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J., 96 (3): 677-684 Over the past decade, scientists have focused on empathy as an essential part of human social interaction. The term empathy derived from Greek empathy – passion – is a multifaceted construct which is believed to include both cognitive (i.e. understanding of another person's beliefs and feelings) and affectionate components (i.e. the ability to share another's feeling) (Jankowiak-Siuda et al., 2011; Betti and Aglioti, 2016). It is believed that people have become embroiled in other imitates their mental states or feelings. According to the empathy perception-acting model (PAM), simulation processes discovered and defined in the field of action arise from the fact that the images of the subject's emotional state are automatically activated when the subject pays attention to the emotional state of the object (Preston and de Waal, 2002, p. 1; de Waal and Preston, 2017). Paying attention to the emotional state of another, in turn leads to a related autonomous and somatic response (Preston, 2007). In keeping with this pattern, a positive relationship was observed between emotional empathy and somatic response both due to skin conduction (Levenson and Ruef, 1992; Blair, 1999; Hooker et al., 2008) and cardiac activation (Krebs, 1975; Hastings et al., 2000). This may mean that more empathic individuals react with a stronger love. Recent studies also show that empathic traits are associated with changes in facial mimicry (FM) (Sonnby-Borgström, 2002; Sonnby-Borgström et al., 2003; Dimberg et al., 2011; Balconi and Canavesio, 2013a, 2014; Rymarczyk et al., 2016b). Facial mimica is a spontaneous unconscious reflection of other emotional facial expressions that converge facial muscle activity (Dimberg, 1982). This phenomenon is usually measured by electromiography e.g. Dimberg, 1982; Larsen et al., 2003). Evidence FM was the most consistently reported when viewed happy (Dimberg and Petterson, 2000; Weyers and Others, 2006; Rymarczyk et others, 2011) and angry (Dimberg et al., 2002; Sato et al., 2008) facial expressions. Interestingly, angry facial expressions cause greater activity than happy faces corrugator supercilii (CS, muscle involved in frowning), while happy facial expressions lead to greater activity in the zygomaticus core (ZM, muscle involved in smiling) and decreased CS activity. In addition, few EMG studies also support the FM phenomenon for other i.e. fear of increased CS activity (e.g. van der Schalk et al., 2011a) or frontal muscles (e.g. Rymarczyk et al., 2016b) and disgust with increased CS activity (e.g. Lundquist and Dimberg, 1995) or levator labii (LL) (e.g. Vrana, 1993). In addition, it was found that the size of the FM depends on a number of factors (for the review see Sonnby-Borgström et al., 2003; Dimberg et al., 2011; Balconi and Canavesio, 2013a; Balconi et al., 2014; Rymarczyk et al., 2016b). For example, Dimberg et al. (2011) found that more empathic individuals showed greater CS contraction with angry faces and greater ZM contraction in happy faces compared to less empathic individuals. Similar patterns were observed in response to fearful facial expressions, where more empathic individuals experienced higher CS reactions (Balconi and Canavesio, 2016). Recently, Rymarczyk et al. (2016b) found that emotional empathy moderates activity in other muscles, such as levator labii, in response to disgust and lateral fronts in response to fearful facial expressions. The results of these studies show that more empathic individuals are more sensitive to other expressed emotions at the level of facial mimicry. It has been suggested that FM has important consequences for social behaviour (Kret et al., 2015) as it facilitates the understanding of emotions by causing an appropriate empathic response (Adolphs, 2002; Preston and de Waal, 2002; Decety and Jackson, 2004). Emotional facial expressions, mirrored neuronal system and limbic structures at neuronal level PAM assume that by observing the actions of others, observers encourage the same action by activating brain structures that are involved in the same behavior (Preston, 2007). It has been suggested that the mirror neuronal system (MNS) is the neural basis of PAM (Gallese et al., 1996; Rizzolatti and Sinigaglia, 2010). Indeed, the first evidence of mirror neurons (localized in monkeys in the F5 region of the F5 region in monkeys) was obtained from experiments where monkeys performed a target action (e.g. held, grabbed or manipulated objects) or when they watched the person (monkey or man) performs the same act (Gallese et al., 1996; Rizzolatti and Craighero, 2004; Gallese et al., 2009). In addition, studies in humans have shown that MNS is activated during imagination or by simulating simple or complex hand movements (Ruby and Decety, 2001; Iacoboni et al., 2005; Iacoboni and Dapretto, 2006). In addition, neuroimaging studies have shown that pure observation and imitation of emotional facial expressions involved MNS, especially regions of inferior anterior gyroscopes (IFG) and inferior parietal lobes (ILD) (Rizzolatti et al., 2001; Carr et al., 2003; Rizzolatti and Craighero, 2004; Iacoboni and Dapretto, 2006), which are considered to be the main regions of the MNS for humans. In addition to the main regions of MNS, insula and amygdala, limbic system structures are proposed to participate in the processing of emotional facial expressions (Iacoboni et al., 2005). For example, amygdala activation was displayed in fear expressions (Carr et al., 2003; Ohrmann and Others, 2007; van der Zwaag et al., 2012) and the front insula (DI) for expressions of disgust (Jabbi and Keysers, 2008; Seubert et al., 2010). Recently, the insula and the back of the anterior cinculus cortex together with a set of limbic and subcortical structures (including the amygdala) form a network of salinity of the brain (Seeley et al., 2007). It is believed that the salinity network will mediate in identifying and integrating the behavioral stimuli (Menon and Uddin, 2010), including stimuli that cause fear (Liberzon et al., 2003; Zheng et al., 2017). In view of the participation of MNS in the social mirror and the phenomenon of facial mimicry, the interaction between MNS and the limbic system is postulated (Iacoboni et al., 2005). It is proposed that by observing and simulating emotional expressions, the main regions of MNS (i.e. IFG and IPL) would activate insula, which further activates another limbic structure, i.e. the amygdala (Jabbi and Keysers, 2008). However, it should be stressed that the specific function of the amygdala is still under consideration (Adolphs, 2010). For example, van der Gaag et al. (2007) found bilateral front insula activation by realizing happy, ugly and fearful facial expressions compared to non-emotional facial expressions, but they did not find any activation of amygdala. Research has revealed that the amygdala is activated more quickly during conscious imitation than pure observation of emotional facial expressions (Lee et al., 2006; van der Gaag et al., 2007; Montgomery and Haxby, 2008). In addition, it has been shown that the extent of activation of the amygdala can be predicted by simulating facial expressions by simulating facial expressions (Lee et al., 2006). Some authors have suggested that amygdala activation by simulating, but not observing, the emotional face may reflect increased autonomic activity or facial muscle feedback to the amygdala (Pohl et al., 2013). In conclusion, there is a general consensus among scientists that insula is related to an alien. In addition, it was suggested that insula and amygdala are part of the system of emotional perception and coordination (Iacoboni and Dapretto, 2006; Keystrokes and Gazzola, 2006) and therefore expand the classical MNS during emotion processing (van der Gaag et al., 