Knowledge Management & E-Learning, Vol.11, No.2. Jun 2019

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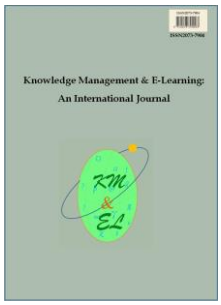

Knowledge Management & E-Learning: An International Journal (KM&EL)
ISSN 2073-7904

Recommended citation:
Kazemitabar, M., Lajoie, S. P., & Doleck, T. (2019). Examining changes in medical students' emotion regulation in an online PBL session. *Knowledge Management & E-Learning*, *11*(2), 129–157. https://doi.org/10.34105/j.kmel.2019.11.008

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Examining changes in medical students' emotion regulation in an online PBL session

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Abstract: Given recent attention to emotion regulation (ER) as an important factor in personal well-being and effective social communication, there is a need for detection mechanisms that accurately capture ER and facilitate adaptive responding (Calvo & D'Mello, 2010). Current approaches to determining ER are mainly limited to self-report data such as questionnaires, inventories and interviews (e.g., Davis, Griffith, Thiel, & Connelly, 2015). Although beneficial, these self-report approaches have important shortcomings such as social desirability biases, recall issues, and inability to capture unconscious ER (Scherer, 2005). The research presented here explores this gap by examining the use of multimodal observational data as well as self-report data to more accurately capture ER. Specifically, this study develops and employs a multimodal analysis of emotion data channels (facial, vocal and postural emotion data channels) to provide a rich analysis of ER in an international case study of four medical students interacting in an emotionally challenging learning session (i.e., communicating bad news to patients) in a technology-rich learning environment. The findings reported in the paper can provide insights for educators in designing programs to enhance and evaluate ER strategies of students in order to regulate personal emotions as well as the emotional needs of others in stressful situations. This work also makes important contributions to the design of technology-rich environments to embed dynamic ER detection mechanisms that enable systems to gain a more holistic view of the participants, and to adapt instructions based on their affective needs.

Keywords: Emotion regulation; Medical students; Multimodal data channels

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1. Introduction

Emotions play an important role in human life, from activating behavioral responses to easing decision making and enhancing memory (Gross & Thompson, 2007). Even though the term emotion is used frequently and in everyday contexts, it is a complex and indeterminate yet important scientific construct. Kleinginna and Kleinginna (1981) proposed a definition that addresses different aspects of emotions: "Emotion is a complex set of interactions among subjective and objective factors, mediated by neural/hormonal systems, which can: (a) give rise to affective experiences; (b) generate cognitive processes; (c) activate physiological adjustments to the arousing conditions; and (d) lead to behavior that is often goal directed" (p. 11). Thus, emotion consists of different subcategories of feelings, cognitive appraisals, physiology and behaviors (Gross & Barrett, 2011; Scherer, 2005; Zelazo & Cunningham, 2007). Each of these subcategories is a channel in which emotions can be expressed and thus measured.

Emotions occur in a variety of settings and they can activate us to action or deactivate us into complacency. Anger may make us take action against an injustice. Fear may make us more alert. Sadness may make us withdraw from pre-existing interests and activities. Shame may make us conceal our self. Delight, interest, curiosity, and many other emotions may mobilize us to move towards an action. Indeed, emotions can deeply affect our personal and social lives, benefiting us in many ways; but sometimes they may be detrimental. Some examples include the anxiety of a goalie who lets in a goal in the world cup and performs poorly in the rest of the match; the fear of a firefighter who loses courage with children who are in danger (Scott & Myers, 2005); and, patients who lose hope when faced with extreme physiological illnesses (Baile et al., 2000). In the latter case (patients with critical illnesses), negative emotions can be significantly detrimental and clearly require to be managed.

In fact, studies have shown that being aware of emotions and managing them can enhance personal well-being and increase social competence (Gross & Thompson, 2007). Managing emotions is otherwise labelled as Emotion Regulation (ER, Gross, 1998a) that refers to "the processes by which individuals influence which emotions they have, when they have them, and how they experience and express those emotions" (Gross & Thompson, 2007, p. 275). Individuals may show intrinsic (IER) or extrinsic ER (EER). IER refers to ER strategies that one applies to regulate their own emotions, and EER refers to ER strategies that one applies to regulate other's emotions (Lajoie et al., 2015)

Unfortunately, "enthusiasm for this topic continues to outstrip conceptual clarity" (Gross, 2015, p. 1). The emotion literature suffers from the lack of a clear distinction in understanding regulated versus unregulated emotions. For the purpose of this paper, we distinguish regulated emotions from unregulated emotions in that regulated emotions are those emotions that are regulated in expression differently from the actual experienced emotion, arising from competence in managing and expressing emotions (of self and others). The ability to notice regulated emotions and to respond accordingly is an important component of emotional intelligence (Mayer, Salovey, Caruso, & Sitarenios, 2001) that pertains to the development of social competence and empathy (Eisenberg, Hofer, & Vaughan, 2007). We emphasize that emotions that are regulated should be

managed differently. As an example, the smile of a sad person (regulated smile) is different than a smile of a happy person (regular smile). This study highlights the importance of becoming competent in distinguishing between such two smiles since they have different meanings, and inform us of the need to apply different interactive approaches in our communication (e.g., showing more empathy to the sad person). To our knowledge, no research has yet been conducted to facilitate the detection of regulated emotions.

Within medical education, a critical aspect of student training involves practicing intrinsic regulation (IR; Gross, 1998a) or self-regulation of one's emotions as well as external regulation (ER; Gross, 1998a) of patients' emotions, when delivering bad news. This is because bad news delivery transfers a strong emotional load on the patient. Bad news in this context refers to information about an important undesirable health situation of a patient. Providing bad news effectively to patients is a delicate and challenging task, and even experienced physicians find it hard to communicate such news to their patients (Lajoie et al., 2015). Research has vastly shown how poor communication has led to low patient-physician communication and long-lasting negative effects on patient health and well-being. Effective communication can strengthen patient trust to physician, and smoothen acceptance of illnesses and the necessity to undergo treatments, leading to significantly-enhanced patient care. However, although the importance of effectively delivering bad news has been acknowledged and recognized, yet this topic remains understudied (Reed et al., 2015). Still, patients and physicians report low physician competence in effective communication with patients regarding health diseases. This may be since to date, much of the medical education has put major focus on pathology and illness treatment. Little research has been conducted on the teaching and evaluation of critical (yet less tangible) skills such as effective communication. Specifically, regarding the emotionally-challenging task of bad news delivery, physician emotional competence becomes of critical importance. However, scarce research has examined the power of emotions in bad news delivery (Lajoie et al., 2015). Furthermore, research has not yet studied the power of emotion regulation on effective bed news delivery.

2. Emotion regulation channels in TREs

One of the key affordances of technology-rich environments (TREs; Lajoie & Azevedo, 2006) is the ability to measure emotions through multiple channels. Current channels include: (a) self-reports, (b) observational channels (e.g., facial expressions and posture), (c) content analysis of speech and vocal characteristics, (d) physiological measures, as well as (e) brain imaging.

This paper will apply a unique multimodal approach to measure emotion regulation within a TRE, which will significantly enhance accuracy of inferring regulatory instances (Calvo & D'Mello, 2010). Such exercises (multimodal measurement of emotion channels) remain an understudied aspect of the field of affective computing-defined as "computing that relates to, arises from, or deliberately influences emotion" (Picard, 1999, p.1). In recognition of the role of emotions in learning, affect-sensitive interfaces are being developed and integrated into learning technologies. In order to improve learner-system interaction, it is important to both accurately recognize and respond to learners' emotional experiences and reaction. However, affective computing systems have deficiencies that could in part stem from their assumption that there is a one-to one correspondence between the experience and expression of emotions. This assumption may be in contradiction with research on emotion regulation (Gross, John, &

Richards, 2000). The Mona Lisa, a portrait by Leonardo da Vinci, considered to be one of the most famous paintings exemplifying such emotional ambiguity. When asked to discern the emotion expression of Mona Lisa's face, most human coders are not clear as to whether she is happy or sad. In contrast, affective computing models calculate that the emotion expression of Mona Lisa shows happiness. Such divergence has significant implications for work conducted in affective computing, as ambiguities lead to inconsistent results.

Although problematic, convergence of affective signals from different emotion detection channels to infer a unique emotional state remains a key goal of affective researchers. Empirical findings have revealed that through such attempts, different emotion signals are merged with loose coherence levels (Russell, Bachorowski, & Fernández-Dols, 2003; Ruch, 1995; Barrett, 2006). However, the loose coherence of emotional channels may have an underlying meaning. We propose that this coherence gap, if understood, can lead to better emotion detection models that can enhance automatic affective computing. The current study aims to detect instances where emotional components are coherent versus incoherent, and understand whether such experiences may explain emotional regulation.

In this study, multimodality measurement of emotions was conducted since inference of an emotional state from only one emotional channel might be subject to misinterpretation (Calvo & D'Mello, 2010; Lang, 1995). The multimodal channels of attention tendencies, vocal characteristics, and motor expressions were chosen as indicators of emotion (Scherer, 2005; Mauss & Robinson, 2009; Calvo & D'Mello, 2010) as well as verbal utterances containing emotional cues. These emotion channels and their subcategories will be further elaborated in the methods section.

3. Emotion regulation strategies

There are several methods that can be used to regulate emotions. The modal model of ER (Gross, 1998b) represents an integrated framework of five sequential processes involved in emotion generation and regulation: Situation selection, situation modification, attention deployment, cognitive change, and response modulation. The following is a brief description of each strategy along with an example for further understanding.

