Job Assessment Through Bioelectrical Measures: A Neuromanagement Perspective

Margherita Zito\textsuperscript{1,2}, Marco Bilucaglia\textsuperscript{1,2}, Alessandro Fici\textsuperscript{1,2,*}, Giorgio Gabrielli\textsuperscript{1,2} and Vincenzo Russo\textsuperscript{1,2}

\textsuperscript{1}Department of Business, Law, Economics and Consumer Behavior “Carlo A. Ricciardi,” Università IULM, Milan, Italy, \textsuperscript{2}Behavior and Brain Lab IULM, Neuromarketing Research Center, Università IULM, Milan, Italy

During recruitment, human resource departments face two challenges: finding the right people for the job and attracting talent. Therefore, the hiring process requires both the ability to communicate a good company brand image and to understand the characteristics and potential of candidates. In this study, we used a neuroscientific approach to measure the experience of candidates during a job interview. The experiment involved 30 participants that individually took part in a job interview lasting 40 min. During the experiment, their engagement and stress levels were measured in real-time with skin conductance and electroencephalographic (EEG) data. From the results, we identified both the most stressful phases (the second and the fourth parts, relating to the explanation of the job and remuneration) and the most engaging phases (the first and the third phases, relating to the presentation of the company and the explanation of the career process) of the interview, suggesting implications for the assessment process. This study is a contribution to the field of neuromanagement, as a neuroscientific approach was applied to management issues in light of work and organizational psychology.

Keywords: neuromanagement, human resources, EEG, skin conductance, job assessment

INTRODUCTION

During the last decades, organizational needs and goals have changed and improved through the Tayloristic methodology, which focuses on new critical elements such as work motivation and the need of an individual to socialize in the workplace (Argentero, 2010). Indeed, the functioning of an organization depends on its working people, and investment in human resources has started to reflect this. As the awareness of what a candidate could contribute to an organization has grown, the assessment process has changed its focus, which has not only become technically oriented but also personality-oriented. These elements require the recruiter to have a new consideration of candidates who are no longer considered "passive" but participatory and able to express ideas, motivations, and goals during the job interview (Schneider et al., 2001), giving more elements to the recruiter who has to evaluate a candidate for a specific role or job, also in light of organizational growth (Abbasi et al., 2020).

Therefore, the selection process is seen as two-way, involving the interviewer and the candidate, with both parties taking an active role in the outcome (Argentero, 2010). If the latter can propose oneself as actively collecting information on the organization and on the job to evaluate the possibility of joining it, the selection process becomes an endeavor that not only seeks to understand
the characteristics and potential of the candidates, but also for
the interviewer to communicate a good company image. While
recruitment specialists have specific strategies for the evaluation
of a candidate, the communication of brand image—that is
to say, the attempt to "sell" the organization to attract the
candidate—actually lacks. This means that the candidate may
evaluate their expectations for the new job, also on the basis
of previous jobs, by applying a sort of association with what is
known that has to be balanced with what is desired. This has
important implications for engagement and satisfaction (Davies
et al., 2018). From the perspective of the company, this calls into
consideration marketing rules and studies suggesting that the
familiarity of a brand name has an advantage because of brand
awareness, quality, and direct association (Ma et al., 2007). On
the basis of these advantages, it is important for an organization
that aims to attract talent to show both a good and coherent
image of the company and a human resource structure oriented
to a practical and positive organization (Schneider and Bowen,
1993; Zito et al., 2019), considering that brand names seem
to be saved in the memory of people who are in a structure
devoted to associative general knowledge (Keller, 1993). This
is in line with the neuroeconomics assumption stating that
professional expectations, activities, and relations leave a trace
in the functioning of the brain (Cocco, 2016), conditioning
subsequent behavior in similar situations.

On the evaluation side, however, emotional activation during
a job interview needs to be considered; in fact, public speaking
is suggested as a stressor (Sieverind et al., 2005). Moreover,
contrary to the traditional assumption that considers job-seekers
as rational in the search and choice processes (Kidd, 1998;
Emmerling and Cherniss, 2003), other studies highlight the
importance of examining the emotional side of these processes
(Satpathy, 2012; Bonaccio et al., 2014). This is in line with the
assumptions stating that the competitive nature of the selection
process can develop negative affective states and stress (McCarthy
and Goffin, 2004) and anxiety (Feller and Powell, 2015; Powell
et al., 2018), with the risk of compromising the evaluation of
the candidate and his/her performance by the company during
the assessment. In this sense, the individual characteristics of
the candidate should also be detected, since studies highlight
that some personality characteristics, such as conscientiousness,
extroversion (Boudreau et al., 2001), and biographical elements,
can determine success in a job interview and the ability to
manage the evaluation situation (Tay et al., 2006). The issue
of personal characteristics in the organizational environment
leads also to important considerations on personal resources,
positive aspects of the self, links to resilience, and the ability
of individuals to control and manage their environment (Hobfoll
et al., 2003). These resources can make people able to deal
with demanding situations, have a protective role against stress,
and allow individuals to perform better (Salanova et al., 2010;
Xantheopoulou et al., 2013).

Encouraging the use and expression of such resources could
be fundamental for the creation of a friendly and relaxed
environment and useful to achieve organizational goals even
during the assessment process. From this point of view, one of
the resources considered important is self-efficacy. This resource
can be useful in the mastery of challenging tasks and in the
management of behavior during the job interview (Bandura
and Schunk, 1981; Tay et al., 2006), with important consequences
on work engagement (Barbier et al., 2012). Therefore, it would
be worth considering that a job assessment situation that
allows the candidates to experiment with self-efficacy through a
relaxing situation—in particular, through a positive and peaceful
job interview style—would also allow them to have a better
performance. This would make the interview effective because it
would allow the organization to detect the potential of the subject.