2007; Likowski et al., 2012; Pohl et al., 2013). It is believed that the mirror mechanism may be responsible for motor modelling of facial expressions (main MNS, i.e. IFG and IPL) (Carr et al., 2003; Wied, etc., 2003; Grosbras and Paus, 2006; Iacoboni, 2009) and affective imitations (extended MNS, i.e. insula) (van der Gaag et al., 2007; Jabbi and Keysers, 2008). However, the exact role of the amygdala in these processes is not clear. MNS, FM and Empathy According to the perception action model facial mimic is an automatic coordinated motor response based on a reference to perception and behavior (Chartrand and Bargh, 1999; Preston and de Waal, 2002). However, other authors suggested that FM would not only be a simple motor reaction, but also the result of more general processes for interpreting expressed emotions (Hess and Fischer, 2013, 2014). Some of this claim is supported by two studies using simultaneous blood oxygen (BOLD) and facial electromyography (EMG) signals in an MRI scanner (Likowski et al., 2012; Rymarczyk and Others, 2018). Likowski et al. (2012) found that the emotional facial expressions of happiness, sadness and anger in the face emg correlate with BOLD activity localized parts of the main MNS (i.e. IFG), as well as in the areas responsible for processing emotions (i.e.AI). Similar results were obtained in a separate study, which also used additional videos of happiness and anger facial expressions (Rymarczyk et al., 2018). In this study Rymarczyk et al. (2018) showed that activation in the main structures of MNS and MNS was more often observed when dynamic emotional expressions were presented compared to presentations of static emotional expressions. The authors concluded that dynamic emotional facial expressions may be a clearer signal to trigger motor modeling processes in the main MNS, as well as emotional resonance processes in limbic structures, i.e. insula. It is worth noting that dynamic stimuli, compared to static, selectively active structures associated with the perception of motion and biological motion (Arsalidou et al., 2011; Foley et al., 2012; Furl et al., 2015), as well as MNS brain structures (Sato et al., 2004; Kessler et al., 2011; Sato et al., 2015). The results of the above-mentioned EMG-fMRI studies show that the main studies related to MNS and structures (e.g. insula) may form fm neurons correlated. In addition, it seems that the FM phenomenon is an engine and emotional component, each representing a certain neural network of active brain structures that correlate with the response of the facial muscles through perception of emotions. Responsible for the engine component are structures which are considered to be one of the main MNS (e.g. inferior front gyroscopes) involved in the monitoring and conduct of motor operations. Insula, a limbic structure associated with MNS, participates in emotional activity-related processes. It should be noted that this premise is limited to FM's happiness, sadness and anger emotions, based on the results of EMG-fMRI research. In addition, several studies have linked the empathic traits of neural activity to MNS showing that individuals who have higher activity in MNS also result in higher emotional aspects of empathy (Kaplan and Iacoboni, 2006; Jabbi et al., 2007; Pfeifer et al., 2008). For example, Jabbi et al. (2007) found a positive correlation between bilateral frontal insula and frontal opercular activation when subjects watched video clips showing satisfied or nasty facial expressions. To sum up, there is some evidence that MNS is the basis for empathy and that the MNS subsystems support engine and operational modelling. However, so far, there is no empirical evidence to link MNS, empathy and modelling processes. The objectives of the study In our study, emg and BOLD signal recording at the time of perception of facial irritants were used at the same time. From the Amsterdam Dynamic Facial Expression Kit (ADFES) (van der Schalk et al., 2011b), we selected natural, static and dynamic facial expressions (neutral, fearful and disgust), based on studies showing that dynamic stimuli are a more realistic reflection of real situations (Krumhuber et al., 2013; Sato and Others, 2015; Rymarczyk et al., 2016a). Levels of empathy were assessed by the Emotional Empathy Questionnaire Tool (QMEE), which defined empathy as vicarious emotional response to perceived emotional experiences of others (Mehrabian and Epstein, 1972, p. 1). On the basis of the above, our EMG-fMRI study had two main objectives. Firstly, we wanted to examine whether fm neuronal bases set up for socially related stimuli, i.e. anger and happiness, would be the same for more biologically relevant, i.e. fear and disgust. We predicted that, much like anger and happiness, the main limbic structures (i.e. insula, amygdala) of MNS (i.e. insula, amygdala) would be included in the emotional perception of facial expressions. Because of that, there is evidence that the perception of dynamic emotional stimuli leads to increased brain activity compared to static stimuli (Arsalidou et al., 2011; Kessler et al., 2011; Foley et al., 2012; Furl al., 2015), we expected that all structures of the MNS subsystems would have stronger activation dynamically compared to static emotional facial expressions. Secondly, based on evidence that the traits of empathy modulates the facial mimicry of fear (Balconi and Canavesio, 2016) and disgust (Balconi and Canavesio, 2016; Rymarczyk et al., 2016b), and on the assumption that MNS is the basis for empathy processes, we wanted to check whether there is a link between facial mimicry, empathy and the mirror neuronal system. We predicted that highly empathic people would be characterized by greater activation of extended MNS sites, i.e. insulos and amygdala, and that these activations would be associated with stronger facial reactions. In addition, based on neuroimaging evidence that dynamics compared to static emotional stimuli are a stronger signal for social communication (Bernstein and Yovel, 2015; We grzyn et al., 2015) explored whether the relationship between MNS facial mimics, empathy and subsystems could also depend on the modality of irritants. Substances and methods Forty-six healthy subjects (25 males, 21 females, mean ± standard deviation age = 23.8 ± 2.5 years) were included in this study. The vision of the subjects was normal or adjusted and neurological diseases were not reported. This study was carried out in accordance with the recommendations of the Ethics Committee of the Faculty of Psychology of the University of Social sciences and humanities, with the written informed consent of all subjects. All subjects gave their written informed consent in accordance with the Helsinki Declaration. The protocol was approved by the Ethics Committee of the University of Social sciences and humanities at the SWPS. Each participant has signed an informed consent form after the experimental procedures have been clearly explained. After the scan session, the subjects were informed of the objectives of the study. Empathy scores were measured by the questionnaire's measure of emotional empathy (QMEE), which defined empathy as vicarious emotional response to perceived emotional experiences of others (Mehrabian and Epstein, 1972, p. 1). QMEE consists of 33 points to be completed using 9-point ratings from -4 (=very strong disagreement) to +4 (=very solid agreement) and was selected on the basis that the questionnaire is a Polish adaptation (Rembowski, 1989) and has been shown to be a useful fm research tool (Sonnby-Borgström, 2002; Dimberg et al., 2011). For analytical purposes, subjects were divided into High Empathy (HE) and Low Empathy (LE) groups according to the median scores in the QMEE questionnaire. Facial stimuli and apparatus Expressions of disgust and fear were taken from Amsterdam's dynamic