Emotions and Activity Recognition. A computer vision approach for augmentation of psychosocial risk evaluation.

Computer vision assistance in psychosocial risk factor evaluation via emotions and activities monitoring.

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Abstract

Psychosocial risk evaluation has played a dominant role in ensuring the wellbeing and health of people. Nevertheless, mechanisms such as interviews and questionaries are susceptible to inaccurate or skewed results due to the lack of data that cannot be acquired during assessments. This work proposes an initial approach to identify activities and emotions that are implicitly queried by current evaluations and have the potential of being detected by cameras. By extracting features from video frames using computer vision, machine learning-oriented classifiers become feasible to conduct continuous and non-intrusive monitoring. Activities and emotions registering could provide additional data to support better-informed psychosocial risk evaluations.

1 Introduction

According to the World Health Organization, a risk factor is defined as any trait or exposure of an individual that could increase the probability of suffering any disease or injury[1]. Among different types of situations that can influence people's health, there are chemical risk factors[2]; biological risk factors[3]; environmental risk factors[4] and psychosocial risk factors. This las one, involves physical aspects of the environment, such as noise or temperature[5]; psychological aspects in people such as stress[6] and burnout caused by high workloads or persistent excess in working hours[7][8].

Throughout the last 50 years, several psychosocial assessment methods have been created by medicine and psychology professionals, to allow quantitative and qualitative evaluation of psychosocial risk exposure. A psychosocial assessment is an evaluation of mental, physical, and emotional health[]. Usually, it takes the form of a series of questions and screening tools, covering many aspects of a person's life to get a picture of his or her mental state[]. With that information, professionals can draw recommendations about specific environmental issues or treatment plans[].

On the other hand, since the end of the '80s, Artificial Intelligence has been used for applications in industry, aeronautics, autonomous driving. As it is evolving, it has allowed the construction of many devices for producing and interpreting the text, recognize speech, and even generate entities such as eBay's virtual agents. Artificial intelligence sub-disciplines such as machine Learning provides algorithms tools to analyze data, as well as to design, train, and deploy models into applications, processes. However, machine learning algorithms and other artificial intelligence approaches are still under research in other areas such as wellbeing and psychosocial evaluations.

The main goal of the present project is to identify a potential contribution of artificial intelligence to psychosocial risk assessment, by performing a state of the art review of evaluation methods and current technological approaches to support them. This project will present implicit scenarios from questionaries,

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where some artificial intelligence disciplines such as computer vision and machine learning, can be applied to obtain additional information for better-informed assessments.

The present work is composed of seven sections, including the previous introduction. In section 2, we present the Psychosocial Risk Assessment (PRIA) advantages and limitations, as well as technological approaches that support some aspects of PRIA. In section 3, we show the problem statement by describing the keywords review about the gap between artificial intelligence and PRIA. Also, it states the motivation of the present work. Section 4 is devoted to the description of questionary items that have the potential of being measured by extracting data captured with surveillance cameras. Section 5 list a set of works oriented to recognize activities and emotions via single and multi-mode systems. Therefore, it will show techniques and methodologic references for the design and implementation of artificial-oriented architectures. Section 6 presents a brief review of motion-capture libraries that can be potential feature extraction components. In section 7, experimentation of selected libraries, using public video databases. Finally, we conclude the presented material in Section 8.

2 Related work

Within the context of psychosocial risk factors, some variants may be inherent individually or together in a work environment. It is essential to clarify that the environments can be external when working outdoors and internal when working indoors. The most common types of risks for both cases are: Physical risks (also known as workplace risk) refer to aspects of the environment where the work takes place. Among the most significant aspects are noise, lighting, or the temperature of the environment[9][10]. Chemical risks are highly related to industrial environments where any worker may have contact with dust, gases, or abrasive products[11][12]. Biological risks involve contact with living things such as fungi, bacteria, or viruses, particularly by the interaction with people who may have a disease, infections, animals, or plants that may be carriers of a harmful organism[13][14]. Mechanical risks may be associated with some aspects of the work environment. It is related to heavy machinery usage or the development of an activity in which any person exposes to the effects of vibration [15][16]. Environmental type risks involve scenes or work, where there is a high probability of floods, storms, or contamination[17][18]. Finally, psychosocial risks occur in the normal execution of daily activities. These are strongly related to the work conditions, people's interaction, and socio-demographic conditions. Among the most studied aspects, it is stress, monotony, and job fatigue due to excess hours worked[19][20]. As this last type of risk is the main focus of the present work, section 2.1 will present the evaluation methods.

