region of interest (ROI). Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons.

Theta. The condition factor was found significant (F[1,19] = 8.45, $p \leq 0.05$, $\eta^2 = 0.45$), with increased intra-brain connectivity for the face-to-face condition compared to the remote one. Data is reported in Figure 3a. Furthermore, the interaction effect Role*ROI was found to be significant (F[3,54] = 6.70, $p \leq 0.05$, $\eta^2 = 0.40$). Post hoc analyses highlighted higher intra-brain connectivity in the candidates compared to the recruiters (F[1,19] = 6.16, $p \leq 0.05$, $\eta^2 = 0.38$) in the frontal region. Data is reported in Figure 3b. Moreover, the interaction effect Interview*ROI*Role was also found to be significant (F[9,162] = 7.65, $p \leq 0.05$, $\eta^2 = 0.44$). The post hoc analyses highlighted increased intra-brain connectivity in the frontal region for the candidates during the technical phase compared to the introductory (F[1,9] = 6.78, $p \leq 0.05$, $\eta^2 = 0.40$) and attitudinal (F[1,9] = 6.98, $p \leq 0.05$, $\eta^2 = 0.40$) phases, as well as during the conclusive phase compared to the introductory (F[1,9] = 9.14, $p \leq 0.05$, $\eta^2 = 0.46$) and attitudinal (F[1,9] = 7.74, $p \leq 0.05$, $\eta^2 = 0.40$) phases. Data is reported in Figure 3c.

No other significant results for intra-brain connectivity were detected.

3.1.2. Inter-Brain Connectivity

Delta. The factor Interview resulted in being significant (F[3,27] = 9.32, $p \leq 0.05$, $\eta^2 = 0.49$). Post hoc analyses highlighted higher inter-brain connectivity for the conclusive compared to the introductory phase (F[1,9] = 10.98, $p \leq 0.05$, $\eta^2 = 0.46$). Data is reported in Figure 4a. Furthermore, Condition resulted in being significant (F[1,9] = 9.32, $p \leq 0.05$, $\eta^2 = 0.48$), with higher inter-brain connectivity for the face-to-face condition compared to the remote condition. Data is reported in Figure 4b.

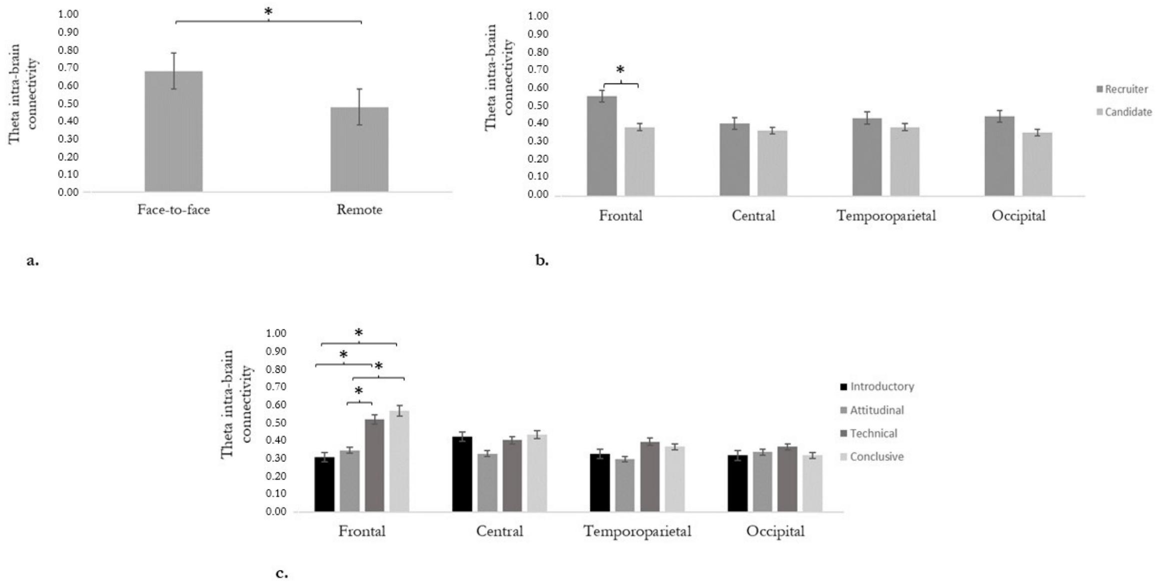

Figure 3. Theta intra-brain connectivity results (**a**) Bar graph shows differences in Condition (ROI). Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons. (**b**) Bar graph shows differences considering Condition*ROI. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons. (**c**) Bar graph shows differences considering the interaction Interview*ROI*Role. Here are reported only candidate's data where significant differences were detected. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons.