facial expression set (van der Schalk et al., 2011b). In addition, neutral conditions for the same human actors were used, there are no visible units of action characteristic of emotional facial expressions. The stimuli (F02, F04, F05, M02, M08 and M12) consisted of forward-facing facial expressions presented as static and dynamic displays. The static condition stimuli consisted of one shot from the dynamic video clip corresponding to its condition. Due to static fear and disgust, the chosen frame meant the highest moment of facial expression. In the case of neutral dynamic expressions, the movement was still evident, as the actors either closed their eyes or slightly changing the position of their heads. The stimulus was 576 pixels high and 720 pixels wide. All expressions were presented on a gray background. An overview of procedures and irritants is given in Figure 1. Figure 1: The procedure scheme used in the study. The images used in the image were obtained and published with the permission of the copyright holder of the Amsterdam Dynamic Facial Expression Collection (van der Schalk et al., 2011b). Electromyography data was obtained using MRI-compatible Brain Products

BrainCap, which consists of 2 bipolar and one reference electrode. Electrodes with a diameter of 2 mm were filled with electrode paste and positioned in pairs above CS and LL on the left side of the face (Cacioppo et al., 1986; Fridlund and Cacioppo, 1986). The 6 mm diameter reference electrode was filled with electrode paste and attached to the forehead. Before attaching the electrodes, the skin was cleaned with alcohol. This procedure was repeated until the electrode barrier was reduced to 5 kΩ or less. Digitized EMG signals were recorded using brainamp MR plus ExG amplifier and BrainVision recorder. At the time of purchase, the signal was filtered at a frequency of 250 Hz. Finally, the data was digitized using a 5 kHz sampling frequency and stored on a computer running MS Windows 7 for offline analysis. Image acquisition MRI data was obtained in the Siemens Trio 3 T MR scanner with a 12-channel phased array head coil. Functional MRI images were collected using the T2∗ weighted sequence of EPI gradient echo pulses with the following parameters: TR = 2000 ms, TE = 25 ms; 90° invert angle, FOV = 250 mm, matrix = 64 × 64, envelope size = 3,5 mm × 3,5 mm × 3,5 mm, intertwined equivalent acquisition, slice thickness = 3,5 mm, 39 slices. Procedure Each volunteer was introduced to the experimental procedure and signed a consent form. In order to disguise the true purpose of facial electromyography records, participants were told that the activity of the sweat gland is captured by observing the faces of the actors selected by the external marketing company for advertising. After the FaceEMGCap-MR electrodes were attached, participants were reminded to closely monitor the actors on the screen and they were positioned in the scanner. Things were verbally encouraged to feel comfortable and behave naturally. session began with a reminder of the subject's task. During the session, the topics were presented with 72 attempts that lasted about 15 minutes. Each attempt began with a white locking cross with a diameter of 80 pixels, which was visible in the center of the 2 s screen. Below, one of the stimuli with facial expression (disgust, fear or neutral, each presented as a static image or dynamic video clip) was introduced in 6 seconds. After the expression, a blank gray screen was placed between 2.75 and 5.25 s (see Figure 1). All irritants were placed in the center of the screen. In conclusion, each stimulus was repeated once, a total of 6 presentations by type of expression (e.g. 6 dynamic deliveries of happiness). The stimulus appeared in an event-related way, a pseudo-randomized study of the trail with restrictions on scar absences of facial expressions from the same actor, and no more than 2 actors of the same sex or the same emotion were presented in a row. A total of 6 randomized event-related sessions with restrictions were balanced between subjects. The procedure was managed using Presentation® software running on a Microsoft Windows operating system and was displayed on a 32-inch NNL LCD MRT-compatible monitor with a mirror system (1920 pixels × 1080 pixel resolution; 32-bit frequency; 60 Hz refresh rate) at a viewing distance of approximately 140 cm. The pre-processing of data analysis by EMG analysis was carried out using BrainVision Analyzer 2 (version 2.1.0.327). First, the epi gradient echo pulse artifacts were removed using the average artifact subtraction AAS method (Allen et al., 2000), implemented by the BrainVision analyzer. This method is based on the calculation of the sliding mean and consists of 11 consecutive functional volumes marked in data logs. Synchronization hardware and MR trigger markers have enabled the AAS method to successfully remove MR-related artifacts from the data. The standard EMG processing was followed, which included the transformation of the signal with a 30 Hz high pass filter. Subsequently, EMG data was corrected and integrated for more than 125 ms and replanted to 10 Hz. Emg-related artifacts were detected by two methods. First, when the initial muscle activity was greater than 8 μV (i.e. the visibility of the locking cross) (Weyers et al., 2006; Likowski et al., 2008, 2011), the study was classified as an artifact and not included in further analysis. All remaining tests were blindly coded and visually inspected for artifacts. In the next phase, the baseline scenario of the studies was adjusted so that the EMG response was measured as the difference in mean signal activity between the duration of the irritants (6 s) and the baseline period (2 s). Finally, the signal was set to average for each condition, for each participant. These average values were subsequently imported into 21 statistical analysis. Analysis. EMG responses were investigated using a three-way mixed pattern of ANOVA with expression (disgust, fear, and neutral) and stimulus mode (dynamic and static) as a factor between the subject factors and empathy group [low empathy (LE), high empathy (HE)] as among subjects. Individual ANOVAs were calculated for response from each muscle and reported with Bonferroni correction and Greenhouse-Geisser correction when the spherical assumption was violated. In order to confirm that EMG activity has changed since baseline and that FM has occurred, emg data on each significant effect have been verified for a difference from zero (baseline) using single sample two-sided t-tests. fMRI processing and analysis Image processing and analysis was performed using SPM12 software (6470) exposed to MATLAB 2013b (The Mathworks Inc. 2013). The functional images were subject to standard pre-processing phases, i.e. motion correction and general registration for the average functional image. The independent SPM segmentation module was used to divide structural images into different tissue classes [grey matter, white matter and non-brain (cerebrospinal fluid, skull)]. In addition, based on previously segmented structural images, affine was created and registered in the MNI space using the DARTEL algorithm. In particular, the functional images were hot into the MNI space, based on DARTEL priors, resliced up to 2 mm × 2 mm × 2 mm isotropic envelopes and later leveled 8 mm × 8 mm × 8 mm full width half of the maximum Gaussian kernel. The design arrays of one object were constructed under six experimental conditions corresponding to dynamic and static tests for each of the three conditions of expression (disgust, fear and neutral). These conditions were modelled on the standard hemodynamic response function, as well as with other covariates, including head movements and parameters that did not include other fMRI artifacts produced in the artifact detection toolkit (ART). The same contrasts of interest were subsequently calculated for each subject under investigation (listed in the results section, i.e. fMRI data) and used for the analysis of statistical interest regions (ROI) in the group-level analysis (i.e. one sample t-test). The analysis was carried out using the MarsBar toolkit (Brett et al., 2002) for individual ROI. RoI consisted of anatomical masks obtained from WFU Pickatlas (Wake Forest University, 2014) and SPM Anatomy Tool Kit (Eickhoff, 2016). The STS was defined as a set of overlapping peaks with a radius of 8 mm based on the activation peaks reported in the literature (Van Overwalle, 2009). Each ROI was extracted as the average value of the mask. Brain activity statistics in each contrast were reported with bonferroni correction. Correlation Analysis To Understand Brain Activity and Facial Muscle and disclose which ROI are directly related to FM, bootstrapped (BCa, (BCa, = 1000) Pearson correlation coefficients were calculated between the contrasts of brain activity (disgust dynamic, disgust static, fear dynamic and fear static) and corresponding mimicry. Each ROI consisted of one value, which was the average of all the envelopes of that anatomical mask in each hemisphere. Muscle activity was defined as initial corrected EMG tests of the same muscle and type. Correlations were performed in pairs of muscle and EMG activity variables, such as CS response to static disgust faces with fMRI response in the left insula to static faces of disgust. Results empathy scores QMEE scores from two groups were very different [t(44) = 9.583, p < 0.001; MHE = 69,4, SEHE = 3,7; MLE = 14,64, SELE = 4,3]. 13 men were included in the HE group (M = 61.38, SE = 4,86) and 11 females (M = 78,91, SE = 4,42) and le group consisted of 12 males (M = 12,83, SE = 6,35) and 10 males (M = 16,8, SE = 6,18). Emg measures by M. Corrugator Supercilii ANOVA showed a significant principal effect of expression [F(2,72) = 26,527, p < 0,001, η2 = 0,424], indicating that SCL activity for disgust (M = 0,217, SE = 0,025) was similar to fear [M = 0,216, SE = 0,020; t(36) = 0,036, p > 0,999] and higher for both fear and disgust compared to neutral expressions [M = 0.028, SE = 0,018; disgust vs neutral: t(36) = 5,559 , p < 0,001; t(36) = 6,714, p < 0.001]. Among subjects, the effect of empathy was also significant [F(1.36) = 24,813, p < 0,001, η2 = 0,408] where CS activity is generally higher in the HE (M = 0,215, SE = 0,016) group LE (M = 0,092, SE = 0,019). Significant expression × empathy groups [F(2.72) = 4,583, p = 0.013, η2 = 0,113] interaction revealed that CS activity in the HE group for disgust (M = 0.307, SE = 0.032) was similar to fear [M = 0,300, SE = 0.026; t(36) = 0,194, p > 0,999] and higher for both emotions, vs. neutral expressions [M = 0.037, SE = 0.024; disgust vs neutral: t(36) = 6,136, p < 0.001; fear versus neutral : t(35) = 7,306, p < 0,001]. Le, on the contrary, higher CS activity was observed for fear (M = 0.131, SE = 0,030) compared to neutral phrases [M = 0,019, SE = 0,028; t(36) = 2,690, p = 0,034] and no other differences in pairs were observed [MLE disgust = 0,126, SELE disgust = 0,038; LE: disgust and neutral: t(36) = 2.118, p = 0.128; LE: disgust vs fear: t(36) = 0,119, p > 0.999]. Higher CS activity was observed in the HE group compared to le group due to disgust [t(36) = 3,620, p =0,001] and fearful faces [t(36) = 4,225, p < 0,001]. No differences were observed between neutral expression groups [t(36) = 0.486, p = 0,621] (see Figure 2). Figure 2: Mean (±SE) changes in EMG activity and corresponding supercilii statistics under the conditions of submission. Individual stars show significant differences in EMG conditions (simple effect) effect) ∗p < 0,05, ∗∗p < 0.01, ∗∗∗p < 0,001. SE, standard error. There was no significant effect of the main modality [F(1,36) = 0,169, p= 0,683, η2 = 0,005] and the following interactions were not relevant: modality × empathy [F(1,36) = 0,044, p = 0,834, η2 = 0,001], expression × modality [F(2,72) = 0,013, p = 0,987, η2 = 0,000] and the phrase × modality × empathy [F(2,72) = 0,039, p = 0,962, η2 = 0,001]. Studies in the HE and LE groups of one sample of t showed a significant increase in CS activity in all conditions of disgust and fear (see Table 1). In response to neutral expressions, CS activity is not very unseased from the entry level. Table 1: Descriptive statistics on the activity of the correlation supercilii. ANOVA showed a significant major effect of expression [F(2.76) = 33,989, p < 0.001, η2 = 0,486], indicating that LL activity was higher due to disgust (M = 0,170, SE = 0.022) compared to both fears [M = -0.073, SE = 0,031; t(36) = 6,914, p < 0,001] and neutral phrases [M = -0,073, SE = 0,025; t(36) = 8,483, p < 0,001]. LL activity was not expected to change between fear and neutral conditions [t(36) = 0,105, p > 0.999]. The effect of empathy among subjects was significant [F(1.36) = 6,579, p=0.015, η2 = 0.155], higher ACTIVITY OF LL (M = 0.052, SE = 0.023) compared to LE (M = -0.038, SE = 0.026) groups. Significant expression interactions × empathy group [F(2.72) = 3,980, p = 0.023, η2 = 0,100] revealed that the ACTIVITY OF LL in the HE group was higher due to disgust (M = 0.270, SE = 0.028) compared to both fears [M = -0.053, SE = 0,040; t(36) = 7,022, p < 0,001] and neutral phrases [M = -0,062, SE = 0,033; t(36) = 8,973, p < 0,001]. Similarly, higher L-activity in the LE group was observed in the Abomination (M = 0.070, SE = 0.033) compared to fear [M = -0.092, SE = 0,030; t(36) = 2,981, p = 0,014] and neutral expressions [M = -0,090, SE = 0,039; t(36) = 3,636, p = 0,003] (see Figure 3). There was no difference between fear and neutral expressions in the groups [HE: t(36) = 0,184, p > 0,999; LE: t(36) = 0,034, p > 0,999]. Figure 3: Mean (±SE) changes in EMG activity and corresponding levator labii statistics under the conditions of presentation. Individual asterisks show significant differences in EMG response conditions (simple effect): ∗p < 0.05, ∗∗p < 0.01, ∗∗∗p < 0.001. SE, standard error. The main effect of the modality was not significant [F(1,36) = 1,315, p= 0,259, η2 = 0,035] and the following interactions were not relevant: modality × empathy [F(1,36) = 0,000, p = 0,995, η2 = 0,000], expression × modality [F(2,72) = 0,458, p= 0,634, η2 = 0,013] and the expression ×smied × empathy [F(2,72) = 0,238, p = 0,789, η2 = 0,007]. Single sample t studies in the HE and LE groups revealed higher L&L activity for all conditions of disgust compared to baseline (See Table 2). In response to fear and neutral expressions, LL activity is not expected to be at baseline. Table 2: Descriptive statistics on the activity of the levator. Contrasts were made in the regions of interest, which compared the activation of the brain by looking at dynamic and static facial expressions, so there were eleven contrasts of interest: disgust with dynamic > disgust with static, fear dynamics > static fear, neutral static > emotional dynamic > emotion static (emotion dynamics – concentrated dynamic disgust, and fear conditions; emotions static – similar aggregation), all dynamic > all structures (all dynamic – concentrated dynamic disgust, fear and neutral conditions; all static – similar aggregation), abominable >s dynamic > neutral static, fear dynamic > neutral > static, emotional dynamic > neutral structure > static. The above contrasts were calculated to examine two types of issues. Contrast emotions/disgust/fear/all dynamic/static > neutral dynamic/static addresses nerve correlates FM emotional/disgust/fear/all expressions. Other contrasts (i.e. emotions/disgust/fear/all dynamic > emotions/disgust/fear/all structures) are associated with the difference between dynamic and static irritant processing. Due to any differences in groups between HE and LE subjects, we report only fMRI ROI