3.1. Situation selection

This strategy refers to choosing situations that relieve emotions. For example, one might experience anger in a noisy restaurant and chose to leave the restaurant to ease one's emotions. Gross and Thompson (2007) state that situation selection requires an understanding of how one might act in a prototypical situation and what emotional responses would occur as a consequence of a specific situation. Moreover, people under or overestimate emotional outcomes of unforeseen situations (Gilbert et al., 1998); for example, negative emotions are estimated to be longer lasting than their real duration.

3.2. Situation modification

This strategy refers to interventions that target direct modification of an emotion-provoking situation. For example, when a patient has been diagnosed with cancer, the doctor provides empathy and instructional support to help the patient manage this distressing situation. This emotional support can be delivered through empathetic

emotional expressions of one's face, voice, posture, etc., as well as in combination. "Situation" is sometimes ambiguous given that modification of a situation might turn it into a new situation. To distinguish situation selection and modification, Gross and Thompson (2007) submit that situation modification refers to external rather than internal situations. Consequently, regulating emotions pertinent to implicit mental situations does not fall in the category of situation modification.

3.3. Attention deployment

This strategy is used to divert attention away from an emotion-triggering stimulus, and is especially beneficial when one cannot alter a situation by selecting or modifying it. Attention deployment can be used for both IER and EER. For example, when doctors want to communicate a cancer diagnosis to a patient, they may (un)consciously divert their attention away from the patient's face to decrease the emotional distress transferred from the patient. This method has two key subcategories: distraction (changing the focus of attention through physically withdrawing by shifting gaze and internal redirection of attention such as invoking thoughts and memories of (un)pleasant situations) and concentration (drawing attention to the emotion-provoking stimulus and deliberately attending to it, for example when a standardized patient focuses on a sad scenario to elevate sad emotions) (Gross & Thompson, 2007).

3.4. Cognitive change

Emotions and cognitions are two interwoven constructs (Pessoa, 2008). Thus, emotions cannot be detached from how we perceive them and their contexts. An emotion needs to be regulated cognitively to have longer lasting effects. Through cognitive change, one can attempt to manipulate the meaning of a situation in order to alter its emotional significance. Cognitive change has several subcategories, as an example, one strategy is to change how an individual think about an emotional trigger (i.e. reinterpreting the situation); and another strategy is to change one's capability of handling the demands the trigger causes (Gross & Thompson, 2007). For example, when a person has been diagnosed with a disease, he or she may think there are worse things in the world (using downward social comparison).

3.5. Response modulation

The former methods of ER occur prior to generating an emotional response. However, if a response is produced, there still is some chance of regulating it: through direct modulation of the experiential, physiological, and behavioral consequences it may have on an individual (Gross & Thompson, 2007); such situations are called response modulation, where a response has actually been generated. One important method of modulating emotional responses involves balancing emotional expressions, where an individual regulates the responses he or she is expressing, through venting or suppressing emotions. For example, when a doctor reveals upsetting news to a patient, the former needs to express sadness and suppress cheer to empathize with the patient. Literature has shown that suppression has some risks if used in maladaptive ways, resulting in long-term harm on the emotional, physiological and behavioral well-being of the person (Thompson, 1994). Thus, enhancing competency to regulate emotions prior to generating a response seems to be more effective.

4. Context

The research described in this paper is part of a larger study that investigated the use of technology to facilitate online problem-based learning (PBL) activities in an international group of medical students and facilitators (see Lajoie et al., 2015). PBL (Hmelo-Silver & Barrows, 2008) is a special inquiry-based approach that supports knowledge co-construction through guided problem-solving activities with the aid of a facilitator that guides the discussion towards achieving the goal of the learning session. The medical curriculum covered in the PBL was related to effectively delivering a cancer diagnosis to a patient.

In the context of this study, technology (i.e., Adobe Acrobat) was used to bring together the international group of participants. Web conferencing software supported the groups' synchronous video interactions and shared applications. The case scenario recreated a triadic interview in which the patient was a native Farsi speaker who could not understand English, and was accompanied by a hospital-assigned official translator. The standardized patient (SP) was trained by a physician-educator participating in this research, portraying an actual patient as accurately as possible (showing emotional reactions including questioning behavior, crying, and concerns about death). The benefit of the aforementioned set up was that indirect multicultural communication would increase the difficulty of the task for all and would increase opportunities for emotional arousal and regulation.

5. Research questions

The focus of our analysis is centered on observations of bad news delivery to identify ER strategies. The process model of ER (Gross, 1998b) was used to identify intrinsic and extrinsic ER strategies applied by the medical students in delivering cancer news to an SP. Our research question is: Do medical students change their ER strategies from pre- to post- PBL intervention? We describe the intervention in the methods section below.

6. Methods

6.1. Participants

Four medical students, two from a Canadian university and two from a Hong Kong university (3 males and 1 female, average age 25 years old), with approximately 2.5 years of medical education were recruited through university email and medical list-serves as volunteers. One experienced male physician-educator from Canada and one from Hong Kong participated in the intervention sessions. A standardized patient (female, 26 years old) and two translators (1 male, 28 years old and 1 female, 26 years old) were conscripted for the interview sessions. Ethics approval was obtained from both universities, and informed consent was collected from all participants for using audio, video and text data.

6.2. Procedures and materials

Data collection spanned over five consecutive days and consisted of two individual practice sessions with a standardized patient (SP), two PBL sessions, and a final debriefing session (Fig. 1). All of the sessions were supported through web-conferencing

software called Adobe Connect 9. For the purpose of this paper we concentrate on the data from day 1 and 4.

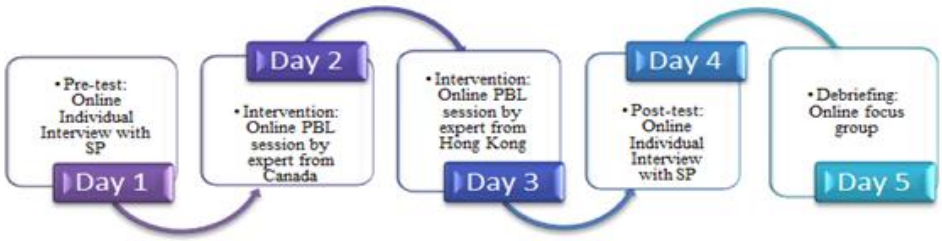

Fig. 1. Data collection sessions and activities

The learning sessions were designed to provide practice of communicating emotionally-sensitive issues, and to give multiple perspectives on how best to deliver bad news to patients. Based on participants' post-reflection notes, the learning context presented significant emotional load on participants. Apart from the difficulty of communicating important undesired news to a patient, this tenseness was due to: (a) the cultural diversity of participants; (b) the indirect communication with the patient through a translator; and, (c) dialogue through a technology-based platform rather than face to face.

6.3. Pre- and post- test

The pre and the post-test consisted of two online individual interviews with the SP that were performed before and after two online PBL sessions. The cancer news that was to be delivered to the patient was Hodgkin's lymphoma, cancer of the lymph nodes that form part of the immune system (Parham, 2005). The pre-and post-tests were identical, but the translator in the pre-test was a male and, in the post-test, a female. The cases provided an equally unique context for both cross-country examinations between Canada and Hong Kong. Each student was given the same instructions for the SP: "Mrs. Mehri is a 30-year-old unilingual Farsi-speaking woman who underwent a biopsy last week of a lymph node on the right side of her neck. She was told by her doctor to come in to clinic today to be given the results of the biopsy. Mr. Amir has accompanied her as a Farsi translator. Her doctor is unavailable at this time. Your task is to give Mrs. Mehri the results of her biopsy. The biopsy report reveals Hodgkin's Lymphoma".

Participants went through a general procedure of initiating the session, explaining the unfavorable news, and closing the session (Silverman et al., 2005). Initiation consisted of starting with an introduction, identifying reasons of the consultation, and gathering information from the patient. Explanation referred to providing information on the news and empathizing. And, closure included forward planning and ending the session.

6.4. Intervention (PBL sessions)

The PBL intervention sessions facilitated students through collaborative group work in their understanding of communicating bad news to the SP. They reviewed two video cases on communicating positive HIV results, one from a Canadian context (first PBL session) and one from a Hong Kong context (second PBL session), each facilitated by a physician from the respective country. Additionally, a PBL expert synchronously

supported the two instructors during the PBL sessions through a private chat window in Adobe Connect, which medical students could not view. Both medical instructors used a SPIKES model (see Table 1) to illustrate best practices for communicating bad news. SPIKES is used for disclosing unfavorable health related news with a clear emphasis on teaching techniques, helping physicians respond appropriately to the emotional reaction of patients (Baile et al., 2000).

Table 1
The SPIKES protocol (Buckman, 2005; Fishel & Hochman, 2009)

Category	Explanation
Setting	Planning and arrangements in order to deliver bad news
Perception	Evaluation of patient perception about the medical situation
Invitation	Assessment of patient's desire for information
Knowledge	Providing appropriate medical information
Empathy	Acknowledgement of patient's emotional reactions
Strategies & Summary	Strategizing and summarizing proceeding follow-up activities

In the PBL sessions, students were to: (1) Identify difficulties in communicating bad news; (2) search for an approach to giving bad news; (3) use that approach to analyze a sample video of bad news delivery; and, (4) discuss and reflect on how the use of that approach may have to be changed in response to context, culture, and language barriers. For the purpose of the present study, we focus only on trajectories of change of the online practice activities with the SP day 1 and 4.