2.1 Psychosocial Risk Assesment (PRIA)

Currently, some methods facilitate the evaluation of FRP developed from the integration of models and scales, which seek to qualify risk factors. In works such as Charria, Sarsosa, and Arenas[21] is suggested a taxonomy of mechanisms, taking into account the form in the information extracted and its scope. In this work, there are two large groups of questionnaires oriented to industrial hygiene and psychosocial factors. In the first group, evaluates aspects such as the work environment, the physical effects on workers, and details of hiring and remuneration. The assessments of these aspects use questionnaires that are carried out by an external agent to the organization, who seeks an objective evaluation of the situation. Some examples of this group are the Questionnaire for the Fifth European Survey on Working Conditions[] and the Quality of Life at Work Survey Questionnaire[]. In the second group, there are questionnaires oriented to psychosocial factors acquired through interviews or a self-report procedure. Interview questionnaires collect information related to job satisfaction, burnout, or bullying. On the other hand, self-report questionnaires extract information related to individual aspects of the person, such as the relationship between health and illness, aspects of daily life, and their social interactions. Some examples of this second group are the EAE Stress Assessment questionnaire[], the occupational burnout scale[], the Bocanument and Berján evaluation[], and the Demand-Control model[].

Concerning the groups of questionnaires mentioned, there are investigations which reveals that some conditions generate effects related to physical health such as musculoskeletal disorders[22] or the behavior of people such as sedentary lifestyle [23]. On the other hand, other studies show effects related to people's mood[24] with mental health such as stress [25] and psychological disorders such as anxiety [26] or depression [27] [28].

Although the psychosocial risk is widely related to work, it is not exclusive to these environments. Researches such as that of Abdullah Alotaibi [29], Christian Hederich[30], and Malarvili[31] address the relationship between sleep quality and stress in academic settings. Within the research carried out in the academic context, There are studies of the prevalence and correlation of depression, anxiety, and suicidal tendencies such as Eisenberg's [32]. Other approaches, such as Danuta's[33], seek to identify the relationship of demographic aspects such as the students' place of residence as intervening variables in their state of health. It is also essential to show that in these scenarios, students are not the only actors prone to risk factors. Works such as that of Briones[34] and Pedditzi[8] show a presence of stress and job exhaustion among teachers.

During the last years, many mechanisms have been developed in the form of questionnaires. These mechanisms have favored the improvement of interactions at work, the conditions of their organization, as well as the worker's abilities, needs, culture, and the personal situation outside of work, all of which, through perceptions and experiences, can influence health and performance and job satisfaction. However, the influence not only comes from the work environment[35] but also from the extra-work environment[36]. In this last aspect, psychosocial assessment methods seek to evaluate aspects such as time away from work activities, family relationships, the economy of the family group, commuting to work, among others. Some derivations or generalizations of the exposed evaluation methods have contributed to the improvement of well-being and good practices in the academic context, promoted or the development of a mechanism for the promise of stress management evidenced in Collen's work[37]. Other contributions have allowed approaches to identify the behaviors associated with happiness, well-being, and the stress perceived in university students[6].

The diversity of scenarios where evaluation methods play an essential role, in turn, entails a series of challenges of experimental validation, in which the aim is to establish correlation values of the aspects evaluated with the real scenario[38] or its factor structure[39]. Although there is high statistical support for several of the items raised within the questionnaires, it can be evidenced that the mechanisms and procedures are susceptible to variability and subjectivity in the measures[40][41]. Experimentations have the caveat that samples are related to a particular segment of the population. Also, some items in questionnaires assess relevant aspects of daily activities that are not observed by specialists in occupational safety and health that a. This last issue reduces the amount of evidence drastically to establish reference values[42].