As for the evaluation of the reaction of the subject during the
assessment situation, neurosciences could be a key element, as
it provides a different interpretation between real experienced
emotions and the rational side and gives the possibility to
study the processing of information considering the role played
by emotions (Passyn and Sujan, 2006). This approach finds
applications among different fields, such as neuromarketing,
neuroeconomy, and neuromanagement. The application of
neuroscience to these different disciplines, in particular to
consumer neuroscience, allows researchers to delve into and
apply neuroscientific tools to detect the decision-making process
(Plassmann et al., 2012, 2015; Bazzani et al., 2020). This discipline
investigates the antecedents and consequences of behavior, looks
at the biological side, and even focuses on the information
processing and functioning of attention, memory, and emotion
(Yarkoni et al., 2011; Plassmann et al., 2015).

Neuromanagement is a key concept by Prof. Qingguo
Ma from the Zhejiang University that integrates economics
and cognitive neuroscience with management sciences (Ma
and Wang, 2006). The concept is based on a neuroscientific
approach applied to management issues to explore behavioral
and management processes and analyse brain activity. This
allows researchers to understand the mental processes of people
when facing management situations, human decision-making,
and social behaviors and their influence on the management
and economic processes (Parincu et al., 2020). Moreover, the
neuroscientific approach allows for the reliable detection of
emotions and mental processes also linked to self-regulation
and social ability in several contexts, such as the professional one
(Balconi and Salati, 2020).

According to studies on general consumer behaviors and
decision processes, measurements based on the registration of
neuro-physiological parameters could give accurate and reliable
results because of the fact that they lack the mediation of
emotions and mental processes also linked to self-regulation
and economic processes (Parincu et al., 2020). In fact, neuroscience, when applied to marketing issues,
aims to discover what is happening in the brain in response
to products or advertising stimuli and, in turn, discover which
strategy can lead to the buying process (Ciceri et al., 2019; Russo
et al., 2020).

Neuroscience techniques, which are focused on forms of
interpretations of reality based on cognitive schemes and
experienced emotions and on the detection of decision-making
process, can be used and applied in any communication exchange
activating a reaction that can be detected (Plassmann et al.,
2015; Cocco, 2016; Bazzani et al., 2020). This approach can
also help the specific assessment process by measuring reactions
useful for the choosing and meeting of organizational goals, detecting those elements related to engagement and stress, and supplying organizations with instruments to evaluate and conduct effective job interviews and, thus, meet their own organizational goals. In fact, being aware of the possibilities offered by recruiting strategies is crucial, since recruiting behavior can have implications in the design of labor market policies (Behrenz, 2001).

Taking together the aim of the research and the used techniques suggest that the meeting between the company needs of brand communication and recruitment evaluations is possible by joining the neurosciences science applied to management issues. In fact, neuromanagement in particular detects how communication can affect people within organizational and work situations (Venturella et al., 2017) through neuroscience instrumentation.

The main aim of this study is to measure the experience of the candidates during a job interview through a neuroscientific approach. The experiment provided a job interview with five different interviewers (A, B, C, D, and E), each belonging to one of the two main interview styles proposed in the literature (Raccanello, 2015; Argentero, 2016). These styles have been further exposed in the hypotheses section: one is characterized by many questions and is potentially stressful, and the other is a quiet style, also characterized by warmness and humor. Interviewers A and E belonged to the first category, while B, C, and D to belonged the second one. The interviews were structured job interviews and included four main phases:

- phase 1, the “ice breaker” and company presentation (namely, P1);
- phase 2, explanation of the work (namely, P2);
- phase 3, explanation of career possibilities (namely, P3);
- phase 4, agency mandate, with the specification of variable remuneration salary (namely, P4).

The four phases are expected to be linked to different engagement and stress levels, as mentioned in the hypotheses section.

To measure engagement and stress levels, we adopted two of the most widespread neuroscientific instruments in marketing research: the electroencephalogram (EEG) and skin conductance (SC) measurements (Alvino et al., 2020). The EEG measures the time-varying electric potential associated with the activity of a large number of neurons within the brain cortex. A differential activity between the left and right frontal cortices (the so-called frontal asymmetry) has been associated with emotional valence: the left frontal cortex is involved in experiencing positive emotions, while the right is involved in processing negative emotions (Davidson, 2004). Frontal asymmetry is defined in terms of frontal alpha asymmetry (FAA) since the electrical power in the alpha band (8–12 Hz) is inversely related to the neuronal activity: a greater left-over-right frontal asymmetry corresponds to a greater right-over-left frontal alpha prefrontal asymmetry and vice versa (Reznik and Allen, 2018). It has to be considered that emotions are defined as an adaptation to problems, and analyses on this topic should consider problematic situations as causes and/or consequences of emotions (Keltner and Gross, 1999). A positive valence underscores an approach toward the stimulus or an interest; on the other hand, a negative valence underscores avoidance toward the stimulus or a detachment (Harmon-Jones et al., 2010). The interest or detachment levels make it possible to understand the level of engagement toward the situations, as engagement is defined as a positive state of mind capturing the experience of a situation (Schaufeli and Bakker, 2010; Bakker and Albrecht, 2018). Moreover, a recent study also underscored the activation of prefrontal areas during the presentation of an advantage for the subject (Balconi and Fronda, 2020), an aspect considered linked to engagement. In this study, we operationalize the FAA as an indicator of engagement.