6.5. Adobe Connect 9

Adobe Connect 9 was used as the TRE (Fig. 2) and data were collected in two laboratories (Canada and Hong Kong). The same procedures were followed in both universities. Each participant was located in a different room and interacted with the other students only through Adobe Connect 9. The Adobe Connect 9 interface could only be modified by the instructors and researchers who could chose to add elements such as note/chat windows, play videos, and share files. Using icons to raise hands to speak, to show agreement or disagreement during the meeting, or request that someone speaks louder or slower, facilitated participation. The software's recording capabilities allowed for independent records of all content sources (audio, video, chats, and notes).

7. Data sources and analysis

Data were collected through time-stamped video-screen captures of the Adobe Connect sessions between an assigned medical student, patient and translator, in two stages (pre-test and post-test); resulting in two interviews per participant resulting in eight interviews in total. The activity required that the medical student meet the standardized patient and tell her the test results, confirming that the patient had Hodgkin's Lymphoma. After the post-test, participants' reflections of their pre and post videos with the SP were collected to capture subjective self-reports of their emotional experiences (Mauss & Robinson, 2009) when managing their interactions with the patient.

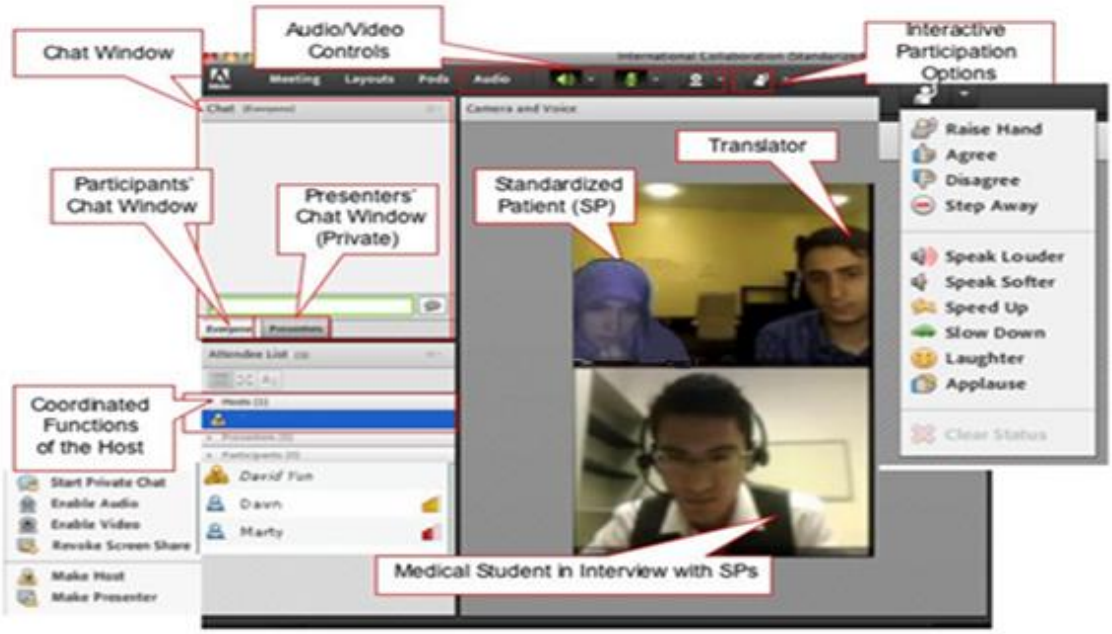

Fig. 2. Description of features of Adobe Connect 9

All three stages of the interview (i.e., initiation, explanation, and closure) were analyzed: (a) the initiating stage was analyzed to identify the baseline for emotion coding (since bad news had not been delivered yet); (b) the explanation stage where the diagnosis was given was regarded as the emotional peak for both student and patient since this is the main part of communication; and, (c) the closing stage when the medical student tried to provide support to the patient and close the session effectively through regulation of the standardized patient.

Approximately two hours of video records per participant (one-hour pre and one-hour post-test interview) were collected and transcribed verbatim (word by word) and behaviorally (including non-verbal expressions). The interview data were coded using a coding scheme developed from ER and coping literature then quantified to look for patterns of change in students' application of regulatory strategies over the two days. The transcripts were initially segmented into "units of meaning" (Pratt, 1992). Units of meaning are segments that contain part of a sentence, one sentence or more than a sentence, representing an idea or a single meaning without any limitation on the length (Butterworth & Beattie, 1978). Meaning units were inductively coded (Chi, 1997) based on multiple emotional verbal and non-verbal channels (Mauss & Robinson, 2009). Video analysis (Derry et al., 2010) was used to time stamp ER codes at a fine-grain size documenting both verbal and behavioral patterns expressed by participants. Verbal utterances (either in the form of a word, sentence, or paragraph) and behavioral expressions were divided based on meaning units. In this event, meaning units would signify any kind of change in emotion representation based on verbal, vocal and/or motor expressions. These codes were then quantitatively analyzed to examine the extent to which the ER strategies (Gross, 1998b) evolved from the pre to post interview sessions. The determination of an emotional state was done through manual coding. Manual video coding required a significant amount of time (approximately 15 minutes for 1-minute

video). The focus of the coding and analysis was on the medical student in dialogue with the SP. Table 6 shows a summary of emotion expression channels (verbal, vocal, behavioral) indicating evidences of IER. The SP provided the context to understand the reactions of the medical student and the ongoing conversation. Frequency counts of the ER strategies applied by the participants and the SP were obtained and graphically represented in order to examine trajectories of change from pre to post, and also to view which strategies were most prominently used by the participants.

7.1. The multimodal measures of emotion

For the purpose of this study, attention tendencies, vocal characteristics, and motor expressions were chosen as indicators of emotion (Scherer, 2005; Mauss & Robinson, 2009; Calvo & D'Mello, 2010) as well as verbal utterances containing emotional cues. These channels were chosen since they could be coded manually without requiring machine coding via costly software, and could be analyzed real-time within common authentic contexts.

Motor expressions referred to facial clues and body motions which included codes based on: (a) Facial expressions (Mauss & Robinson, 2009) such as smiling, frowning, raising eyebrows, gazing eyes, becoming upset and crying; (b) general motor behaviors such as nodding, shaking head, leaning head on hand, covering face, expressing with hands or head movements, changing position, and playing with lips; (c) looking at physician/patient, looking back and forth and looking away; and finally (d) activation and withdrawal indicating the dimensional perspective of an emotional state (Mauss & Robinson, 2009). Activation in this context refers to sitting upright or leaning in with eyes focused at a specific point. The three different levels of activation are illustrated in Fig. 3.


(a) Not activated.


(b) Moderately activated.


(c) Highly activated.

Fig. 3. Levels of activation

Attention (action) tendencies refer to states of readiness to act in a particular way when confronted with an emotional stimulus, e.g. "approach" is associated with "desire" (Frijda, 1987). From the perspective of attention tendencies, the participant's/patient's direction of face and verbal utterances were coded simultaneously. These included attention towards physician/patient, attention away from physician/patient, attention self-centered and information search. As an example when the SP said: "How can I have that disease?" the participant answered: "Well, that's a good question" which can simply be coded as "attention towards patient", but with expanding our viewpoint to the participant's nonverbal cues, i.e. facial direction, which in this case was "looking down while speaking", we can more accurately code this segment as "information search".

Vocal characteristics, or the implicit paralinguistic features of speech, provided an enriching passage to infer the emotional and thereby the ER state of the participants. Subcategories of vocal characteristics (voice frequency analysis and voice amplitude) were established based on theory (Scherer, 2005; Bachorowski, 1999) and observational notes; including silence, normal voice, voice volume increased/decreased, voice pace increased/decreased, voice trembling, assertive voice (activated) and speaking hesitantly (unconfidently). Coding was initially based on speech analyzing software, named icSpeech Analyzer (http://rose-medical.com/speech-analyzer.html) and via analysis of waveform graphs. Waveform analysis gave information regarding vocal pitch. Based on literature (Bachorowski & Owren, 1995; Kappas, Hess, & Scherer, 1991) vocal pitch was used to assess the level of emotional activation experienced by the participants; i.e. higher levels of activation were linked to higher-pitched vocal samples. Voice amplitude was also used to assess loudness of the speech. The initial set of data (one interview) was compared with manual coding of two individual coders. However due to high consistency of the codes but the time-consuming procedure of speech analysis using waveform graphs, as well as limited access to the software, further cases were only coded based on manual detection. It should be noted that "normal voice" was categorized based on the initial stage of each interview (gathering data) as the baseline to infer codes since unfavorable news was not yet communicated.