2.2 Technologic approaches supporting PRIA

Some references have addressed some aspects related to the mental health of people in the workplace[43][44]. Some of these works have resulted in technological solutions for monitoring some specific aspects of psychosocial risk, ranging from the implementation of load controls on the extremities and other parts of the body based on sensors[45]. Other approaches focus on reducing accidents by detecting elements or obstacles that can generate an accident. Among these approaches, works that identify liquid spills or tools oriented to the environment can be noted[46]. On the other hand, to identify aspects related to the mental condition in people, approaches have been made through the use of artificial intelligence and computer vision. In some of these approaches, electroencephalogram images analysis is used to assess stress in people[47]. Other works such as those by Zack Zhu[48] or Raffaele Gravina[49], suggest alternative perspectives, based on the recognition of mood, from the capture of signals with portable electronic devices.

Other approaches address the capture and integration with other data sources, resulting in multimodal architectures[50][51], in which the processing of video images, text, signals, among others, is used to support the diagnosis of emotions[52]. Works such as that of Le Yang[53] and Poria Soujana[54] suggest the fusion of paralinguistic analysis, capturing interview responses, features of the face widely addressed[55][56], and eye movement[57]. Some approaches are oriented to detect the effects of psychosocial risk factors, such as stress by performance demands[58] and depression.

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advances represent significant potential for the manufacturing industry, construction, among others[59], there are studies such as that of Shall Mark[60], where there is evidence of limitations for its adoption, the implications of cost; the interruption of work activities, the intrusive nature represented in the discomfort with the devices and the privacy of people.

In these approaches, a significant contribution is evident in the analysis of voice patterns, and some aspects of interest are addressed within the evaluation of FRP. However, the video mode used in the posts above, focuses only on facial recognition, requiring the close-up capture of people's faces and the use of sensors. Also, constant monitoring considered.

3 Problem statement

This paragraph will explain the motivations of this project by showing the low quantity of works involving artificial intelligence in psychosocial risk factors, mentioning that there are articles orbitating the problem but just adressing specific matters whitout any intention to be a part of an integral solution for psychosocial risk. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

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3.1 Statitical analysis

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3.2 Gap Analisis de pocos papers que se encuentran relacionados con la conjuncion de temas

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Table 1: Estadísticas Generales

Single.term	search.results	artificial.intelligence	cognitive.decision	machine.learning	neural.network	deep.learning	random.forest	SVM	decision.tree	linear.regression	logistic.regression	naive.bayes	markov.chain	fuzzy.logic	ensamble.method	Total.Found
psychosocial risk factor	9.000	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
psychosocial factor	13.000	1	0	0	2	0	0	0	0	0	0	0	0	0	0	3
psychosocial evaluation	71.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
psychosocial assessment	218.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
psychosocial risk	672.000	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
psychosocial	24.057	1	0	2	2	0	2	0	1	0	2	0	0	0	0	10
work fatigue	24.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
chemical risk	214.000	0	0	1	1	1	0	0	1	0	0	0	0	0	0	4
biological risk	250.000	0	0	1	1	0	0	0	1	0	0	0	0	0	0	3
drowsiness	324.000	0	0	2	13	3	1	3	0	0	1	0	0	1	0	24
tobbacco consumption	404.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
musculoskeletal disorder	463.000	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
boredom	625.000	0	0	2	1	0	0	0	0	0	0	0	0	0	0	3
eating habit	999.000	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
environmental risk	2.497	0	0	2	3	2	1	1	0	0	1	0	0	2	0	12
burnout	7.909	1	0	0	5	0	0	0	0	1	1	1	0	0	0	9
alcohol consumption	8.370	0	0	1	0	1	0	0	1	0	1	0	0	0	0	4
eatingýdisorder	11.787	0	0	2	2	0	0	1	2	0	2	0	0	0	0	9
sleep disorder	12.516	0	1	9	8	1	0	0	0	0	0	0	0	0	0	19
anxiety	54.469	5	1	17	6	0	0	3	1	0	5	0	0	0	0	38
depression	101.106	5	0	75	63	7	3	7	6	3	10	0	1	2	4	186
stress	302.437	7	4	77	198	12	8	11	4	4	5	0	5	14	21	370