Skin conductance refers to the electrical conductance of the skin as a consequence of the sympathetic activity of the autonomic nervous system (ANS) on sudomotor nerves. Sudomotor nerves modulate the amount of sweat produced by the sweat glands, decreasing the electrical resistance of the sweat ducts and, in turn, increasing the net conductance of the skin. The skin conductance (SC) signal is modeled as the sum of two distinct components: the SC level (SCL), reflecting slow drifts, and the skin-conductance response (SCR), reflecting fast changes (Posada-Quintero and Chon, 2020). Scientific literature correlates SC and emotions, suggesting SC as a good indicator of arousal (Bolls et al., 2001; Ravaja, 2004; Gakhal and Senior, 2008; Sequeira et al., 2009) and stress or mental workload (Jacobs et al., 1994; Liapis et al., 2015; Greene et al., 2016). In particular, the phasic SCL has been previously adopted for measuring stress levels (Borghini et al., 2020). Accordingly, we operationalize the SCL as an indicator of stress.

**EXPERIMENTAL HYPOTHESES**

According to the main aim of the study, three hypotheses were developed following the neuromanagement perspective from both theoretical and empirical standpoints. Also considering the job perspective, the hypotheses were formulated in light of the literature regarding work and organizational psychology. It has to be noted that the first two hypotheses were particularly related to the phases of the interview, while the third one was related to the style of the interviewer.

This study operationalized the FAA as an indicator of engagement. From a job perspective, engagement is defined as a positive work-related state of mind that can capture how people experience a job situation (Schaufeli and Bakker, 2010; Bakker and Albrecht, 2018). In this view, a job becomes something that stimulates people by creating meaning and positive accomplishments. Linked to engagement assumptions, the assessment framework must also consider expectations (in terms of environment and advancements) of the future in a company, which is also a form of psychological contract (De Vos et al., 2009).

Hypothesis 1: The phases with higher levels of engagement are those related to the ice breaker and company presentation (P1) and career (P3).
If, on one hand, this study considered the most engaging phases, the research also assessed the most stressful parts of the interview with the operationalized SCL. Stress occurs in work situations and the main antecedents of job stress are related to the role in the organization, the career possibilities, the organizational and the distribution of the tasks structure (Cooper and Marshall, 1978), but also the job demands of an organization (Bakker and Demerouti, 2014), with consequences linked to exhaustion (Setti et al., 2018) and to the turnover intentions (Hallin and Danielson, 2008). This perspective has to be particularly considered in the variable remuneration rules explained in the fourth phase of this study since it could be linked to the perception of job insecurity, which can then make a job less appealing and become a source of perceived stress (De Witte, 1999; Witte et al., 2015). In order to avoid this scenario and in light of the anticipatory psychological contract, detecting this variable is important in the assessment step.

Hypothesis 2: The most stressful phases are those related to the explanation of the job (P2) and remuneration (P4).

Beyond observations on the engagement and stress indices, this study also explored the possible effect of the type of interview on the candidates. According to previous studies, the way of interaction between the interviewers and the candidates can be influenced by certain individual variables, in particular, quiet and positive moods that can strongly influence motivation and social behavior (Raccanello, 2015). A quiet style with transmitting positive moods can enhance flexibility, creativity, motivation, and cooperation (Ison and Reeve, 2005; Raccanello, 2015). This point is particularly crucial, considering that the performance of the candidates can be influenced by his/her perceptions of the situation during the job interview (Melchers et al., 2012). In particular, the affective approach during interviews, characterized by warmth, agreement, and humor, can contribute to the reduction of the anxiety of the candidates (Carless and Imber, 2007), whereas a competitive and pressing situation can lead the interviewed subject to anxiety and stress (McCarthy and Goffin, 2004). Furthermore, an effective approach can be characterized by the personalization level of communication style (Scheuer, 2001); that is, the inclusion of elements linked to the self or expressing personal feelings or experiences, thus establishing a relationship between the interviewer and the candidate. Accordingly, this would put the candidates feel warmth, more commitment, and encouragement in the personal interaction at ease (Scheuer, 2001; Raccanello, 2015).

Among other theoretical standpoints, the way of conducting an interview can be based on different styles (Argentero, 2016). The first can be defined as “friendly,” in which the power of the exchange is equally distributed. This style is not always the best choice in job assessment, since the interviewer needs to conduct the interview. Another style is based on a professional exchange based on assertiveness. In this case, questions and answers alternate, and both interlocutors are involved in a positive atmosphere of mutual openness, with the aim of creating a relaxed situation based on respect and trust. Finally, another style can be based on the so-called “stress interview.” In this case, the interview involves a series of questions (a sort of “interrogation”) posed in a direct and even intrusive way, for which precise answers are expected, in a strongly structured situation where interaction is exclusively guided by the interviewer. This results in a tense and uncomfortable atmosphere, which was created to understand how the candidate can react in stressful situations but not allowing the candidate to express his/her potential and, moreover, not allowing the organization to understand the real competencies and skills of the candidate.

On the basis of the above-mentioned theoretical standpoints, we assume that a cooperative and positive atmosphere would be more productive and favorable for both the organization and the candidate. On one hand, studies highlight the need for environments that can put their candidates at ease (Argentero, 2010), also in light of the possibility for these candidates to feel positive emotions and perform well (Demerouti, 2006; Zito et al., 2019). On the other hand, studies also focus on the crucial role of the support received by the candidate during the job interview as a resource that can decrease the level of stress (Frisch et al., 2014, 2015). Assuming these theoretical points of view, we operationalized the conduction styles as shown in the following method section. It is, therefore, hypothesized that:

Hypothesis 3: A calm and peaceful style of interview (B, C, and D) will produce less stress in the candidate.