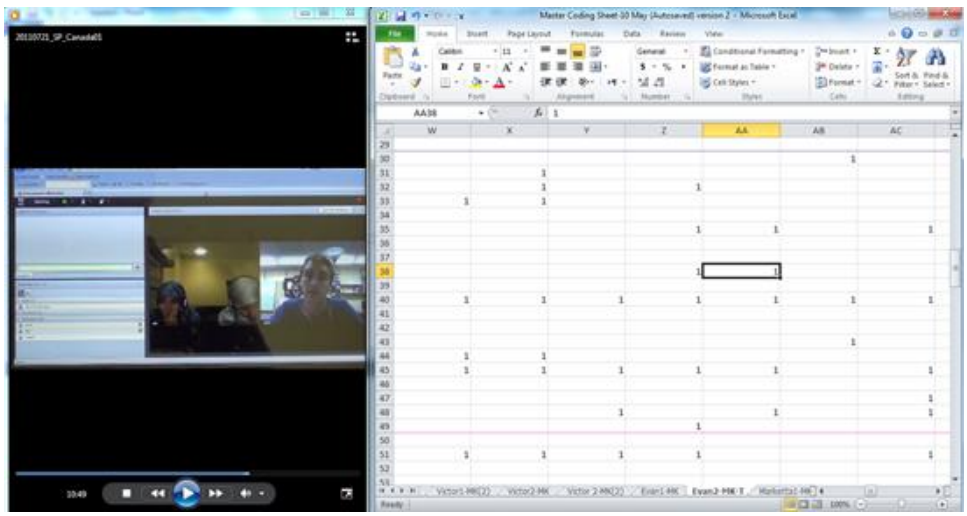

Fig. 4. Recording codes in an excel sheet according to occurrence

An example of speech analysis would be when the participant said: "…unfortunately you have a disease…" which had a low pitch and amplitude was coded

as "speaking hesitantly" since it converged with other non-vocal cues such as "eyes looking up and down" and "becoming activated". Fig. 4 illustrates how codes were documented. Using an Excel spreadsheet, any occurrence of an emotional state was recorded in a binary fashion (1 referring to occurrence and no code representing no occurrence).

Table 2 presents a summary of the multimodal emotion representation channels and their sub categories that were used to code units of analysis.

Table 2
Emotion representation channels (Scherer, 2005)

Emotion Modality	Description	Subcategories
Attention Tendencies	Direction of attention	Attention towards/away from
		Information search
Vocal Characteristics	Implicit paralinguistic	Pace (normal/slow/fast)
	features of speech	Amplitude (normal/low/high)
		State (trembling/crying/hesitant)
Motor Expressions	Facial and bodily motions	Facial clues
		(smiling/crying/frowning)
		Body motions (nodding/shaking
		head/covering face/hand
		movements)
		Arousal (activation/withdrawal)
Verbal Utterances	Explicit verbal statements	[No categories] Emotion stems

In order to increase the validity of the analyses, the above channels of emotional behavior were all coded with two individual coders and Pearson's correlation coefficient was calculated to obtain an inter-rater agreement percentage of 74.6.

In the second stage, in order to infer instances of intrinsic/extrinsic ER strategies, a theory-driven coding scheme of ER was developed based on the Process Model of ER (Gross, 1998b). Data were coded using indicators provided in the form of action units (AUs) and key words/phrases under each category of ER: situation selection, situation modification, attention deployment, cognitive change and response tendencies. These indicators served as an outline to analyze the data. In a further detailed analysis, the subcategories were once again broken into smaller units. Items from the Cognitive Emotion Regulation Questionnaire (CERQ) were modified from the relevant subscales (Garnefski & Kraaij, 2007) to match the context of this study via adaption of the root of the questions to focus on emotion regulation in receiving or delivering bad news. Additional items were derived from coping literature (Skinner, Edge, Altman, & Sherwood, 2003, p. 223-225) in order to provide a more comprehensive layout of emotion regulation strategies within Gross' ER model (Gross, 1998b). Table 3 lists the intrinsic and extrinsic ER codes in a concise format.

Using this coding scheme and the multiple emotional (verbal and non-verbal) channels, a gateway to a more contextualized analysis was achieved in order to infer instances of emotion regulation; either intrinsic (physician and patient) or extrinsic

(physician). In other words, after the two coders coded each video session based on verbal and non-verbal characteristics, they coded emotion regulation instances once individually and then together to calculate: (a) medical student's intrinsic emotion regulation (IER) to regulate self-emotions, and (b) medical student's extrinsic emotion regulation (EER) strategies to regulate the patient's emotions. The coders' inferences about ER (intrinsic/extrinsic) were compared with each corresponding case's self-reflection notes for increased validation. This coding scheme was designed with the aim to develop a non-self-report and inductive measurement scale of evidences of intrinsic/extrinsic ER strategies. This scale is further presented in the Results section.

Table 3
Intrinsic and extrinsic ER strategies (IER & EER)

Category	IER Subcategory	EER Subcategory
1. Situation Selection	Denial	Enabling acceptance
	Acceptance	Keeping appropriate distance
	Self-isolation	Arranging privacy
2. Situation Modification	Turning to religion	Referring causality away from patient
	Rumination	
	Seeking instructional support	Providing instructional support
	Seeking empathetical support	Providing empathetical support
	Seeking empathetical support	
3. Attention Deployment	Self-distraction	Distracting
	Concentration	Concentrating
4. Cognitive Change	Optimistic refocusing	Optimistic refocusing
	Positive reappraisal	Positive reappraisal
	Catastrophizing	
5. Response Modulation	Venting emotions	Easing venting of emotions
	Restraining	Easing suppression of emotions
	Suppressing	

Following is an elaboration of coding using the multimodality approach: The physician smiled while introducing himself whereas the patient looked tense. The physician's face changed quickly from smiling to rather serious (focusing eyes, looking tense and activated) but his tone of voice remained normal resulting in a discrepancy between two emotion expression channels (normal voice and tense face), which was thus coded by two coders as an attempt to consciously or unconsciously regulate intrinsic emotions by suppressing tension: "IER – response tendencies – suppression". Post-reflection notes of the physician also approved the code: "This was my first time meeting this patient, and she looked very anxious. Therefore, I become more nervous and wanted to make careful choices of words in the consultation" (Fig. 5).

A noteworthy point is that the five ER strategies are not necessarily chronologically ordered, and units of analysis can be multi-coded simultaneously.

 at 29.58’  at 30.13’

Fig. 5. Physician smiling initially, but noticing patient’s tenseness, becoming serious

8. Results

Each student-SP interview session is referred to as a case. Quantitative frequency counts of non-verbal behavior of each participant are provided to answer the research question: “Do ER strategies applied by the medical students change between pre- and post-test as a function of the PBL intervention stages?” Also, a complete table of all intrinsic and extrinsic ER strategies (applied by each medical instructor) is provided to summarize the findings. For ethical purposes, pseudonyms (alphabetical letters) are used to refer to the four medical students (A, B, C, & D), each further divided into pre and post-test.

8.1. Pre-post comparison of participant A

In order to have a comparative point of view of participant A from pre to post, a quantitative frequency count of attention tendencies, voice and motor expressions was obtained and the following graphs demonstrate the difference from pre to post. Fig. 6 shows increases in attention tendencies of participant A from pre- to post-test. Fig. 7 demonstrates changes in the voice quality of participant A, and Fig. 8 represent changes in motor and facial expressions of participant A.

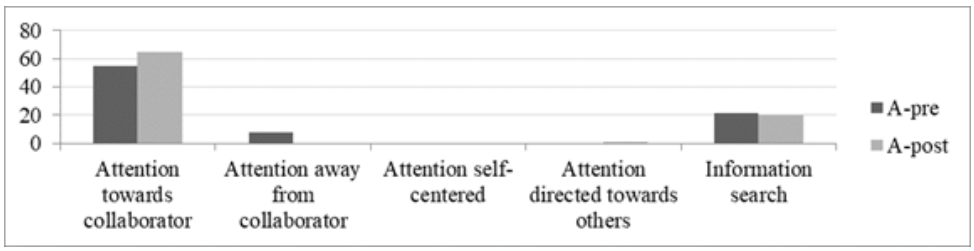

Fig. 6. Attention tendencies of participant A, comparative point of view from pre to post

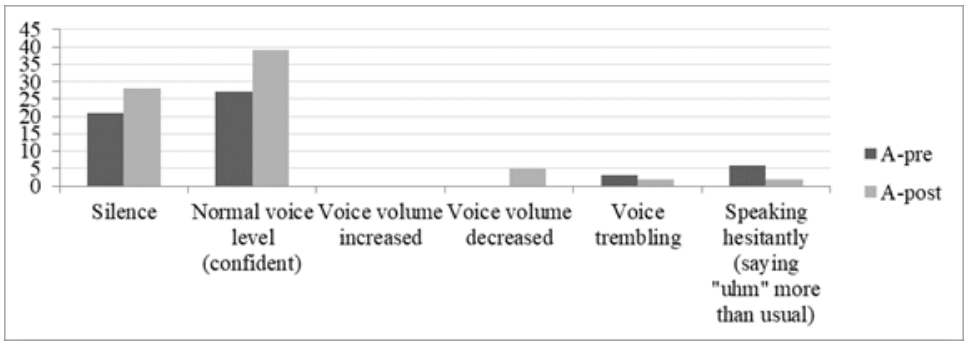

Fig. 7. Voice quality of participant A, a comparative perspective from pre to post

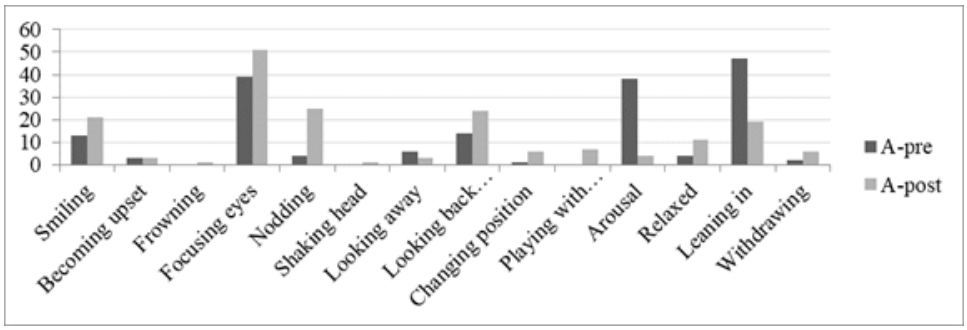

Fig. 8. Motor expressions of participant A, a comparative perspective from pre to post

Based on Fig. 7 and 8, the higher instances of normal voice, lower levels of trembling voice, and fewer instances of arousal in medical student A, illustrate his increased confidence in post than in pre. Fig. 9 shows that A was more efficient at extrinsically regulating the patient in post-test and had more instances of intrinsically regulating himself.