4 Implicit Activities and emotions in PRIF-EM

This subsection introduces the work of extracting activities and emotions from the PRIF-EM. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Spanish Version of the CD-RISC Resilience Scale for Chronic Stress Situations[61] Beck Anxiety Inventory (BAI)[62]

4.1 Methodology of extraction

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hOW DO WE RECOGNIZE EMOTIONS FROM MOVEMENTS[63]

The second paragraph will describe the authors working in methods oriented to assess Psychosocial risk in academic environments. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

The Third paragraph will describe the authors working in methods oriented to assess Psychosocial risk in work environments.Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

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Author	Environment	Assessment mechanism/scale
Golonka, 2019[64]	Work	Maslach Burnout Inventory – General Survey (MBI-GS), NEO Five-Factor Inventory, Beck's Depression Inventory
Mausner, 2000[65]	Work	Quality of Employment Surveys
Boyes, 2002 [66]	Work	Hospital Anxiety and Depression Scale, Short-form Supportive Care Needs Survey
Rodríguez, 2009[67]	Work	Hipótesis de la tensiòn del trabajo Karasek
Blanch, 2010[68]	Work	El cuestionario "FPSICO" El Cuestionario de Bienestar Laboral General
Luca, 2014[69]	Work	Beck Depression Inventory (BDI)
Maeda, 2016 [70]	Work	International Neuropsychiatric Interview

The Fifth paragraph list dimensions and scope identificacion of the items in main PRIF-EM. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

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Mecanismo	año	Items	Topicos
Cuestionario Encuesta de Calidad de Vida en el trabajo, aplicado en España por el Ministerio de Trabajo e Inmigración	2018	3	Trabajo prolongado o jornada extensa,Estrés, Ansiedad, Depresión, Problemas de sueño
Cuestionario para la Evaluación del Estrés, que hace parte de la batería para la evaluación de factores de riesgo psicosocial publicada por el Ministerio de la Protección Social en Colombia	2020	5	Trabajo prolongado Posturas inapropiadas Ausencia o presencia de descansos Estrés
Maslach Burnout Inventory (Edu y Labo)	2001	3	Trabajo prolongado, jornada extensa y condiciones
Escala de Desgaste Ocupacional[63]	2000	2	Trabajo prolongado o jornada extensa. Problemas de sueño Depresión
Utrecht Work Engagement Scale, que evalúa la experiencia de engagement y bienestar	2000	2	Trabajo prolongado o jornada extensa. Actividades de bienestar
Inventario de violencia y acoso psicológico en el trabajo	2000	1	Trabajo prolongado o jornada extensa
Perceived Scale Test (PSS) Cohen, Kamarck and Mermelstein	2000	1	Medición de la percepción del estrés
Depression, anxiety and stress scale (DASS21)	2000	5	Test de autovaloración de síntomas físicos
The Three-Factor Eating Questionnaire	2000	5	Cuestionario de tres factores de ingesta
The Kessler Psychological Distress Scale (K10)	2000	3	Destinado a producir una medida global de angustia basada en preguntas sobre ansiedad y síntomas depresivos
The Pittsburgh Sleep Quality Index (PSQI)	2000	1	Destinado a medir los hábitos de sueño
Survey of personal a social development	2000	5	Medir frecuencias de consumo de tabaco, alcohol y síntomas psicológicos

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4.2 Activities and emotions inventory

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5 Artificial intelligence in activites and emotion recognition

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Video scene analysis: an overview and challenges on deep learning algorithms[71]

5.1 Activities Recognition

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Acculturation, Depression, and Smoking Cessation: A trajectory pattern recognition approach[72] Driver's drowsiness detection using an enhanced image processing technique inspired by the human visual system [73] Driver drowsiness detection using mixed-effect ordered logit model considering time cumulative effect [74]