results for all subjects (see additional tables for all brain analysis, as appropriate). Interest analysis regions have set activation in the right hemisphere for disgust with dynamic > static contrast (see Table 3). Table 3: Summarized statistics on the activation of each ROI in each participant for abominable > abominable static contrast. V5/MT+ and STS were observed bilateral activation due to fear of dynamic > static contrast. In addition, the amygdala and AI were activated in the right hemisphere (see Table 4). Table 4: Summarized activation statistics for each ROI for all participants due to fear dynamic > static contrast. In the case of neutral dynamic > static contrast, only V5/MT+ and STS were activated bilaterally (see Table 5). Table 5: Summary statistics for each ROI activation for all participants for neutral dynamic > neutral static contrast. Regions of emotion dynamics and emotions > contrast interest analysis regions revealed bilateral activation of V5/MT+, STS, AI and amygdala. Other structures activated by this contrast were suitable for BA45 and left AI (see Table 6). Table 6: Summarized statistics on the activation of each ROI for all participants to allow > static contrast of emotions. All dynamic > static contrast, indicated bilateral activations V5/MT+, STS, amygdala and AI. It was also activated BA45 (see Table 7). Table 7: Statistics on the activation of each ROI in all ROI summary statistics all dynamic > contrast of static expressions. The dynamic and neutral regions of disgust have revealed the bilateral activation of V5/MT+, STS and BA45. Other structures revealed by this contrast remained ba44 and left AI (see Table 8). Table 8: Summary statistics for each ROI activation for all participants to be abominable dynamic > neutral dynamic contrast. Interest analysis regions due to disgust static > static contrast showed activation in the left IPL and on the right BA45 (see Table 9). Table 9: Summary statistics for each ROI activation for all participants to be abominable > neutral static contrast. Due to fear dynamic > dynamic contrast, activations were visible bilaterally on V5/MT+, STS, BA45, amygdala and AI. Activation was also observed in the left side of BA44 and right putamen (see Table 10). Table 10: For each ROI activation for all participants, summary statistics that fear dynamic > neutral dynamic contrast. For fear of static > static contrast, activation was observed on the left IPL and left EDI (see Table 11). Table 11: Summarized activation statistics for each ROI for all participants to avoid static > neutral static contrast. Emotion dynamics > dynamic contrast showed bilateral activations V5/MT+, STS, BA45, amygdala and AI. Activation was also observed in the left side of BA44 and right foam for this contrast (see Table 12). Table 12: Summary statistics for each ROI activation for all participants to allow > neutral dynamic contrast. Static emotions > static contrast was associated with activation in the left premotor cortex, left IPL and right BA45 (see Table 13). Table 13: Summarized statistics on the activation of each ROI for all participants to obtain an emotion static > neutral static contrast. A correlation analysis of all subjects revealed a linear connection to the abominable dynamic state between left AI and LL. Abominable static condition had a positive relationship between LL and activation of the right premotor bark, and the right caudate head. In the left hemisphere, positive relationships were found between LL and activation BA44, BA45 and AI (see Table 14). Table 14: Muscle-brain correlation dynamic and static disgust conditions for all subjects. Positive links between CS and brain activity were found in the right hemisphere caudate in the head and globus pallidus, as well as in various regions of the left hemisphere (IPL, STS, ACC, AI, caudate head, globuspallidus) (see Table 14). The analysis of the correlation between the musculoskeletal and brain correlation of all things in all subjects revealed a positive relationship between CS activation left in BA44, right ba45, and AI static fear condition. In a state of dynamic fear, there was a positive relationship CS and activation in the left-hand side of the globus pallidus (see Table 15). Table 15: Musculoskeletal correlation dynamic and static fear conditions for all subjects. A correlation analysis of dynamic disgust with HE subjects revealed a positive relationship between LL and brain activity in several areas on the right (STS, amygdala, ED, caudate head, putamen, globus pallidus) and left hemisphere (amygdala, 2, caudate head, putamen). Due to static disgust with HE subjects, the ratio of LL to brain activity was significant for the left AI, right caudate head and bilateral amygdalae (see Table 16). Table 16: Muscle-brain correlation dynamic and static disgust in conditions of high empathic things. A correlation analysis of dynamic disgust with HE subjects revealed no link between CS and brain activation. Due to static disgust with HE subjects, the relationship between CS and brain activity was significant in the right regions (caudate head, putamen, globus pallidus) and the left hemisphere (amygdala, caudate head, putamen, globus pallidus) (see Table 16). Musculoskeletal correlation dynamic and static fear conditions High Empathic Subjects Correlation analysis of dynamic fear he subjects revealed a positive relationship between CS and brain activity on an amygdalae bilateral basis and left globus pallidus. Due to static fear, the significant relationship between CS and brain activity was significant for bilateral amygdalae and foam and right AI (see Table 17). Table 17: Muscle-brain correlation dynamic and static fear conditions in high empathic things. Le subjects, the relationship between LL and brain activity was found only in a disgusting static state, left ba44, putamen and globus pallidus bilaterally (see Table 18). Table 18: Muscle-brain correlation dynamic and static disgust in conditions of little empathic things. A correlation analysis of dynamic disgust with LE subjects revealed a positive relationship between CS and activity in the right amygdala, and a negative relationship between this muscle and left globus pallidus. Because of the static disgust condition, there was a positive link between CS and brain activity on the right (IPL, STS, ACC, and caudate head) and the left hemisphere (V5/MT+, premotor cortex, IPL, STS, ACC, AI, caudate head, globus pallidus) among LE subjects (see Table 18). In the musculoskeletal correlation of dynamic and static fear conditions in Low Empathic Subjects of LE subjects, there was a link between CS and brain activity only in a static fear condition left in BA44 (see Table 19). Table 19: The correlation between the muscles and the brain in dynamic and static fear conditions is low in empathic things. In this study, static and dynamic stimuli were used to investigate facial reactions and brain activation in response to emotional facial expressions. Evaluate the neuronal structures associated with spontaneous mimicry with a sense of fear and disgust with facial expressions, during the perception of irritants, we collected simultaneous records of EMG signal and BOLD response. In addition, to investigate whether empathic traits are related to facial muscle and brain activity, we divided participants into small and high empathy groups (i.e. LE and HE) based on the median scores of the approved questionnaire. Emg's analysis revealed activity in CS muscles, looking at both fear and disgust at facial screens, and the perception of the facial activity caused by disgust precisely in LL muscles. In addition, the HE group showed a higher response in CS and LL muscles compared to the LE group, but these responses were not different between static and dynamic irritant mode. We used ROI analyses for BOLD data. We