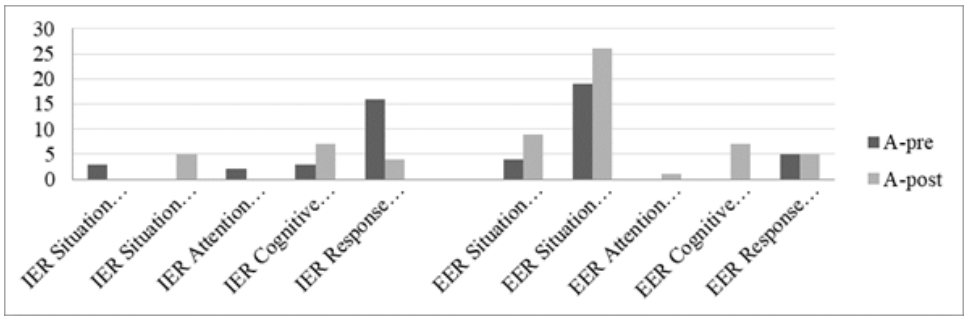

Fig. 9. IER and EER frequency counts of participant A

8.2. Pre-post comparison of participant B

The following quantitative representations demonstrate changes in participant B's emotion expression and regulation from pre to post-test. Fig. 10 illustrates that the physician is more attentive to the patient in pre than post; while in post, he is looking for more information (at notes).

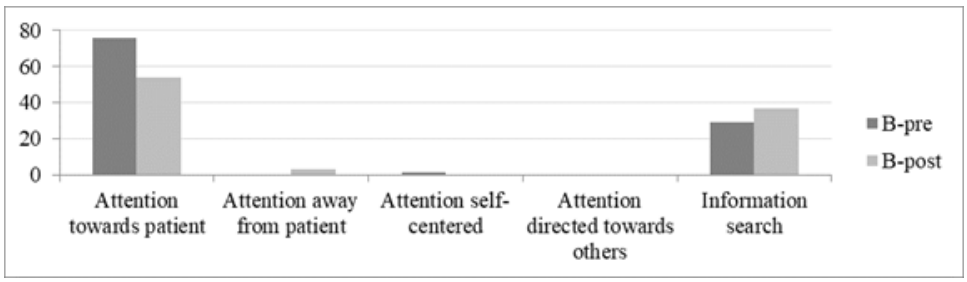

Fig. 10. Attention tendencies of participant B, a comparative point of view

Fig. 11 describes that B expresses less hesitation and lower voice pace in the post interview. As illustrated, B-post has a greater frequency of lowering the volume of his

voice in the post interview while he was sympathizing with the patient. There are also more instances of normal voice in post-test in comparison to the pre-test, which may be an indication that he had become more confident in managing the session.

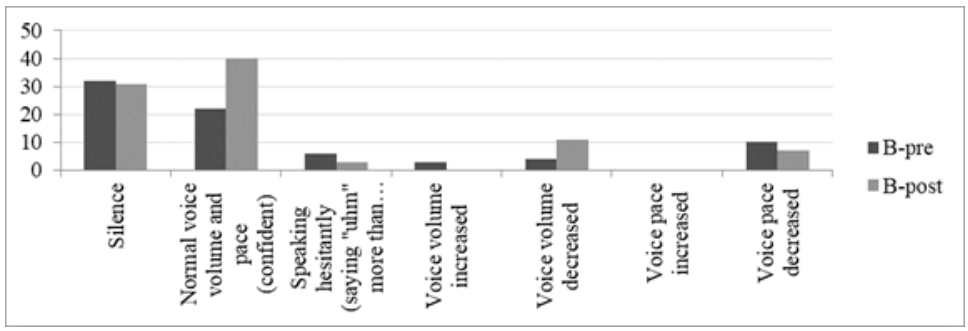

Fig. 11. Voice quality of participant B, a comparative point of view from pre to post

Fig. 12 is a rich representation of behavior changes from pre to post. As the figure illustrates, the level of arousal in post is much less than in pre. This is also visible for the frequency of "leaning inwards to the screen" and having eyes more focused on the patient or translator. As described before, changing position, which is also an indicator of emotion regulation (intrinsic), has occurred less in post than pre. Fig. 13 shows changes in IER and EER from pre- to post-test in participant B.

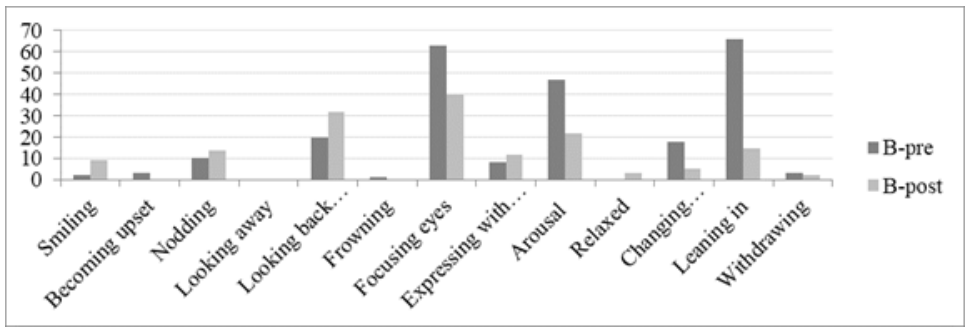

Fig. 12. Motor expressions of participant B, a comparative perspective from pre to post

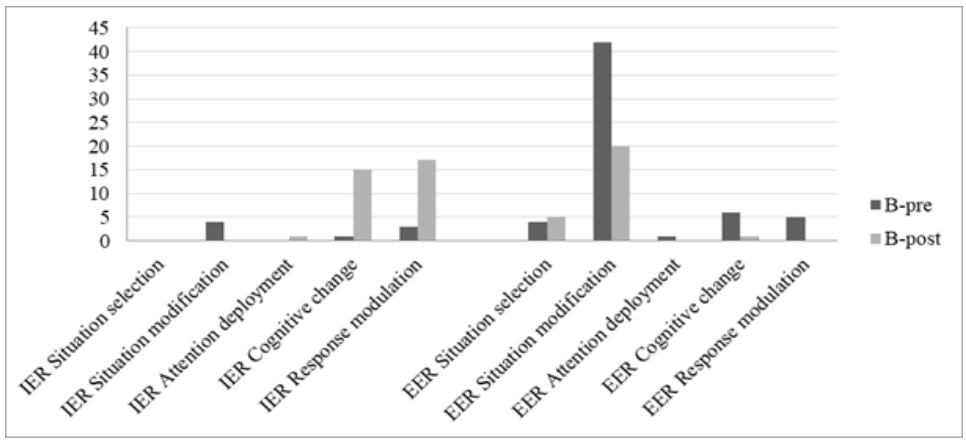

Fig. 13. Frequency counts of IER and EER in participant B

8.3. Pre-post comparison of participant C

Participant C improved from pre to post in his communication strategies and expressed more concern and empathy while communicating with his patient. The following quantitative representations (Fig. 14 and 15) help demonstrate changes in emotion expression regulation and voice quality from pre to post test.

Fig. 14. Attention tendencies of participant C, a comparative point of view from pre to post

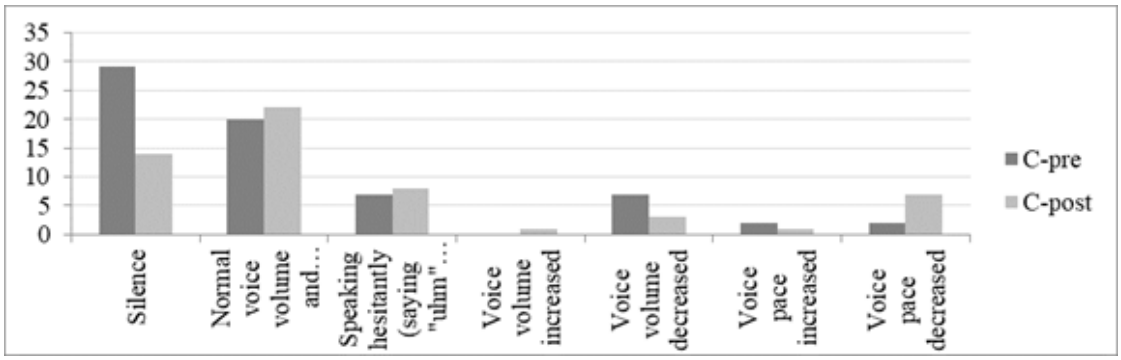

Fig. 15. Voice quality of participant C, a comparative perspective from pre to post

Motor expressions increased over time from pre to post (see Fig. 16). These changes may demonstrate a gain in confidence over time. Fig. 17 provides a comparison of IER and EER strategies of participant C from pre- to post-test.