MATERIALS AND METHODS

Sample and Procedures

This study has been conducted in the specific framework of assessments: a large Swiss company involved in the energy market made available its standardized interview, which is used to assess candidates looking for a job in the company. This company is very solid in the European labor market; therefore, this study considered the assessment interview as a consistent basis to test a novel neuroscientific approach for human resources.

The participants were real candidates who applied for a real job interview. They were informed about the experiment, and they voluntarily accepted to perform their assessment within the laboratory conditions. There were 30 participants (13 males; 17 females) with an age range of between 25 and 45 years ($M = 35.23$, $SD = 8.05$) and were both high school and university graduates looking for a job. All the participants signed an informed consent before the experimental procedure began. None of the participants reported any history of brain disorders or neurological surgery at the date of the enrolment.

In order to avoid a possible carry-over effect, the participants were randomly assigned to the different interviewers that the company assigned to the assessment. Six candidates were assigned to each interviewer. The interviewers were chosen by the energy company, and they belonged to that organization. The researchers could not intervene in the choice of interviewers.

After entering the laboratory, the researchers explained to the participants all the procedures and the phases they were going to experience. In order to track real-time engagement and stress levels, the participants wore two lightweight and wearable devices for EEG and SC measurement. The setting reflected an
assessment situation with the interviewer and candidate sitting and facing each other.

A 60-s long baseline phase (P0) was recorded before the beginning of the interview. The subjects were not given any particular instructions, except for trying to relax as much as possible while both the EEG and SC basal activities were recorded according to previous studies (Bilucaglia et al., 2019; Gabrielli et al., 2020; Laureanti et al., 2020; Russo et al., 2021).

As for the style of the interviewers, according to the above-mentioned theoretical standpoints on the type of interviews and on the basis of conducting style of the interviewers participating in the research, we operationalized two main categories of styles. We provided an observation that considered the method of interviewing and then a classification of the style on the basis of the observed characteristics (Mason, 1994; Jamshed, 2014). This classification followed the characteristics shown in the literature in terms of styles and consequences on the candidates. Going more in-depth, we identified two main styles: the first is characterized by a positive atmosphere with a quiet and peaceful style aimed at putting the candidate at ease through warmness, humor, and openness (Isen and Reeve, 2005; Raccanello, 2015). This type of style was associated with interviewers B, C, and D. The second style is characterized by a lot of questions in a short time and in a competitive and stressful atmosphere (McCarthy and Goffin, 2004; Argentero, 2016). This type of style was associated with interviewers A and E.

**Instrumentation**

The electroencephalogram data were recorded using B-Alert X10 (ABM Inc. New York, NY, United States), which is a wearable and wireless headset. It has nine Ag/AgCl wet electrodes (arranged in a monopolar montage) embedded in a flexible plastic strip, located at the F3, Fz, F4, C3, Cz, C4, P3, POz, and P4 sites of the 10/20 system (Jasper, 1958). The device allows the linked mastoid reference based on two Ag/AgCl adhesive patches placed on M1 and M2. The sample frequency is 256 Hz, and the resolution is 12 bits (Hairston et al., 2014). Prior to the application of the Synapse conductive cream (Kustomer Kinetics Inc., Arcadia, CA, United States), the skin was properly scrubbed with 70% isopropyl alcohol in order to reduce electrode impedance. The SC signal was recorded using the Shimmer 3 GSR+ (Shimmer Sensing Ltd., Boston, MA, United States), which is a wearable and wireless bracket-like device. According to the recommendations in the literature (Boucein et al., 2012), SC was recorded using a constant-voltage mode (0.5 V) by means of two Ag/AgCl electrodes placed on the index and ring fingers of the non-dominant hand.

Both the electroencephalogram and SC wireless data streams were collected with a personal computer (PC) and synchronized using iMotions v6.1 (iMotions, A/S, Copenhagen, Denmark), an integrated software research platform. The interviews were recorded using a LifeCam Studio webcam (Microsoft Corporation, Redmond, WA, United States), and the video was real-time synchronized to both the electroencephalogram (EEG) and SC data by iMotions. The video recordings served to segment each interview into the above-mentioned phases (P1, P2, P3, and P4).

**Data Processing**

The EEG data were processed using iMotions and B-Alert software development kits (SDKs). First, the decontamination procedure illustrated by Berk et al. (2007) was applied. Noise (e.g., spikes, high voltage excursions) and artifact (e.g., eye blinks, EMG noise) data points were identified by means of either a wavelet transform or thresholds on both the amplitude and the time, as well as using a linear discriminant analysis classifier. Depending on their type (i.e., noise or artifacts), the identified points were either filtered by means of the wavelet transform or simply set to zero.

Then, the decontaminated EEG signal was segmented using a 1-s long Keiser window with 50% overlapping. By means of the B-Alert SDKs, for each frontal channel k, the power spectral density (PSD) was computed within each window and averaged every three windows, obtaining a time signal of concatenated PSDs and PSDk(t) with a temporal resolution of 1 s. The alpha powers of F3 and F4 channels, pF3(t) and pF4(t), were automatically computed by integrating the corresponding PSDF3(t) and PSDF4(t) in the alpha band (8–12 Hz). A logarithmic transformation was performed in order to mitigate the skewness of the power values. The frontal alpha asymmetry FAA(t) (Reznik and Allen, 2018) was computed as:

\[
FAA(t) = \log(p_{F3}(t)) - \log(p_{F4}(t))
\]