found that dynamic emotional expressions led to greater activation in bilateral STS, V5/MT+, bilateral amygdalae and right BA45 compared to emotional static expression. For the opposite contrast (static > dynamic), no significant activations were expected. Using a combined analysis of EMG-fMRI, we found significant correlations between brain activity and facial muscle reactions for the perception of dynamic and static emotional stimuli. Related brain structures, such as amygdala and AI, were more common in HE compared to the LE group. EMG's response to fear and disgust The main result of emg recording is that both fear and disgust with emotions increased the reaction of the corulator muscle, and the levator's good muscle activity was more pronounced in response to disgust rather than to fearful expressions. Before discussing this result, it should be emphasized that expressions of fear and disgust have the opposite biological function, it is believed that fear increases the perception and suppresses danger (Susskind et al., 2008). Accordingly, both emotions are characterized by the opposite visible surface characteristics, such as faster eye movements or speed inhalation during fear perception compared to perception of disgust (Susskind et al., 2008). Fear and disgust are suggested to include opposing psychological mechanisms at the physiological level (Krusemark and Li, 2011). Based on the above findings, we have predicted different patterns of reaction of facial muscles to the emotions that are evaluated. Our results related to CS contraction in both negative emotions coincide with previous studies reporting CS activity through anger perception (Sato et al., 2008; Dimberg et al., 2011), fear and emotions of disgust (Murata et al., 2016; Rymarczyk et al., 2016b). In addition, Topolinski and Strack (2015) showed that the perception of highly surprising events compared to lower-level events specifically caused CS activity. In addition, Neta et al. (2009) suggested that CS activities could reflect the bias of the participants, a tendency to rate surprise as positive or negative. It is therefore proposed that CS reactions could be an indicator of global adverse effects (Bradley et al., 2001; Larsen et al., 2003), as well as a tool to measure individual differences in emotion regulation abilities (Lee et al., 2012). In addition, we found increased LL activity in the face of disgust, but no evidence of activity for fear of submission. There is some evidence of the perception of the faces of disgust (Vrana, 1993; Lundquist and Dimberg, 1995; Cacioppo et al., 2007; Rymarczyk et al., 2016b), a nasty image associated with contamination (Yartz and Hawk, 2002) or tasting of unpleasant material (Chapman et al., 2009) leads to specific muscle contraction of LL. In addition, it has been shown that ll muscle reaction was due not only to biological but also moral disgust, i.e. in violation of moral norms (Whitton et al., 2014). At the same time, these results show the reliability of LL as an indicator of the experience of disgust (Armony and Vuilleumier, 2013, p. 62). As for the modality of the stimulus, we did not ask for any differences in the size of facial reactions between static and dynamic stimuli. Similar results were found in our previous study (Rymarczyk et al., 2016b), which measured the reaction of CS, LL and lateral frontal muscles. We showed only the weak effect of dynamic stimuli on the strength of facial reactions in the expressions of fear. These reactions were evident only in the lateral frontal muscle, which was not measured in this study. It should be noted that most studies reported a higher EMG response during a dynamic rather dynamic than static emotional perception of facial expressions (Weyers et al., 2006; Sato and Others, 2008; Rymarczyk et al., 2011); however, most of these studies have tested the role of dynamic mode in fm phenomenon happiness and anger. At the same time, the role of dynamic stimuli in fm phenomena for more biologically rooted emotions needs to be further explored. Facial mimick and empathy Our data also provide some evidence that FM intensity and traits of emotional empathy are relative. We found that IT compared to LE subjects showed stronger activity in CS and LL muscles of fear and disgust. However, the FM model was the same in the HE LE groups. Our results are in line with previous EMG studies in which researchers have shown that HE subjects show greater mimics of emotional expression in happiness and anger (Sonnby-Borgström, 2002; Sonnby-Borgström et al., 2003; Dimberg et al., 2011), as well as fear (Balconi and Canavesio, 2016; Rymarczyk et al., 2016b) and disgust (Balconi and Canavesio, 2013b; Rymarczyk et al., 2016b) compared to LE subjects. At the same time, these results show that FM and emotional empathy are interrelated phenomena (Hatfield et al., 1992; 2006). In addition, FM size can be a strong predictor of empathy. According to PAM (de Waal, 2008), HE people exhibit stronger FM emotional stimuli because at the neuronal level they engage in brain areas associated with their feelings of representation, such as AI (Preston, 2007). Neuroimaging data from the Neural Network of Fear and Disgust revealed that dynamic emotional observation compared to dynamic neutral stimuli caused a distributed brain network consisting of bilateral STS, V5/MT+, amygdala, AI and BA45. The left BA44 and the right foam were also activated. On the contrary, the perception of static emotional faces compared to static neutral faces caused activity in the left IPL, right BA45 and left AI, and in the left premotor cortex. In addition to STS and V5/MT+, higher activity contrast dynamic vs static fear was found on the right ba45, right amygdala, and right AI. Dynamic and static disgust faces caused greater activity on the right BA45. Our conclusions on the bilateral visual area V5/MT+ and STS confirm previous results confirming the importance of these structures for the respective movement and biological movement (Robins et al., 2009; Arsalidou et al., 2011; Foley et al., 2012; 2015). It has been suggested that due to its complex properties, dynamic facial properties require improved visual analysis of V5/MT+, which can lead to large-scale activation patterns (Vaina et al., 2001). Previous studies have reported activations of facial motion STS due to speech production (Hall et al., 2005) or facial emotional expressions of happiness and anger (Kilts et al., 2003; Rymarczyk et others, 2018), fear (LaBar et al., 2003) and disgust (Trautmann et al., 2009). In addition, the activation of STS in the detection of natural faces (Schultz and Pilz, 2009), but not computer faces (Sarkheil et al., 2013) has been reported. According to the neurocognitive model of facial processing (Haxby et al., 2000), STS activity may be associated with enhanced perceptual and/or cognitive processing of dynamic facial characteristics (Sato et al., 2004). Summing up our results, along with others, support the use of dynamic stimuli in researching the correlation of emotional facial expressions of neurons (Fox et al., 2009; Zinchenko et al., 2018). In our study, we found that activity in brain areas is usually associated with a simulated process, namely IFG and IPL (Carr et al., 2003; Jabbi and Keysers, 2008). It has been suggested that the devaluation of other behaviours should be based on a direct reflection of the somatosensory or motor representations of the monitor's brain (Gazzola et al., 2006; van der Gaag et al., 2007; Jabbi and Keysers, 2008). For example, the activation of these MNS structures was determined by monitoring and simulating other actions, i.e. movement of hands (Gallese et al., 1996; Rizzolatti and Craighero, 2004; Molnar-Szakacs et al., 2005; Vogt et al., 2007). In addition, IFG was more concerned by monitoring the circumstances of the actions