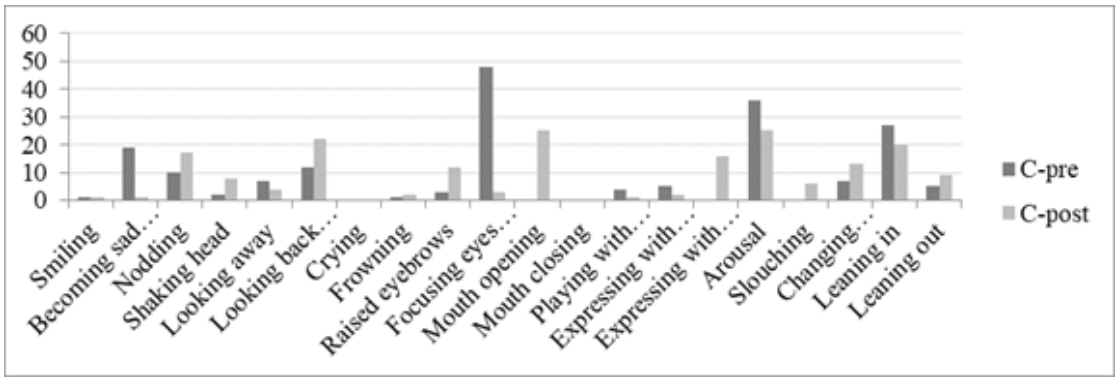

Fig. 16. Motor expressions of participant C, a comparative perspective from pre to post

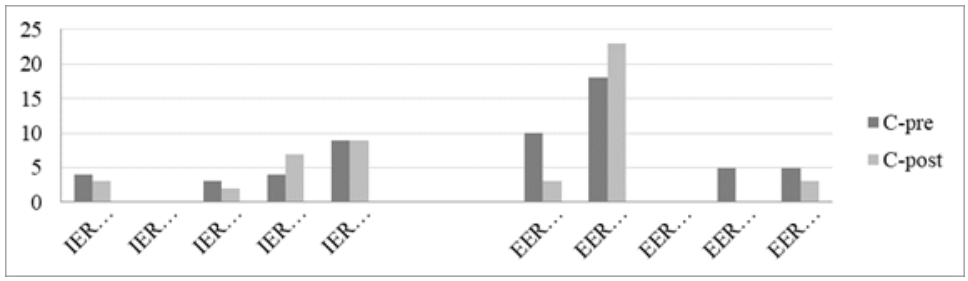

Fig. 17. Pre-post comparison of ER in participant C

8.4. Pre-post comparison of participant D

Overall, D expressed more nonverbal expressions e.g. nodding, shaking head, raising eyebrows, leaning inwards in her post-test (see Fig. 18). Compared to D-pre, there was an increase in her efforts to express feelings toward her patient.

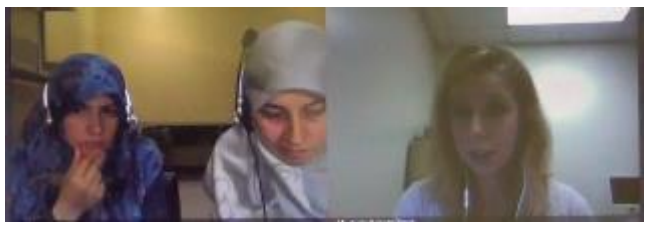

Fig. 18. D-post raises eyebrows, leans in and speaks with a low-volume voice as she begins to explain the results

The quantitative analyses help demonstrate changes from participant D's pre to post in emotion expression and regulation. Fig. 19 shows decreased voice volume and pace, and also moments of silence in participant D from pre- to post-test.

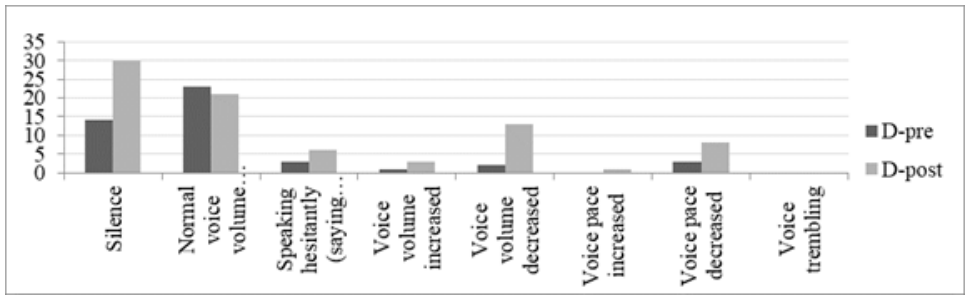

Fig. 19. Voice quality of participant D, a comparative perspective from pre to post

Fig. 20 provides a comparison of attention tendencies from pre- to post-test. As can be seen D demonstrated an increase in attention towards the patient and information change from pre- and post-test.

Based on Fig. 19, D-post is expressing more instances of hesitation in speech, decreased voice volume (due to sympathizing/rumination), and decreased voice pace. This is again in concordance with D-post's goal to externalize emotions. She is also more silent and allows the patient to express her feelings more.

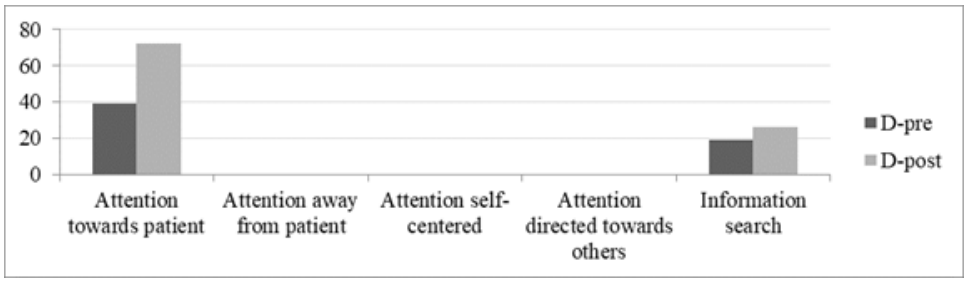

Fig. 20. Attention tendencies of participant D, comparative point of view from pre to post

As evidenced in Fig. 21, nodding and expressing sadness are more frequent in post than in pre-test, which show that D-post attempted to express more of her feelings to sympathize with the patient. Activation, leaning in and focusing eyes have also occurred more in post than pre, which show that the physician was trying to show her attention to the patient. Fig. 22 provides a comparison of IER and EER strategies of participant D across the two sessions.

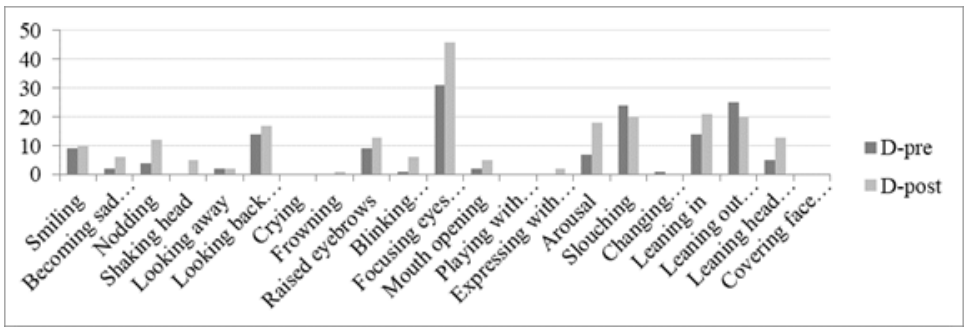

Fig. 21. Motor expressions of participant D, a comparative perspective from pre to post

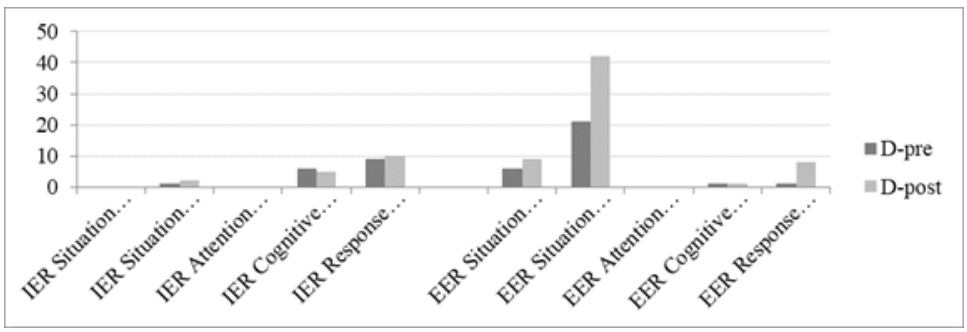

Fig. 22. Comparison of IER and EER strategies of participant D

8.5. Cross case comparisons

Hereafter, we provide a cross case comparison of different channels of emotion expression, followed by a cross-case analysis of the ER strategies used across the participants. Table 4 provides an account of time used for each session regarding the three different stages of each session. The most noticeable changes were increase in time for session initiation, and a decrease in time for explaining bad news.

Regarding attention tendencies (Fig. 23), all participants focused mainly on the patient, followed by a shift of attention toward information search. As the results suggest, information search is more frequent in post than in pre of all participants.