The obtained FAA(t) was then exported to Matlab R2016 (Mathworks Inc., Natick, MA, United States) and segmented according to the phases of the interview identified by means of video recordings. Within each segment, the outliers were detected using the inter-quartile range (IQR) criteria, as those data points outside the interval \([Q1−1.5 \times IQR; Q3 + 1.5 \times IQR]\), where Q1 and Q3 are, respectively, the first and third quartiles (Russo et al., 2021). Outlier points, set as “Not-A-Number,” were excluded from subsequent analyses. In order to remove subjective variability (Bilucaglia et al., 2019; Gabrielli et al., 2020), FAA(t) was z-score transformed as:

\[
FAA(t) = (FAA_0(t) - m)/s
\]

where FAA_0(t) is the untransformed FAA signal, and m and s are the temporal mean and the temporal standard deviation of FAA_0(t), respectively, calculated in the baseline phase (P0). Because of the standard deviation in the denominator, the z-score transformation makes any dimensional signals (e.g., the power values expressed in \(\mu\text{V}^2\) or conductance value expressed as \(\mu\text{S}\)) unitless. Finally, z-scored segments were temporally averaged in order to get a condensed phase-related indicator FAA_i. This procedure was applied on each subject, giving a set of averaged indicators indexed as FAA_i.

The SC data were exported to Matlab and filtered using a second order low-pass FIR filter (fc = 1 Hz), as a simple procedure to attenuate external noise and large artifacts (Posada-Quintero and Chon, 2020). Then, a low-pass FIR filter (fc = 1 \times 10^{-12} Hz, 8,192 samples long) was applied in order to extract the tonic SCL component (Subramanian et al., 2019). Similar to those of the EEG, the SCL data were finally segmented into
the interview phases i, cleaned from the outliers using the IQR criterion, z-score transformed, and temporally averaged to obtain a condensed phase-related indicator SCLi. The procedure was applied on each subject j, giving a set of averaged indicators, indexed as SCLij.

### Statistical Analyses

Statistical analyses were performed using JASP v.0.14 (Love et al., 2019). FAA and SCL indicators were analyzed by two-way mixed ANOVA, considering the interviewer as a between-subject factor (five levels: A, B, C, D, and E) and a within-subject factor the interview phase (four levels: P1, P2, P3, and P4). Prior to the analyses, the sphericity of the phase factor and the equality of variances for the interviewer factor were assessed by the Levene’s and Mauchly’s tests, respectively (Verma, 2015).

### RESULTS

The results allowed us to identify the most stressful and most engaging phases of the interview, as well as understand which interview strategies can reduce the stress level and improve the engagement of candidates. Table 1 shows the mean scores (M) and the standard deviations (SD) of the indicators (z-score transformed FAA and SCL), split for the four phases of the interview.

The results regarding the different phases are shown within the following hypothesis sub-paragraphs. Among the results, it is interesting to monitor data along the different interview styles through the general trend. For this reason, many results in the Figures are split within the interviewers.

### Hypothesis 1

For the FAA, both the interviewer main effect and the interviewer × phase interaction were not significant \( F_{(4,25)} = 1.892, p = 0.143, \eta^2 = 0.018 \) and \( F_{(12,75)} = 0.0394, p = 0.962, \eta^2 = 0.617, \) respectively, while the phase main effect was significant \( F_{(3,75)} = 55.254; p < 0.001 \). Post-hoc t-tests with Bonferroni’s correction confirmed a significant difference between all the phases (all \( p < 0.001 \)), except between P1 and P3 \( (p > 0.05) \). The highest FAA values were found in the phases P3 (M = 0.504, SD = 0.033) and P1 (M = 0.502, SD = 0.053) and associated with career possibilities and ice-break company presentation, respectively. The lowest FAA values were found in P4 (M = 0.363, SD = 0.051) and associated with agency mandate, followed by P2 (M = 0.484, SD = 0.044), which was associated with work explanation.

### Hypothesis 2

For skin conductance level, the interview × phase interaction effect was not significant \( F_{(12,75)} = 0.778, p = 0.671, \eta^2 = 0.034 \), while the phase showed a significant main effect \( F_{(3,75)} = 40.685; p < 0.001, \eta^2 = 0.443 \). Post-hoc t-tests with Bonferroni’s correction confirmed a significant difference between all the phases (all \( p < 0.001 \), except for P1–P2 and P2–P4 where \( p < 0.01 \)). The highest skin conductance level (SCL) values were found in P4 (M = 42.838, SD = 8.613) and P2 (M = 35.012, SD = 8.261), which were associated with agency mandate and work explanation, respectively. The lowest SCL values were found in P1 (M = 19.999, SD = 8.925), the phase associated with ice-break company presentation, followed by P3 (M = 25.941, SD = 13.098), the phase associated with career possibilities.

Figure 1 and Table 2 report the following, respectively; descriptive plot (with error bars) and descriptive statistics of the EEG data split in the four phases of the interview.
Hypothesis 3

For the skin conductance level (SCL), the main effect of the interviewer was significant \( F(4,25) = 11.462; p < 0.001, \eta^2 = 0.162 \). Post-hoc \( t \)-tests with Bonferroni’s correction confirmed a significant difference between A–B (\( p < 0.001 \)), B–E (\( p < 0.001 \)), C–E (\( p < 0.001 \)), and D–E (\( p < 0.01 \)). The highest SCL values were found for A (M = 34.727, SD = 11.155) and E (M = 38.590, SD = 12.729), where the interviewers characterized by a warm and humoristic style. The lowest SCL values were found for B (M = 23.345, SD = 14.195), C (M = 29.652, SD = 11.673), and D (M = 28.422, SD = 11.071), the interviewers characterized by many questions and potentially stressful.

Figure 3 and Table 4 report the following, respectively: descriptive plot (with error bars) and descriptive statistics of the SCL z-scores, split among the five interviewers.