rather than actions without context, which shows that this structure plays an important role not only in recognising but also in the coding of the intentions of others (Iacoboni et al., 2005) and when considering other mental states (for meta-analysis, see Annex II). Neuroimaging studies have shown the involvement of IFG and IPL in observing both dynamic and static (Carr et al., 2003) facial stimuli, for example by comparing dynamic faces with dynamic objects (Fox et al., 2009), dynamic faces with dynamic whipped faces (Sato et al., 2004; Schultz and Pilz, 2009) and dynamic faces for static faces (Arsalidou et al., 2011; Foley et al., 2012; Rymarczyk and Others, 2018). Interestingly, in our study we also found that static compared to neutral images activated by IPL and IFG. It is possible that areas of the brain associated with the process of motor images can be activated also in the absence of biological movement, which is characterized by emotional but not neutral facial expressions. Kilts et al. (2003) therefore reported that the decision of the intensity of emotions in the perception of both angry and happy static expressions compared to neutral expressions activates the engine and premotor barks. These authors suggested that, during the perception of static emotional images, decoding of the content of emotions is carried out by disguised motor modeling of expression before attempting to reconcile static perception with its dynamic mental representation (Kilts et al., 2003, p. 165). To sum up, the growing evidence of neuroimaging confirms the role of frontal and parietal back streams in the processing of both structures (Carr et al., 2003) and dynamic emotional stimuli (Sarkheil et al., 2013), as well as fear (Schaich Borg et al., 2008) and emotions of disgust (Sarkheil et al., 2008). Since facial emotional expressions are a strong hint of social interaction, it is suggested that natural stimuli (Schultz and Pilz, 2009), especially dynamic, may be powerful signals for activating modeling processes in MNS. Relationships between facial muscle reactions and nervous activity In our study we found that activity in several regions correlates with facial reactions. Due to fear expression, CS reactions correlates with activation of the right amygdala, the right AI and left BA44 static displays, and the left pallidus dynamic. A similar pattern correlates structures that have been observed in disgust suggesting that CS reactions correlate with activation left ED, left IPL, pallidus, and caudate head bilaterally, static screens. In addition, the disgust static displays LL reaction correlates with activation in the left BA44 and left BA45, left AI and bilateral correlated with dynamic displays of bark, LL was primarily observed in the left-hand AI (see Table 14). In almost all conditions (i.e. understanding fear and disgust, as well as static and dynamic stimuli), facial reactions correlate with the activity of brain regions associated with motor modeling of facial expressions (i.e. IFG and IPL), as discussed above, as well as AI. Similar results were obtained in other studies, which simultaneously recorded emg signal and BOLD responses in the perception of stimuli (Likowski et al., 2012; Rymarczyk and Others, 2018). For example, Likowski et al. (2012) found that ZM's reactions to static happy expressions and CS reactions to static angry faces correlate with activation in the right-hand ifg. In addition, Rymarczyk et al. (2018) observed such correlations mainly due to dynamic stimuli. Together, these studies highlight the role of IFG and IPL in deliberately simulating emotional expressions and suggest that these regions, which are susceptible to targeted actions, may be FM neural correlated [see Bastiaansen et al., 2009]. The activation of AI in our study in the perception of disgust and fear is consistent with the results of other studies (Phan et al., 2002). For example, it has been shown that AI reacts through unpleasant odors (Wicker et al., 2003), flavors (Jabbi et al., 2007) and disgust-inducing pictures (Shapira et al., 2003), as well as ugly faces (Chen et al., 2009). However, AI seems to be engaged not only in processing negative but also positive emotions, for example, during the execution of a smile (Hennenlotter et al., 2005). In addition, most scientists agree that AI, which is considered a structure that expands MNS, can be modeling the state of emotional feelings (van der Gaag et al., 2007; Jabbi and Keysers, 2008). These assumptions are consistent with other results of simultaneous EMG-fMRI studies that show correlations between insula activity with facial reactions during emotional expression perception. For example, Likowski et al. (2012) showed that CS muscle reactions to angry faces were associated with right-hand insula, while Rymarczyk and Others (2018) established such relationships for expressions of happiness with ZM and orbicularis oculi answers. It should be noted that more recently AI is considered to be the main region of the brain related to the experience of emotions (Menon and Uddin, 2010), among other processes, such as reliability or sexual arousal solutions [for review see section 4.2.1.2. (New Call) Craig, 2009]. In addition, in our study we found correlations between amygdala activity and facial reactions in CS muscles during the perception of fear stimuli. These results are parallel to the findings of other neuroimaging studies that revealed amygdala activity during observation (Carr et al., 2003) as well as the execution of fear and other negative facial expressions (van der Gaag et al., 2007). Many studies highlight the role of the amygdala in social-emotional recognition (Adolphs, 2002; Adolphs and Spezio, 2006), in particular by treating exceptional facial stimuli in unpredictable circumstances (Adolphs, 2010). In addition, it was suggested that the amygdala contributes to the detection of relevant irritants (Sander et al., 2003). Therefore, due to increased vigilance in monitoring the dynamically changing important facial features, the processing of dynamic aspects of faces requires activation of the amygdala. In addition, our EMG-fMRI analysis revealed correlations between the activities of basal ganglia (i.e. globus pallidus and caudate head) and facial reactions due to expressions of fear and disgust. One interpretation of this result may be that the caudate core and globus pallidus, which are involved in engine management (Salih et al., 2009), also play an important role in engine management during automatic FM. On the other hand, clinical trials (Sprengelmeyer et al., 1996; Calder et al., 2016) and neuroimaging data (Sprengelmeyer et al., 1998) show that both globus pallidus and caudate nuclei play an important role in processing expressions of disgust. In addition, it seems that globus pallidus is involved in an aversive response to fear and anxiety (Talalaenko et al., 2008), as well as influence regulation (Murphy et al., 2003). The relationship between facial mimicry, nervous activity and empathy Another innovative feature of our study was to check whether the traits of empathy modulate FM neurons correlate. As discussed above, the high-empathy group provided a separate EMG response model compared to low empathy, which corresponds to a typical FM, i.e. higher CS reactions to fear and disgust and increased LL reactions due to disgust. It is important to note here that FM activity in emotion-related brain structures (e.g. AI, amygdala) was more evident in the HE group. Our conclusion about the frontal activity of insula is partly in line with several neuroimaging studies that used aeusy stimuli (for review, see section 4.2. 