This paragraph will mention articles related to Gait Analysis.Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum. Gait Analysis [75]

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5.2 Emotion Recognition

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Stress and anxiety detection using facial cues from videos [76] Challenge face recognition for emotions [77] HOURGLASS OF EMOTIONS [78] Adaptive Body Gesture Representation for Automatic Emotion Recognition[79] Emotion Recognition from Body Movement [80] Deep Learning Approach for Emotion Recognition from Human Body Movements with Feedforward Deep Convolution Neural Networks[81] A Brief Review of Facial Emotion Recognition Based on Visual Information [82] Automated Analysis of Facial Cues from Videos as a Potential Method for Differentiating Stress and Boredom of Players in Games [83] Extended

Deep Neural Network for Facial Emotion Recognition [84] Automatic Depression Scale Prediction using Facial Expression Dynamics and Regression [85]

This paragraph will mention articles related to Emotions recognition via body movements. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

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From Pixels to Sentiment: Fine-tuning CNNs for Visual Sentiment Prediction [86]

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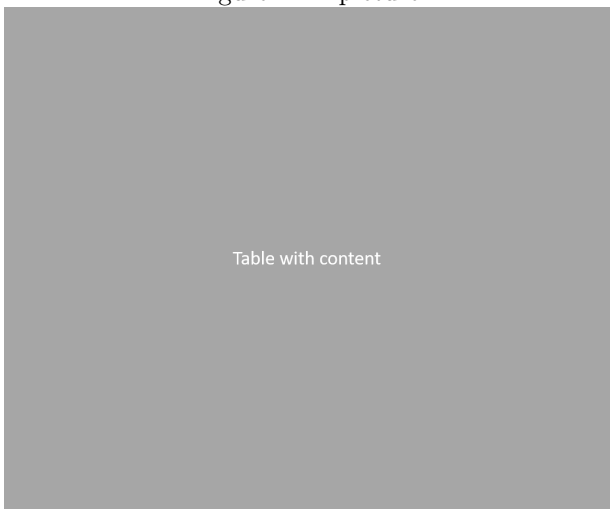

6 Feature extraction via computer vision

This introductory paragraph describes the experimentation that is goin to be carried out to determine if current motion caputre libraries are capable to extract quality data to build descriptors for activity and emotions clasifiers. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

6.1 Motion capture libraries

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6.2 Expermentation and benchmarking

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Activities * Eating and smoking habits * Aggresive conduct * Recurrent extensions of work shift or activities

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7 Results

This paragraph summarizes the obtained results by showing charts.Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

7.1 Activities results analysis

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Recurrent extensions of work shift or activities. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

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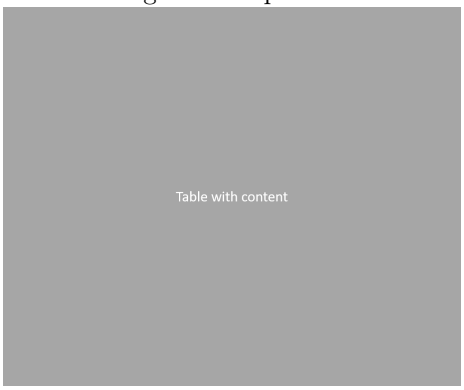

7.2 Emotions results analysis

Stress-related emotions. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

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Depresion-related emotions. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed eiusmod tempor incidunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

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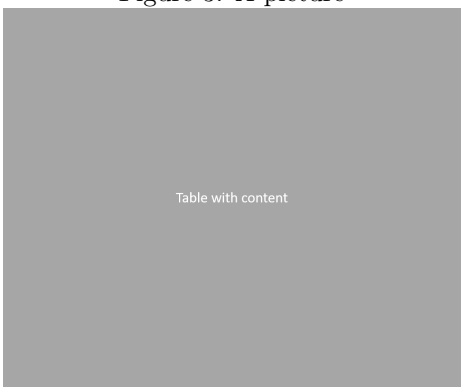

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8 Conclusions

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