DISCUSSION

In this study, we recorded the EEG and SC data of 30 candidates during a 40-min long structured job interview in order to monitor in real-time their engagement and stress levels. The engagement was operationalized through the FAA, and the stress through tonic SCL. The subjects were randomly assigned to five interviewers who differed in interview style: two interviewers were characterized by a style with many stressful questions (A, E) and three interviewers by a more focused, warm, and humorous approach (B, C, and D). The interviews were divided into four phases, characterized by different engagement and stress levels: the “ice breaker” (P1), explanation of the work (P2), career possibilities (P3), and agency mandate (P4). We hypothesized that the different phases would produce different engagement and stress levels (Hypotheses 1 and 2), and that the different...
Among the results, the FAA showed that the most engaging phases were P1, referred to as the ice-breaking activity and presentation of the company, and P3, related to the explanation of career possibility, confirming hypothesis 1. The FAA was operationalized as an indicator of engagement that the literature suggests to be linked to positive work-related states of mind that capture how people can experience a job (Schaufeli and Bakker, 2010; Bakker and Albrecht, 2018). According to studies, job engagement reflects the creation of meaning associated with the job and, from the perspective of the candidates, these aspects, referred to as the expectations on the environment and on what a future in the company could be, appear relevant from a development standpoint. This point, indeed, is defined as crucial in assessment dynamics, since expectations are seen as an anticipatory psychological contract; that is, the belief of individuals in the employment also concerns guarantees to the future employer and expected inducements (De Vos et al., 2009), and is functional to psychological empowerment and employee engagement in future organizational actions (Sandhya and Sulphey, 2019).

On the side of skin conductance level (SCL), data showed that P1, the phase related to the ice-breaking activity and company presentation, is characterized by less stress. Read together with the higher level of FAA measurement, it could lie on the possibility for building a new perspective, collecting information about the company, and evaluating what the guarantee of the candidates could be. These results are also linked to the possibility of experimenting with the so-called “good stress” (Karasek et al., 1998), which implicates the development of active behaviors when demanding situations that are in line with the possibility to decide, therefore leading to motivation or new learning behaviors. In contrast to this first more relaxed phase, SCL underscores that P2, related to the explanation of the job, and P4, referred to as agency mandate with the specific characteristics of the VAT number and explanation of work with variable remuneration, are the most stressful for the candidates. These results, confirming hypothesis 2, could be related, on one hand, to the effort to understand the organization of the job and distributions of the role applied for (Cooper and Marshall, 1978; Setti et al., 2018). On the other hand, the results on P4 could be related to the fact that variable remuneration provides a high effort or unknown reward outcomes. Indeed, remuneration, beyond career satisfaction, is considered a crucial work value in determining career success, which often makes candidates expect high financial rewards (Dries et al., 2008). Variable remuneration is also linked to the issue of duration of the work contract and, therefore, job insecurity, which is a crucial and discussed topic in the field of work and organizational psychology. The psychological concept of job insecurity refers to concerns about the fear of losing a job and becoming unemployed (Rothschild and Hyun, 1990; Sverke and Hellgren, 2002). Job insecurity, indeed, is conceptualized as a source of stress (De Witte, 1999; Witte et al., 2015), with detrimental effects on the well-being of employees and their psychological and physical health (Sverke and Hellgren, 2002; Emberland and Rundmo, 2010; Laszlo et al., 2010; Kerse et al., 2018). Therefore, when evaluating a job situation, this point has to be considered in the enhancement (even reduction) of stress levels.

As for the styles of the interviewers, even if this is the first step of the research, the style based on many questions to the candidates (A and E) produced more stress; on the other hand, the quiet and peaceful style (B, C, and D) seemed to produce less stress in the candidates, confirming hypothesis 3. The non-significant results for the FAA suggest that the style of interview does not affect the engagement of the candidate. The results are in line with the two main styles that we operationalized. At this point in the research, this could be linked to the influence of effect on job interviews (Raccanello, 2015). In fact, a competitive selection can foster the rising of negative affective states, such as stress, frustration, and anxiety (McCarthy and Goffin, 2004), even compromising the performance of the candidates but also reducing their ability to adopt successful strategies (Bonaccio et al., 2014). On the other hand, the affective approach of the interviewers, characterized by warmth, agreement, and humor, can have a role in reducing the anxiety of candidates (Carless and

![FIGURE 4 | Descriptive plot with error bars of the frontal alpha asymmetry (FAA) z-scores split for the five interviewers.](image-url)

**TABLE 5** | Mean (M) and SD of the FAA z-scores, split into the five interviewers.

| Interviewer | A    | B    | C    | D    | E    |
|-------------|------|------|------|------|------|
| M           | 0.469| 0.461| 0.455| 0.465| 0.422|
| SD          | 0.072| 0.064| 0.081| 0.052| 0.087|
Moreover, as already highlighted, it is important to consider the role of support (also in terms of a supporting atmosphere), even coming from the interviewers, since it could be functional in decreasing the levels of stress among candidates (Frisch et al., 2014, 2015). On the basis of the conduction style, it is suggested to deepen expectations and the aspirations from the beginning, referring to the experiences, passions, and hobbies of the candidates. Moreover, it is suggested to encourage the candidates to share these aspirations, leaving space for their stories, to understand the attitudes and qualities of the person, and to put the candidate at ease in order to enhance their self-efficacy (Consiglio et al., 2016). Starting from the result of this study, it is important to present company qualities, especially from an economic-financial point of view with a long history behind it. Underlining its uniqueness and linking it to a complete offer of products and services could be strategic to sell the company image and communicate a good company brand image (Ma et al., 2007); it may also be useful for positive evaluation from the candidates. Moreover, focusing both on the expectations of the candidates and on the presentation of the company is useful to prevent the presence of people looking for a job without any awareness or with haphazard job search strategies (Bonaccio et al., 2014).