2011). For example, it has been shown that the observation of films by people drinking fluids and demonstrating ugly faces has caused activity in the nervous circuit, which consists of AI, IFG and cingulate bark, but only high empathic individuals. It seems that activations associated with disgust have been more commonly observed due to high-bean stimuli, such as pictures of painful situations (Jackson et al., 2006) or facial pain expressions (Botvinick et al., 2005; Saarela and Others, 2007). However, in our study, comparing low and high empathic things, we found no differences in brain activity during the perception of fear and disgust at facial expressions. This may be due to different irritants used in our and other studies. While most studies used high-bean stimuli such as painkillers, our study applied low-sensory stimuli. In other words, the perception of emotional facial expressions compared to the perception of pain-inducing situations may not be sufficient to detect differences in the brain associated with low and high empathetic characteristics of the subjects. As for the correlation between facial reactions to fear and abomination stimuli and amygdala activity, our result remains to accept the assumption that the amygdala, alongside AI, IFG and IPL, are neuronal structures needed for complex empatic processes (Bzdok et al., 2012; Decety et al., 2012; Swamp, 2018). At the same time, it is suggested that the activity of the amygdala, together with the activity of insula, could be the basis for loving modeling neurons, but the specificity of the role of the amygdala in resonance requires a more detailed explanation. As Preston and de Waalas pointed out (2002): So, if the neurons of the mirror represent emotional behaviour, insula can transmit information from the neurons of the premotor mirror to the amygdala (see Annex II). Summary and conclusion The results of our study, using simultaneously recorded EMG and BOLD signals during the perception of fear and disgust, confirmed that much like anger and happiness (Likowski et al., 2012; Rymarczyk et al., 2018), MNS can be the base of FM neurons. In particular, the main structures of the MNS (i.e. IFG and IPL) are considered to be responsible for engine modelling, while limbic regions (e.g. AI) associated with MNS appear to be associated with eritatic resonance. In this context, it is suggested that FM includes both the engine and the emotional component; however, further investigations were needed for their relationship. For example, it is possible that motor imitation causes emotional infestation or vice versa, among other factors that play an important role in social interaction. Our study is the first attempt to investigate the relationship between facial mimicry, MNS subsystems and the level of emotional empathy. We found that high-empathic people showed stronger facial reactions and what is worth noting, these reactions were associated with stronger activation of the core MNS structures and limbic structures associated with MNS. In other words, it seems that high empathic people imitate the emotions of others more than a little empathic. In addition, we showed that the processes of motor imitation and emotional infestation were more evident in dynamic, more natural, than static emotional facial expressions. As for the modality of irritants, our study confirmed the general agreement that exists among scientists that dynamic facial expressions are a valuable source of information in social communication. The evidence was more neural network activation during dynamic compared to static facial expressions of fear and disgust. In addition, it turned out that the presentation of the dynamics of the stimulus is an important factor in the appearance of emotions, especially for fear. Limitations As noted in the introduction, increased CS or LL activity in response to emotional facial expressions is not different from individual emotions, i.e. either for fear or disgust. Some studies have confirmed increased CS activity during perception of various negative emotions (Murata et al., 2016). Accordingly, increased activity of LL was observed not only in abominable mimics, but also in pain expressions, accompanied by increased CS activity (Prkachin and Solomon, 2008). Therefore, our conclusion about brain-muscle relationships is limited due to the specificity of CS and LL nekonk, which are FM indicators for fear and disgust. In addition, there is some evidence that increased activity of other facial muscles, i.e. side frontal, may be associated with the expression of fear (Van Boxtel, 2010). In previous work, we showed that the presentations of fear caused activity in this muscle (Rymarczyk et al., 2016b). However, in the current work, we did not measure this muscle activity, because the LIMIT for EMG measurements in the MRI environment was not intended for this purpose. Author Contributions KR, KJ-S, and ŁŻ conceived and developed experiments. KR and ŁŻ conducted experiments, analyzed data and contributed to materials. KR, ŁŻ, KJ-S and IS wrote the manuscript. Funding This study was based on grant 2011/03/B/HS6/05161 from the Polish National Science Centre and grant WP/2018/A/22_2018_2019 from the SWPS University of Social sciences and humanities. Statement of interest The authors declare that the study was carried out in the absence of any commercial or financial relationship which could be considered a potential conflict of interest. Additional material Additional material for this article can be found online: Footnotes ^ Additionally robust Method 3 ANOVA based on trimmed instruments (finish = 0,1) has been calculated using the WRS2 package (t3way function) in R software (version 3.4.0). ^ Robust ANOVA based crop means confirmed parameters ANOVA results in CS. There was a significant primary effect of expression (Q = 67,741, p < 0.001), empathy (Q = 31,549, p < 0.01) and significant expression × empatimy >s interaction (Q = 12,417, p < 0.01). Qemotion ×modality = 0.144, p > 0.05; Qmodality × empathy = 0.036, p > 0.05; Qemotion × modality × empathy = 0.043, p > 0.05). The Shapiro-Wilk test was used to check the presumption of levator activity in the parameters (WHE:disgust = 0,983, p > 0,05; WHE:slimy = 0,940, p > 0,05; WHE:feardynamic = 0,958, p > 0,05; WHE:fearstatic = 0,976, p > 0,05; WHE:neutraldynamic = 0,956, p > 0,05; WHE:neutral static = 0,880, p < 0,05; WLE:disgust = 0,955, p > 0,05; WLE:slimy = 0,951, p > 0,05; WLE:feardynamic = 0,945, p > 0,05; WLE:fearstatic = 0,992, p > 0,05; WLE:neutraldynamic = 0,958, p > 0,05; WLE:neutral static = 0.966, p > 0,05). ^ Robust ANOVA has confirmed the parametric results of the ANOVA levator on the basis of cropped measures. There was a significant primary effect of expression (Q = 102,411, p < 0.001), empathy (Q = 11,668, p < 0.01) and significant > expression × empathy interaction (Q = 12,923, p < 0.01). Qemotion ×modality = 0.902, p > 0.05; Qmodality × empathy = 0.225, p > 0.05; Qemotion × modality × empathy = 0.070, p > 0.05). The Shapiro-Wilk test was used to verify the assumption of the parametric normality distribution of the ANOVA levator activity (WHE:disgustdynamic = 0,984, p > 0,05; WHE:slimy = 0,941, p > 0,05; WHE:feardynamic = 0,936, p > 0,05; WHE:fearstatic = 0,925, p > 0,05; WHE:neutraldynamic = 0,885, p < 0,05; WHE:neutralstatic = 0,949, p > 0,05; WLE:disgust = 0,937, p > 0,05; WLE:slimy = 0,836, p < 0,01; WLE:feardynamic = 0,975, p > 0,05; WLE:fearstatic = 973, p > 0,05; WLE:neutraldynamic = 0,874, p < 0,05; WLE:neutral static = 0,836, p < 0.01). References Adolphs, R. (2002). Neural systems for emotional recognition. Currency. Opin. Neurobiole. 12, 169–177. doi: 10.1016/S0959-4388(02)00301-X CrossRef Full-text | Google Scholar Adolphs, R., and Spezio, M. (2006). The role of the Amygdala in the processing of visual social stimuli. Prog. Brain Res. 156, 363-378. doi: 10.1016/S0079-6123(06)56020-0 CrossRef Full-text | Google Scholar Allen, P.J., Josephs, O., and Turner, R. (2000). 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