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Does audience size influence actors' and spectators' emotions the same way?

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ABSTRACT

Better understanding how audience size influences emotions and behaviours during public performances is of particular importance since it may both impact the level of anxiety and quality of achievement of the performer and alter the degree of appreciation of the observer. We tested this question in a naturalistic setting by analyzing self-assessment questionnaires, Galvanic skin responses and behaviours of actors and spectators during theatrical representations with small, medium and large audiences. We found that: actors and spectators differed in their perception of the effects of audience size; the different components of emotions (cognitive, physiological, behavioural) were affected differently by audience size, which was also modulated by the individual's status; actors and spectators differed in their representation of the others' emotional state. Although our study remains exploratory, our findings highlight the complexity of audience effect when comparing observers' and performers' emotions.

Keywords: Self-report, Galvanic Skin Response, Behaviour, Theatrical representations, Audience effect.

INTRODUCTION

"Audience effect" or "Social facilitation" is known as the influence of observers on the emotions and behaviours of a performer (Zajonc, 1965; Zuberbühler, 2008)). Performers' emotions vary with the presence/absence of an audience (e.g. real, virtual and imagined: Bode & Brutten, 1963, Zajonc & Sales, 1966; Bond & Titus, 1983; Kelly et al., 2007; André et al., 2014), its composition (e.g. sex, level of expertise, familiarity: Garland & Brown, 1972; Cohen & Davis, 1973; MacIntyre & MacDonald, 1998), spatial location (e.g. distance and distribution: Furbay, 1965; Chevrolet & Lecalve, 1975; Lemasson et al., 2019) and size (Baldwin & Clevenger, 1980; McKinney et al., 1983; LeBlanc et al., 1997; Lemasson et al., 2018).

Cognition and emotions are interrelated. The term emotion arises from latin *« ex movere »*: « going out » of the normal state. The existence of emotions has been mentioned since antiquity and later by Darwin in his 1872 book where he proposes that animal and human emotions form a continuum. There have been different definitions of emotions (e.g. Dantzer, 1988; Panksepp, 2005; Paul et al., 2005) but they all converge towards the following definition: short-lived affective responses, pleasant or painful, elicited by internal or external sudden changes, associated with specific body changes (Boissy et al., 2007). Emotion arises according to the way the individual evaluates and perceives the event rather than the event itself (Boissy & Erhard, 2014). Panksepp (2005, 2011a) has mapped several basic emotional circuits in mammals consisting of neuronal pathways that interconnect midbrain circuits concentrated in midbrain regions, such as periaqueductal gray, with various basal ganglia, such as amygdala, via the hypothalamus and thalamus: for example the SEEKING system is often opposed to the well-known FEAR system, also called "avoidance system", whose main circuitry basically courses between basolateral and central regions of the amygdala and descends through the hypothalamus to the periaqueductal gray of the midbrain (Panksepp, 2011b). The stimulation of this system evokes fearful psychological states in humans while it induces freezing and flight behaviours as well as autonomic responses in non-human animals (Panksepp, 2011b). Beyond

this approach of “discrete emotions”, the “dimensional” approach plots emotions in a two-dimensional space along an affective valence axis and intensity axis (Russell,1980). Valence refers to the positive or negative aspect of emotions while intensity refers to the arousal level. According to the appraisal theory (Scherer, 1984, Scherer, 2005), emotions arise through an evaluation of the relevance of perceptual information to the organism at the present time. Based on this process, a specific valence (+/-) is attributed to the emotion experienced (Lerner and Keltner, 2000). Overall, affective states do influence a number of cognitive processes, inducing biases in information processing (*e.g.* Paul et al., 2005). Studies highly vary in how human emotions are measured and interpreted. Public-performing emotions traditionally distinguish three components: physiological, behavioural and cognitive (review by Bodie, 2010). Physiological measurements were indeed found to be relevant in some studies. For example, systolic and diastolic blood pressure and heart rate of musicians increase when about to perform in front of an audience for critical evaluation (Abel & Larkin, 1990). Cortisol levels increased in students just after they had to speak in public (Sumter et al., 2010). Other authors found behaviours informative. During public speeches, politicians (Heritage & Greatbatch, 1986) and students (Paulmann et al., 2016) exhibit voice changes (e.g. loudness, pitch, and rhythm), eye-contact avoidance and exaggerated gestures. Also, theatrical actors spontaneously adjust their posture (processing time spent in frontal position) with regard to the audience size (Lemasson et al., 2018). At last, authors have used self-report questionnaires to assess the cognitive component of emotions notably during public-speaking (Hofmann & Di Bartolo, 2000). Interestingly, some studies tried to correlate the different components of emotion and most of them found moderate correlations between physiology and cognition as well as between cognition and behaviour (Bodie, 2010; Lemasson et al., 2019).