Table 4
Time used to deliver bad news from initiation to explanation and closing the session in pre and post-intervention stages

Medical Student	Initiating the session		Explaining bad news		Closing the session	
	Pre	Post	Pre	Post	Pre	Post
A	02.07	03.32	07.30	4.54	01.01	02.01
B	02.24	04.43	11.51	4.44	03.56	03.27
C	01.09	01.06	09.23	06.39	03.01	01.32
D	01.07	04.16	04.18	05.45	03.58	08.16

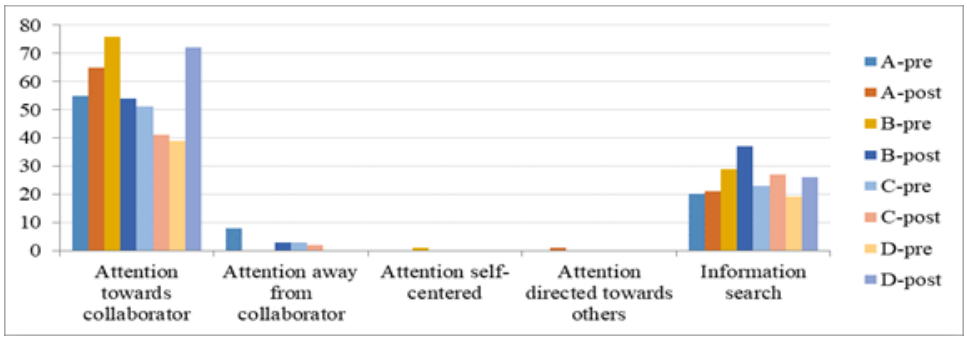

Fig. 23. Cross-case comparison of attention tendencies

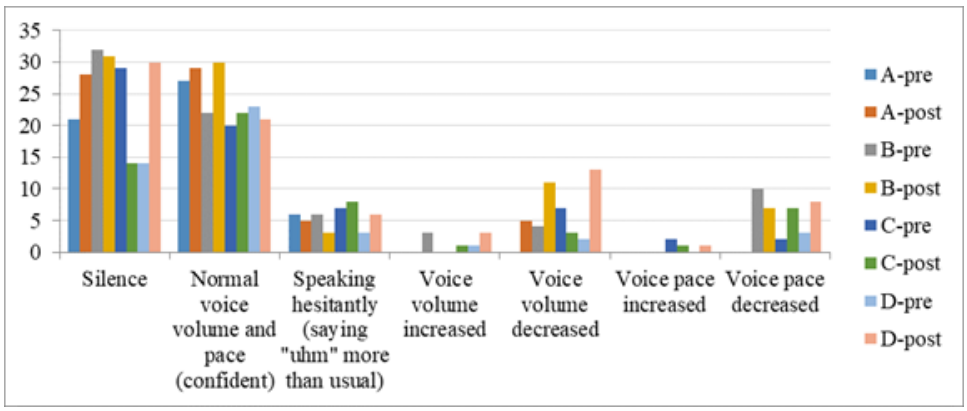

Fig. 24. Cross case comparison of vocal characteristics

Based on Fig. 24, fewer instances are coded for voice volume and voice pace *increase*, while voice volume and voice pace *decrease* have more often been observed. Hesitation in speech is more in A-pre and B-pre than A-post and respectively B-post; but C-post and D-post have more hesitation than C-pre and D-pre.

Fig. 25 shows a cross-case comparison of motor expressions. It is interesting to see that nodding and looking back and forth have increased from pre to post in all participants. Activation and leaning inwards have decreased from pre to post in three participants, except for participant D, which expressed more in post. Cognitive change has decreased from pre to post in all four participants, however response modulation has increased (mainly suppression) from pre to post. Situation selection and modification have also mainly increased from pre to post.

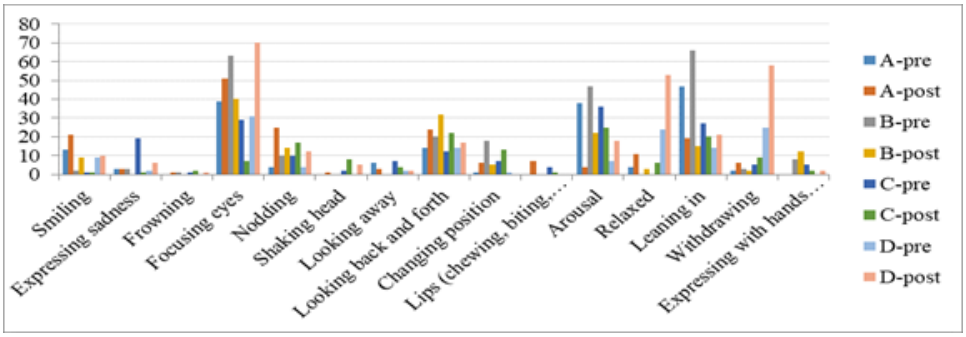

Fig. 25. Cross case comparison of motor expressions

Fig. 26 provides a cross-case comparison of IER and EER strategies applied by the four participants. Situation modification was the most frequently used, and attention deployment was least used EER strategy across all participants. Response modulation was the most frequent and attention deployment was the least frequent IER strategy used across all of the participants.

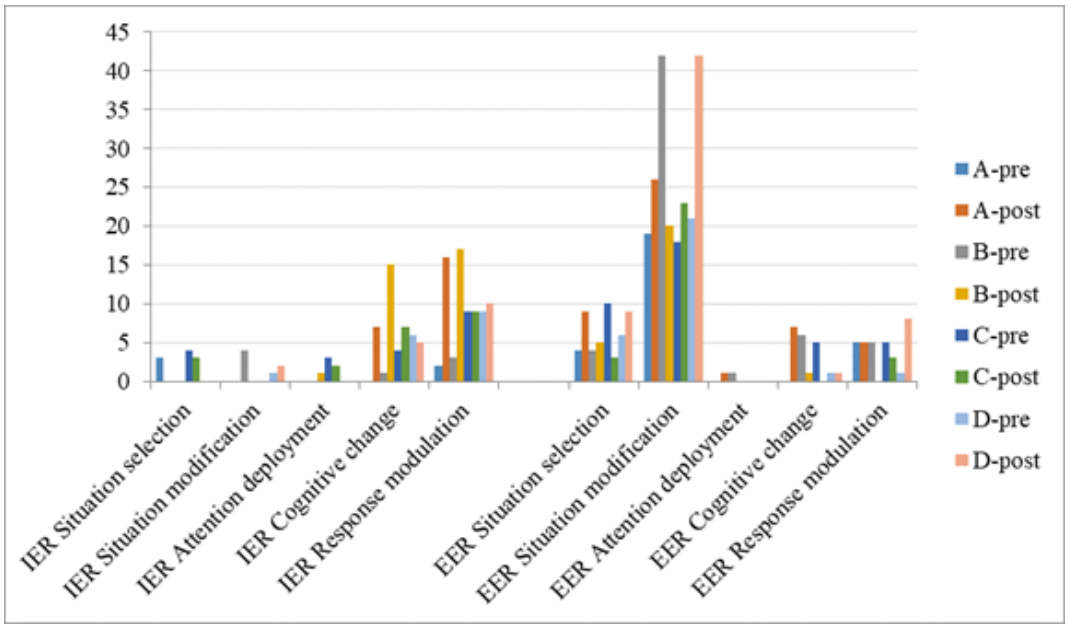

Fig. 26. Cross case comparison of intrinsic (IER) and extrinsic (EER) emotion regulation strategies

9. Conclusion

We anchor the discussion of the results on the main research question of the study: Do medical students change their ER from pre to post-test? (It should be noted that our focus was not to evaluate the effectiveness of the intervention stage).

The results showed that after the PBL sessions medical students shifted their focus from elaborating in the explanation stage to initiating and closing the session. The initial and closing parts of the session are geared toward the emotional needs of the patient. When the medical student shifts attention towards these sections it is indicative of the students' raised awareness of the importance of empathizing with and externally regulating the patient.

Three motor expressions, focusing eyes, activation, and leaning in, tended to occur together and were more frequently observed in pre-test sessions of the four participants. These codes revealed the extent of alertness of a participant and the level s/he was engaged in the task of bad news delivery. Hesitant speech and changing position on seat, an indicator of intrinsic ER, also occurred more in pre-test than in post-test.

On the other hand, evidence of positive reappraisal of the situation was illustrated by students pressing lips together and nodding more frequently in the post as comparison to pre-test. Intrinsic ER instances were less visible in the post-test participants, which might be because emotional inducers were less frequent. The fewer emotion provoking instances in post-test might be explained by the fact that the procedure of data gathering remained the same. Therefore, the participants were more acquainted with the multicultural, bilingual TRE session, as well as the task itself (knowledge about Hodgkin's Lymphoma and effective communication skills) and learned how to better communicate bad news through the PBL intervention.

Medical students were more attentive to the patient in pre than post; while in post-test, students looked back and forth at the screen more often. Specifically, their attention tendencies were downwards towards the notes taken from the PBL sessions. This shows the students' dependence on these notes, especially during translation times.

The cross-case comparisons indicated two main attention tendencies throughout the eight sessions: attention towards the patient and information search. The most important method of empathizing is attending to the person in need (rather than attending elsewhere) and looking directly at him or her (Cole, Gellatly, & Blurton, 2001).

The motor expression cross cases analysis indicated nodding and looking back and forth increased from pre to post in all participants. Activation and leaning inwards decreased from pre to post in three participants; participant D expressing more in the post-test. The common decrease could be explained by the intervention effect of the PBL sessions where participant D realized the necessity of empathizing with the patient.

Analysis of the vocal characteristics revealed a decrease in voice volume and pace by all participants. As described earlier, decreased voice volume is associated with attempts to empathize with the patient, and decreased voice pace refers to participants IER—rumination. Interestingly, the frequency of using "decreased voice volume" dropped from pre to post, which might be explained by participants' familiarity with the scenario in the post-test. These findings augment our understanding of the differences among the different channels of emotion regulation. An interesting observation was the relative power of voice, compared to other channels (such as attention tendencies, posture), as a unique channel to regulate emotions. This is in line with the findings of Calvo and D'Mello (2010), that among the various emotion regulation channels, posture

had the least flexibility related to controllability of emotions. Additionally, we contend that voice assumed an important role out of the different channels in the emotion regulation mechanism. As an example, in participant D, we saw that although the participant used emotion-expressive embodiments (leaning inwards, making eye contact, etc.) her voice was normal and confident, which overall was not effective in empathizing with the patient. In another instance however, D could express sympathy through her voice (decreased volume) although not leaning inwards and not looking at patient.