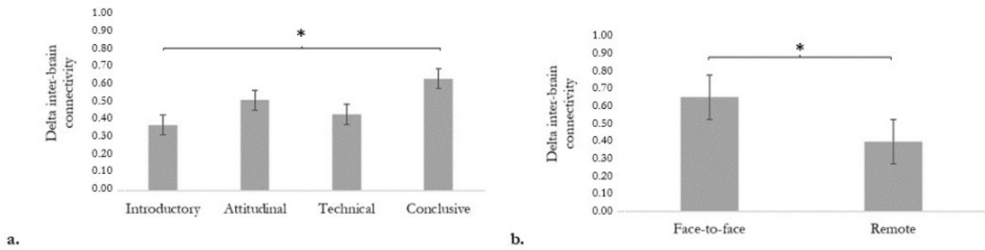

Figure 4. Delta inter-brain connectivity results. (**a**) Bar graph shows differences considering the factor Interview. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons. (**b**) Bar graph shows differences considering the Condition factor. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons.

Theta. The factor Condition was found to be significant (F[1,9] = 8.80, $p \leq 0.05$, $\eta^2 = 0.45$), with increased inter-brain connectivity in the face-to-face condition compared to the remote setting. Data is reported in Figure 5a.

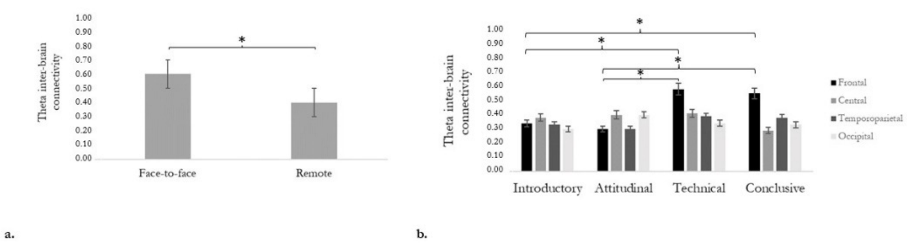

Figure 5. Theta inter-brain connectivity results. (**a**) Bar graph shows differences considering Condition. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons. (**b**) Bar graph shows differences considering Interview*ROI. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons.

The interaction effect Interview*ROI was also found to be significant (F[9,81] = 6.78, $p \leq 0.05$, $\eta^2 = 0.40$). Post hoc comparisons detected significant differences with increased inter-brain connectivity in the frontal area for technical and conclusion phases compared to introductory (respectively: F[1,9] =6.04, $p \leq 0.05$, $\eta^2 = 0.37$; and F[1,9] = 6.11, $p \leq 0.05$, $\eta^2 = 0.36$) and attitudinal (respectively: F[1,9] = 7.13, $p \leq 0.05$, $\eta^2 = 0.41$; and F[1,9] = 6.93, $p \leq 0.05$, $\eta^2 = 0.37$) phases. Data is reported in Figure 5b.

No other significant results for inter-brain connectivity were detected from the statistical analysis.

3.2. Autonomic Data

HR. The interaction effect Interview*Condition was found to be significant (F[3,27] = 6.16, $p \leq 0.05$, $\eta^2 = 0.39$), revealing higher synchronization in the technical and conclusive phases compared to introductory (respectively: F[1,9] = 6.21, $p \leq 0.05$, $\eta^2 = 0.40$; and F[1,19] = 6.78, $p \leq 0.05$, $\eta^2 = 0.40$) and attitudinal (respectively: F[1,9] = 7.12, $p \leq 0.05$, $\eta^2 = 0.41$; and F[1,9] = 8.90, $p \leq 0.05$, $\eta^2 = 0.41$) phases in the face-to-face condition. Data is reported in Figure 6a.

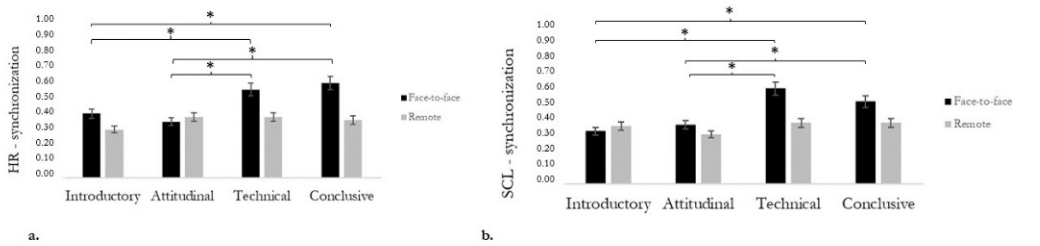

Figure 6. Heart rate (HR) and skin conductance level (SCL) significant results. (**a**) Bar graph shows the difference in HR considering the Condition*Interview interaction. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons. (**b**) Bar graph shows the difference in SCL considering the Condition*Interview interaction. Bars represent ±1 SE. Stars mark statistically significant pairwise comparisons.