As for stress produced by those several questions that are necessary to know the characteristics, attitudes, and expectations of the candidates, it could be useful to offer resources, such as support from supervisors or the possibility to have job autonomy, in line with the Job Demands-Resources Model (Bakker and Demerouti, 2014). Considering not only the demands but also the resources that an organization could make available for employees could reduce distress outcomes and foster well-being. This can also be done through positive experience at work, which is functional to protect from emotional or cognitive and physical exhaustion (Zito et al., 2016). In fact, a situation of strain can also occur when the psychological demands are higher than the possibility to use a very important resource, such as autonomy (Zito et al., 2019) or decision latitude (Karasek and Theorell, 1990).

As the psychological contract plays a relevant role (De Vos et al., 2009), it could also be useful to create an adequate interview on the expectations to meet the needs of the company and the candidate, in order to better reach organizational goals.

Neuromanagement is quite a young discipline, and this study would contribute to deepening this issue in light of organizational psychology. In line with recent guidelines and studies on neuromanagement, it has to be underscored that this discipline can design new intervention strategies that can develop a direct evaluation of both individual potential and performance (Parincu, 2019; Balconi and Salati, 2020) with a positive outcome on employee growth and organizational efficacy. As neuromanagement deepens the research on this subject, it is important to consider that this is the first discipline to look at an organizational issue considering the brain processes deriving from the dynamics in an organization and allowing the detection of human brain actions and interactions in the business context from the neuroscience perspective (Ghadiri et al., 2012). In this sense, neuromanagement can be useful for the emotional brain and building of social connections, helping organizations in managing emotions in the workplace (Parincu, 2019), and preventing negative emotional dynamics and designing positive emotional and collaborative workplaces. This would be particularly useful in the perspective of assessment, in which it is important to detect the real aspect and potential of candidates. In light of the potential of the individual, the possibility to use neuroscience tools during the assessment session could be functional in better capturing the abilities and qualities of an individual. This would match important organizational aims such as informing employees of their future perspectives and possibilities or advising employees on the job to improve career opportunities (Balconi and Salati, 2020). This is an interesting point to deepen and to take into account that this study has also confirmed with the high engagement of candidates found in P3, which is related to the explanation of career possibilities. In this sense, even if this is a first pilot study, it uses a neuroscientific approach that can be a first contribution to understanding their abilities and potential. Understanding the engaging and stressful elements in this crucial phase is very important to select the right person and to understand the phases to be activated for their growth, even in terms of organizational performance. Moreover, having participatory and engaged candidates is functional for organizations to communicate the characteristics and all the crucial information needed to “sell” the job to the ideal candidate.

Even if this is a first exploratory study, as listed, it calls into consideration different implications and practical suggestions for human resources departments engaged in the assessment process. Knowing the psychological and physiological implications of the different phases of the hiring dynamics not only allows companies to attract and identify the right employees but also to plan future organizational implications. In fact, involved and motivated individuals aware of the challenges and possible available resources can contribute to the creation of positive organizational environments (Zito et al., 2016). This is functional to enhance motivation and give meaning to the job with positive consequences on performance and on individual and collective well-being (Demerouti, 2006; Cantele, 2018), also in light of the importance of investing in human resources management policies related to human capital and the evaluation and enhancement of the resources of the individuals (Manuti et al., 2020) that are identified as competitive advantages for an organization.

The limitation of this study is related to the detection of a unique work context. This did not permit the generalization of results, but it gives suggestions for the management of job interviews in pursuit of reaching organizational goals. Even with this limitation, however, this study shows an important strength, since it uses neuroscience techniques that allowing the capture of real reactions in real-time, which is useful in declining new assessment and evaluation directions. In fact, at the implication level, the ability of the interviewers to adapt to the candidate and to create empathy was crucial, though an in-depth analysis of personal aspects and life experiences was not strictly linked to a mere work aspect. Therefore, applying the neuroscience approach to strategic company planning that considers both the...
internal organization and the external communication appeared to be a key factor, and it allowed it to flow into the issue of neuromanagement. This approach can also be useful to explore organizational processes and the way to react and cope with daily job circumstances (Venturella et al., 2017). Moreover, the fact of collecting data in real-time allows us to have data on real reactions, not mediated by cognitive elaborations typical of the retrospective approach. Another limitation of the study is the classification of the characteristics of the interviews only on the basis of observations. Future studies should classify these characteristics (such as humorous or stressful cadencies) also considering the characteristics, traits, and expertise of the interviewers. A limitation of this study is also linked to large standard deviations, particularly for the SCL data. This could be linked to the different characteristics of the candidates composing the sample (Van Voorhis and Morgan, 2007), and future studies should also consider and detect these aspects.

For the future, this study should collect more data among different working categories in order to try to generalize data, and to extend and detect critical phases among other working contexts and cultures. Moreover, age should be useful in the investigation of the stress reactions that could be particularly highlighted within young job-seekers, since they would be less able to manage emotions because of their inexperience in job assessment (Bonaccio et al., 2014).