Observational ER detection methods yield an important approach to analyze participants' communication skills and demonstrate the individual differences in each participant learning and emotion regulation strategies. For instance, these techniques demonstrated the manner in which participant D increased her ability to extrinsically regulate the patient showing improvements in her communication skills. Participant B, on the other hand decreased in EER as well as IER application. This decline however, was not necessarily a negative outcome since B expressed over-empathetic responses in the pre-test. Participants A and C increased in EER strategies as a result of the discussions in the PBL sessions, although their IER strategies decreased. Again, the decrease in IER strategies at post-test might be due to familiarity with the context that reduced emotional triggers and led to fewer instances in need of intrinsic regulation.

The pre-tests revealed that the most frequent IER was response modulation with the subcategory of suppression and common EER was situation modification with the subcategory of providing empathetic and instructional support. IER suppression occurred when medical students were trying to hide their uncertainty in delivering information to the patient (main cause) or they were trying to hide non-corresponding emotions (e.g. smile). Gross (1998a) found considerable evidence that antecedent strategies result in more effective regulation outcomes than response-focused strategies. There is, however, variation between the impact of antecedent-focused ER strategies. In this present study students attempt to modify the situation rather than distract their attention by deploying it elsewhere. This strategy is a necessity for helping patients face stressful situations to plan further follow-up sessions and discuss treatment options. In serious situations such as these, action is needed to control an emotion provoking stimulus. If an emotional stimulus paralyzes an individual and action is not taken disastrous outcomes may occur; i.e. when physicians cannot control a deteriorating patient (Wiseman & Snell, 2008), when firefighters cannot control a widespread fire (Scott & Myers, 2005), and in avionics when a pilot cannot divert a crashing airplane.

9.1. Implications

The efficacy of convergence of multi-modal emotional response systems is still lacking. Correlations among multiple measures of emotion are moderate at best and inconsistent across studies (Barrett, 2006; Ruch, 1995; Russell, Bachorowski, & Fernández-Dols, 2003). Mauss and Robinson (2009, p. 228) offered three explanations and implications for the dissociation of emotional channels: (1) "The construct of emotion cannot be captured with only one measure considered alone. (2) Dissociations among different measures of emotion may be relatively normal rather than necessarily reflective of a dysregulated system. In this context, research that examines the mechanisms that mediate and explain particular response-system dissociations will be particularly useful. (3) Third, there are likely to be moderator variables that affect convergence across measures of emotion (Fridlund, Schwartz, & Fowler, 1984; Lacey, Bateman, & Vanlehn, 1953; Picard, Vyzas, & Healey, 2001). If this is the case, then a more idiographic approach would be necessary to understand the nature of emotional response coherence".

Differences in emotion channels have spurred researchers to attempt to converge emotion signals. However, Campos, Frankel, and Camral (2004) challenge research approaches that attempt to look for the coherence of emotional response indexes, suggesting instead that coherence of emotional behavior is neither typical nor expected in studies of emotion regulation. Such tried and tested attempts in this line of research have yielded inconsistent results; thus, we contend that workable solutions may lie elsewhere. Research requires understanding the nature of emotional responses to ascertain if such responses should be coherent or if a discrepancy between elicited signals is normal. The idea of *evaluation* and *modulation* of response tendencies before expression, based on Gross' (1998b) consensual process model of emotion generation (Fig. 27), is, we contend, the key missing piece of the process that needs to be implemented in models to lead to more valid systems of emotion detection. Such efforts, then, need to be pursued rather than attempting to converge emotional signals.

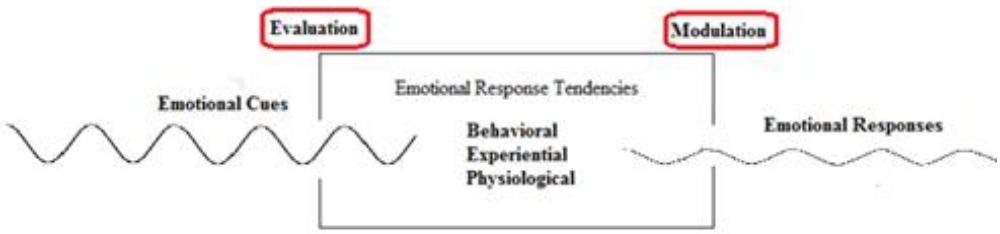

Fig. 27. A consensual process model of emotion generation, Adapted from Gross (1998b).

9.2. Co-occurrence of multimodals – Intrinsic and extrinsic ER inferences

The results of the multimodality analysis of emotion data in this study revealed some noteworthy co-occurrences, which could be used to recognize IER in a similar context either from the lens of an individual for enhancing social communication, or as a model framework to be implemented in affective computing systems to improve user-interface interactions. Intrinsic ER denotes those strategies that are applied to *self*-regulate emotions. Some examples of co-occurrence are worth mentioning: (1) "Decreased voice pace" was commonly associated with "rumination", as in the case where a physician was doubtful about his statements and thinking as he spoke; (2) "decrease in voice volume" occurred mostly while the physician was sympathizing with the patient.

As a means to provide a comprehensive overview, Tables 5 and 6 list the intrinsic and extrinsic ER strategies introduced to complement the multiple emotion channels co-analyzed in this study. Campos, Frankel, and Camras (2004) note that "many behaviours can be in the service of an emotion, and the same behaviour can be in the service of many emotions" (p. 378). Given that the underlying features of emotions and their regulation are similar, it is necessary to exercise heedfulness to reliably recognize emotion regulation instances. This led us to identify the regulatory processes of emotions through a multi-analysis of observational channels of attention (action) tendencies, vocal characteristics and motor expressions, as well as oral transcripts of participants.

Table 5
Examples of intrinsic ER subcategories and emotion channels in association

IER Category	IER Sub-category	Attention Tendency	Voice	Motor Expressions
Situation Selection	Behavior disengagement	Self-centered	Silence	Leaning out
		Away from participants	Normal voice	Looking away
				Inactivity
Situation Modification	Planning	Information search	Voice pace decreasing	Looking back and forth
			Long pauses	Leaning out
Cognitive Change	Positive reappraisal	Attention towards participants	Confident voice	Nodding
				Smiling
				Pressing lips together
Response Modulation	Venting of emotions	Non specific	Change in voice volume	Crying
				Smiling
				Frowning
				Sinking in

Table 6
Examples of extrinsic ER subcategories and emotion channels in association

EER Category	EER Subcategory	Attention Tendency	Voice	Motor Expressions
Situation Modification	Providing empathetical support	Attention towards participants	Voice volume	Leaning in
			And pace decreased	Expressing sadness
				Nodding
				Raising eyebrows
Cognitive Change	Positive reappraisal	Attention towards participants	Confident voice	Nodding
				Smiling
				Pressing lips together
Response Modulation	Easing venting of emotions	Attention towards participant	Voice volume decreased	Leaning in
				Pressing lips together
				Expressing sadness

9.3. ER detection as a means to evaluate IER and EER application

The importance of regulating emotions in medical settings has been emphasized in medical literature (Larson & Yao, 2005; Maes & karoly, 2005; Taylor, Bagby & Parker, 1999). *Observational* methods, in comparison to self-reports that are traditional methods of evaluating ER, can be beneficial to medical educators. Medical instructors can evaluate the manner in which their students acquire the appropriate abilities to

communicate with and manage patient needs by comparing the changes their students make in pre- to post-test scenarios where intrinsic and extrinsic ER strategies are critical to successful practice.

The small group PBL sessions that serve as the learning context in this study can also be thought of as a platform for increasing awareness of ER detection methods. As an example, using the power of voice as a channel of extrinsic ER can be highlighted in educational settings, and students can become more aware of the relative weight of this channel in comparison to other nonverbal behavior in enhancing their competencies in EER application.

9.4. Contributions and future directions

This study makes important contributions to the methodological foundations of scientific examination of ER in AC research. This work is also important in improving the design of TREs to embed dynamic ER detection mechanisms that enable the system to adapt instructions based on different needs of individual students.

This research showed the importance of voice in extrinsic ER in the intercultural context of delivering bad news in medical settings. Further research is required to generalize the findings and analyze whether various channels of emotion expression and their weight of internal/external regulation are different in other contexts. In other words, is there an emotion modality which can better transfer the emotions one is experiencing, or that one wants to be perceived experiencing, and if so, is it context-dependent? What is the relative power of words (text), voice, embodiments, attention tendencies, etc. in extrinsic emotion regulation in other contexts? Studies have shown that basic emotions (Ekman, 1992) of sadness, anger, and fear are best identified through vocal characteristics; but disgust is the hardest to be identified through paralinguistic measures (Calvo & D'Mello, 2010). Further research can examine whether there is an ER mediator effect in detecting which emotion channels can be used to infer specific emotions. As an example, is there an ER mediation effect that hinders a clear identification of disgust through the channel of implicit vocal features?

This paper also illustrates the need to identify the relation between emotion regulation and other forms of self-regulation. Research has shown that emotional distress damages self-regulation (Gross & Thompson, 2007). Studies could be conducted to analyze whether the processes used to regulate emotions are similar to those used to regulate cognitions. An important factor impacting cognitions is working memory capacity (WMC). Higher WMC results in a greater wealth of resources and past experiences available (Barrett, Tugade, & Engle, 2004). Thus, studies can examine whether individuals with higher WMC can better implement regulatory strategies, cognitive or affective, leading to more control of attentional resources for regulatory purposes.

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