SCL. The interaction effect Interview*Condition was found to be significant (F[3,27] = 8.23, $p \leq 0.05$, $\eta^2 = 0.42$). As revealed by post hoc analyses, synchronization was generally higher in the technical and conclusive phases compared to the introductory (respectively: F[1,9] = 8.90, $p \leq 0.05$, $\eta^2 = 0.44$; and F[1,9] = 8.98, $p \leq 0.05$, $\eta^2 = 0.42$) and attitudinal (respectively: F[1,9] = 6.09, $p \leq 0.05$, $\eta^2 = 0.40$; and F[1,9] = 9.04, $p \leq 0.05$, $\eta^2 = 0.40$) phases in the face-to-face condition. Data is reported in Figure 6b.

4. Discussion

In the present study, we focused on the job interview as a critical example of complex social interaction in organizational contexts. The research aimed at investigating the effect of face-to-face vs. remote computer-mediated interaction, of the phase of the job interview (introductory, attitudinal, technical, and conclusive), and of the role (candidate vs. recruiter) on neurophysiological and autonomic markers of inter-personal coupling between candidates and recruiters, as well as on intra-brain connectivity measures. Data analysis highlighted the influence of the investigated factors on both intra- and inter-brain connectivity measures and on autonomic synchronization of interlocutors.

Face-to-face interactions have systematically elicited higher intra-brain connectivity in delta and theta frequency ranges, mirroring a peculiarly coherent activation of neural networks likely involved in supporting the understanding of interlocutors' behavior [44]. It is worth noting that slower components of the EEG spectra are known to be linked to emotional processing and responsiveness, in particular when social reinforcements are present [45]. Greater intra-brain connectivity in lower frequency bands during face-to-face interviews, compared to remote ones, might hint at the greater information-processing demand imposed on social understanding and regulation processes by such a complex form of interaction. Namely, social exchanges occurring in face-to-face conditions are intrinsically connoted by richer social information deriving from the full set of verbal and non-verbal communication channels available for the dyadic exchange. Conversely, computer-mediated communication, due to setting and technical limitations, allows conveying only a part of non-verbal communication cues (e.g., degraded information on body posture, proxemics, and gestures in case a webcam is used, or loss of relevant information apart from verbal and vocal ones if no webcam is used). The greater presence of social cues in face-to-face interaction, while likely allowing the understanding of the interlocutor's motives and communication and fostering adaptive social regulation, increases processing effort. Furthermore, their multimodal nature plausibly requires the combined involvement of different neural structures.

Intra-brain connectivity in slower EEG bands changed with the progress of the job interview and was modulated by the phases and content of the interaction. In particular, the interview phases with higher delta connectivity indices appear to be the attitudinal and the technical ones. Those two phases were the most cognitively demanding during the interview and plausibly required peak attention from both the candidates—who were trying to provide the best presentation of their skills—and the recruiters—who were involved in checking matches and discrepancies in candidates' skills. The different observed levels of intra-brain connectivity might reflect the mediation of broad cortical networks for cognitive elaboration, with a more relevant impact and greater "echo effect" on the recruiter role e.g., [46]. At the same time, the peculiar pattern of increased intra-brain connectivity in the theta band specifically shown by candidates in the last phases of the interview compared to the first ones might mirror the progressive increase in cohesion among frontal structures involved in cognitive-affective control and behavior regulation in complex situations [47].

Then, higher intra-brain connectivity indices were observed in frontal and temporoparietal areas for the recruiters in the delta frequency range, while candidates showed higher intra-brain connectivity in frontal areas in the theta range. Intra-brain connectivity in the frontal and posterior regions is generally involved in mirroring mechanisms during action execution and the observation of similar actions and may be evidence of an interdependent synchronization at a cognitive level [48]. In fact, increased delta intra-brain connectivity was observed in the temporoparietal area while decoding informative gestures [23] and linked to the involvement of mirroring mechanisms e.g., [49]. Complementarily, delta intra-brain connectivity in frontal areas was associated with social-and affective- gesture encoding [23] and could be linked to the ability to respond to relational and social situations [50]. Building on such evidence, present findings might reflect the greater expertise of senior recruiters in decoding and understanding non-verbal language and socially relevant cues, compared to candidates. Yet, we acknowledge that this interpretation would benefit from additional testing and corroboration via focused investigations. The higher theta connectivity indices shown by candidates over the frontal region, instead, likely mark, as above mentioned, the shared neural effort imposed by the socially-salient situation in terms of cognitive-affective control and self-regulation.