Furthermore, interesting points for the future could be the detection of possible differences between women and men and the analysis if the level of salivary cortisol before, during, and after job interviews, which would help researchers understand and correlate hormone fluctuations among different steps and interview phases with stress and activation reactions. This could be in line with studies indicating different gender approaches to risky decision-making, which seem to be influenced by different levels of stress hormones (van de Bos et al., 2014). Finally, future studies should replicate this study by also taking into account the reactions of the interviewers, investigating, e.g., the bioelectrical signal similarities with the candidate (Gabrielli et al., 2020). According to the emotional contagion assumptions (Hatfield et al., 1993), people tend to mimic facial or vocal expression, postures, and behaviors of people around them; thus, also acquiring their emotions. This could be functional in detecting how the interviewer can influence the candidate, and suggests the need for specific training to conduct assessments that are functional to put the subject at ease. This is also in line with theory about the “chameleon effect” (Tanner et al., 2008), which suggests that people tend to unconsciously imitate the body movements and facial expressions of others, also in order to facilitate the emotional connection. This effect could also be used to condition the behavior of others: it could be interesting that the awareness of a trained interviewer can be used to positively affect the mood of a candidate in order to reduce stress levels and increase his/her performance, allowing the company to conduct a more precise selection process.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics committee of Università IULM. Participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

VR and GG designed the research. MB and AF collected the data and carried out data analysis and interpretation. MZ and MB wrote the manuscript. MZ, AF, and VR edited the final version. VR and GG supervised the project and the writing of the study. All the authors contributed to this study, final version of the manuscript has been approved for submission, and accountable for the whole study.

ACKNOWLEDGMENTS

We would like to thank Megan Wright for editing and reviewing this manuscript in the English language.

REFERENCES

Abbasi, S. G., Tahir, M. S., Abbas, M., and Shabbir, M. S. (2020). Examining the relationship between recruitment & selection practices and business growth: An exploratory study. J. Public Affairs 21:e2438. doi: 10.1002/pa.2438

Alvino, L., Pavone, L., Abhishta, A., and Robben, H. (2020). Picking your brains: Where and how neuroscience tools can enhance marketing research. Front. Neurosci. 14:577666. doi: 10.3389/fnins.2020.577666

Argentero, P. (2010). “La selezione del personale,” in Psicologia delle risorse umane, eds P. Argentero, C. G. Cortese, and C. Piccardo (Milano: Raffaello Cortina Editore), 17–48

Argentero, P. (2016). L’intervista di selezione. Teoria, ricerca, Pratica. Milano: Franco Angeli

Bakker, A. B., and Albrecht, S. (2018). Work engagement: current trends. Career Dev. Int. 23, 4–11. doi: 10.1108/CDI-11-2017-0207

Bakker, A. B., and Demerouti, E. (2014). “Job demands-resources theory,” in Work and wellbeing: Wellbeing: complete reference guide, eds P. Y. Chen and C. L. Cooper (Hoboken, NJ :Wiley-Blackwell). 37–64. doi: 10.1002/9781118539415.wbwell019

Balconi, M., and Fronda, G. (2020). Morality and management: an oxymoron? fNIRS and neuromanagement perspective explain us why things are not like this. Cognit. Affect. Behav. Neurosci. 20, 1336–1348. doi: 10.1002/9781118539415.wbwell019

Balconi, M., and Salati, E. (2020). “Dalle funzioni esecutive ai programmi di neuropotenziamento. Nuove prospettive per il neuroassessment,” in Il neuromanagement tra cambiamento, tecnologia e benessere, eds M. Balconi, B. Nava, and E. Salati (Milano: LED).

Bandura, A., and Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. J. Personal. Soc. Psychol. 41, 586–598. doi: 10.1037/0022-3514.41.3.586

Barbier, M., Hansel, I., Chmiel, N., and Demerouti, E. (2012): Performance expectations, personal resources, and job resources: How do they predict work engagement? Eur. J. Work Organizational Psychol. 18, 1–13. doi: 10.1080/1359432X.2012.704675

Bonaccio, M., and Van de Bos, C. (2014). Pi cking your brains: Where and how neuroscience tools can enhance marketing research. Front. Neurosci. 14:577666. doi: 10.3389/fnins.2020.577666

Hatfield et al., 1993

Bakker, A. B., and Van Zelst, S. (2010). “Performance: current trends.” Work and wellbeing. Wellbeing: complete reference guide, eds M. Balconi, B. Nava, and E. Salati (Milano: LED).
Zito, M., Cortese, C. G., and Colombo, L. (2019). The role of resources and flow at work in well-being. *Sage Open* 9, 1–12. doi: 10.1177/2158244019849732

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Copyright © 2021 Zito, Bilucaglia, Fici, Gabrielli and Russo. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Venturella, I., Gatti, L., Vanutelli, M. E., and Balconi, M. (2017). When brains dialogue by synchronized or unsynchronized languages. Hyperscanning applications to neuromanagement. *Neuropsychol. Trends* 21, 35–51. doi: 10.7358/neur-2017-021-vent

Verma, J. P. (2015). *Repeated Measures Design for Empirical Researchers*. Hoboken, NJ: John Wiley & Sons.

Witte, H. D., Elst, T. V., and Cuyper, N. D. (2015). *Job Insecurity, Health and Well-Being. Aligning Perspectives on Health, Safety and Well-Being*. New York, NY: Springer. doi: 10.1007/978-94-017-9798-67

Xanthopoulou, D., Bakker, A. B., and Fischbach, A. (2013). Work engagement among employees facing emotional demands: The role of personal resources. *J. Person. Psychol.* 12, 74–84. doi: 10.1027/1866-5888/a000085

Yarkoni, T., Poldrack, R. A., Nichols, T. E., Van Essen, D. C., and Wager, T. D. (2011). Large-scale automated synthesis of human functional neuroimaging data. *Nat. Methods* 8, 665–670. doi: 10.1038/nmeth.1635

Zito, M., Cortese, C. G., and Colombo, L. (2016). Nurses’ exhaustion: the role of flow at work between job demands and job resources. *J. Nurs. Manage.* 24, E12–22. doi: 10.1111/jonm.12284