Regarding inter-brain connectivity data, connectivity indices in both theta and delta ranges were higher in the face-to-face than in the remote condition. Such a pattern is consistent with the one emerging from the analysis of intra-brain connectivity measures. Decoding and encoding of affective non-verbal communication were previously linked to modulations of delta and theta frequency waves [51]. The response in slower EEG components might suggest a greater focus of the dyads on social processing and on the regulation of interpersonal interaction and its affective correlates during the face-to-face condition [52]. As above noted, the observed difference in neurophysiological indices of inter-brain coupling between face-to-face and remote computer-mediated interactions might plausibly reflect the intrinsic limitations in properly conveying part of non-verbal communication cues in remote interaction settings. The use of web-based communication platforms, indeed, leads to a greater focus on linguistic content and, among non-verbal communication channels, on non-verbal vocal cues (e.g., prosody), paralinguistic contents, eye behavior, and facial expressions, while neglecting other unavailable cues. The difference in the amount and in the source of information used to guide interpersonal regulation and sense-making processes during the interviews likely provides different socio-psychological contexts for engagement and interpersonal coupling.

In addition, inter-brain connectivity changed with the progress of the interview, with higher inter-brain connectivity measures in the delta range during the final phase than in the initial phase of social interaction. A similar pattern, though localized in frontal areas, for the theta frequency range was detected. Consistently, we observed greater autonomic synchronization during the final phases of the task, specifically in the face-to-face condition. This gradually increased interpersonal coupling pattern is consistent with the hypothesis that attunement in dyads increases by building on the progressive shared communication experience and fine-tuning processes aimed at optimizing the exchange and communication efficacy. Specifically, activity in the theta frequency range has been related to emotional tuning and encoding/recall processes [53], which might have happened more intensively in the last part of the job interview. Slow EEG activity predicts working memory, navigation, and encoding [54] during the wake. Furthermore, the implicit/explicit exchange of feedback during social interaction enhances emotional elaboration, shapes adaptation, and self-regulation mechanisms, and boosts long-term memory formation, modulating the degree of syntonization between inter-agents. Again, recent perspectives see inter-brain synchronization correlated to the degree of the sense of joint agency in communicative and shared actions e.g., [55]. Previous studies found that brain activities in the frontal region were synchronized in dyads engaged in joint actions [56] and, in particular, that inter-brain theta synchronization in the prefrontal cortex was especially associated with collaborative tasks between individuals that strongly involve executive functions [57].

In addition, being involved in a collaborative or a social communication task proved to elicit greater autonomic synchronization between the involved individuals, with a greater inter-personal correlation between cardiovascular and electrodermal activities.

5. Conclusions

This study explored the benefits of applying neuroscience methods in the investigation of human resource management (HRM), with a focus on job interviews. Given their strategic value and their psychological salience for both candidates and company representatives, such a form of social interaction typically elicits remarkable recruitment of cognitive resources and requires high levels of engagement in both inter-agents, which in turn modulate social attunement and interactional dynamics. Present findings highlight the value of hyperscanning investigations as a methodology to explore the quality of social dynamics and attunement even in real-life social exchanges, point out the feasibility of such investigations at the workplace, and hint at their potential to foster the development of neuroscience-informed evidence-based practices in HRM processes.

Indeed, some initial guidelines, in the form of practical implications can be derived from the acquired data. Firstly, job interviewing is a two-way process, but recruiters are more emotionally in control of the situation. Therefore, they should foster an emphatic connection with the candidate. For a reliable assessment, a successful tuning in the first phases of the interaction before proceeding into technical assessment is advisable. Secondly, the setting condition is relevant. Especially for positions that require social skills, available data suggests the employment of a face-to-face interview, in which the richness of social cues allows for a deeper attunement between recruiter and candidate and, therefore, for a more reliable evaluation.

The study is, however, not exempt from limitations. Firstly, the strength of current results would benefit from replication and investigation with bigger samples. Furthermore, interviews were simulated and the use of research tools might have impacted the setting and the individuals' interaction (i.e., observer bias) in terms of ecological validity. Psychometric data (e.g., personality traits) were not gathered in this work. Further research could use them to confront self-report measures and neurophysiological correlates. In replications studies, other factors could also be employed as covariates to ensure higher internal validity such as the recruiter's experience, interviewing style, and job position. Furthermore, in the future, other potentially relevant factors modulating the quality and efficacy of mediated vs. presence communication could be considered in addition. For instance, individual and socio-demographic factors play a role in acceptance and user experience with technology-mediated communication and should be explored. Moreover, the use of a deep-learning-based job interview solution was recently proposed [58], based on voice and video data. Personality, aptitude, and neurophysiological data could be further fed into the algorithm.

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