Moreover, people vary in the way they are influenced by the changes in the audience characteristics. Several factors are known to influence the emotional state of performing

individuals, such as the performer's sex (e.g. Garland & Brown, 1972; Baldwin & Clevenger, 1980; LeBlanc et al., 1997) and age (e.g. Sumter et al., 2010). But the vast majority of studies investigating performing configurations has focused on the influence of performers only (but see Lemasson et al., 2019 for counter-example). The question remains thus open about: (1) the possible convergences or divergences between the observee's and the observer's emotions, and (2) the accuracy of the mutual perception of each other's emotion. Also, as mentioned earlier, affective states may bias cognitive assessments: there is strong evidence that perceivers' specific emotions and arousal influence judgements about other people's emotional states (Clark et al., 1984; Detweiler-Beddell et al., 2006), but this may also influence how individuals represent the quality of their own or the other's performance. Most studies performed up to now have been based on data collected in controlled experimental situations and more work is now needed on more naturalistic settings (see for example: Lemasson et al., 2018 and 2019).

Here, we used a naturalistic design to probe how audience size affects the emotions of actors and spectators. Behavioural (spectators only) and galvanic skin responses were measured during theatrical representations that varied in audience size (small/medium/large) while the cognitive component was assessed through self-report questionnaires. Video recordings allowed later behavioural analysis, and for the physiological component, the galvanic response, an innovative tool for such settings was used as it has proved reliable in assessing emotions in other contexts (Fleureau et al. 2012, Du et al. 2016). Thus, in this exploratory study, which is part of a larger project based on a series of experiments on the effects of audience characteristics on actors and spectators' emotions (Lemasson et al. 2018, 2019, in rev.), we investigated whether:

1) Audience size would affect actors and spectators differently;
2) The different components of emotions (cognition, physiology and behaviour) would be influenced differently;

3) The different components of emotions vary according to the individual's status (i.e. actor *versus* spectator);
4) Audience size, via emotional biases, would affect the other's assessment of actors' quality of performance (e.g. actors' opinion of spectators' state).

METHODS

1. Experimental setup

The experiment took place at the Diapason theatre (Rennes city, France) from the 4th to the 8th of February 2013. Fifteen actors (8 females and 7 males, aged between 18 and 25 years old) under training (Acting school of "Théâtre National de Bretagne") took part in a play. The play was composed of 15 different skits lasting about 3 minutes each. Each actor had the leading role in one skit only. The fifteen skits were played consecutively (in the same order) in the evening and on three different days of the same week. All representations were identical and the only experimental variable was the audience size with three categories: small (8 spectators), medium (30 spectators) and large (128 spectators). The original plans (based on pilot observations) were for 10, 50, 150 spectators, but these numbers had to be reduced due to a lower attendance of spectators. Spectators were people who responded to an advertisement mentioning that a free play was going to be held and that they had to book in advance because the number of seats was limited. Spectators were composed of 63% of women, 71% of people going more than twice a year to the theatre, 55% of students and 77% persons younger than 30 years old. Since our study was not experimental per se (first-come, first-served basis), we could not select or adjust the composition of the audience for each representation. As a result, the socio-demographic characteristics of the three audiences were totally random and not controlled to properly match with one another. The order of the three representations was randomized: 1st day -small, 2nd day - large, 3rd day - medium. Both spectators and actors were totally naive as they did not know what the research was about (objectives, measures) and did not know that

the audience size could vary. Actors were merely informed that they had to perform the skit that they had prepared for the entrance exam and thus practiced several times (months and again days before). The number of seats in the hall, facing the stage, did not change and people were invited to sit wherever they wanted. Two cameras (Sony HVR-1000E), positioned on both sides of the hall, filmed the entire audience.

2. Data collection

Three types of data were collected: spectators' behaviours, spectators' and actors' responses to questionnaires, spectators and actors' Galvanic Response scores.

- Video analysis

Video recordings, targeted at the audience, were performed at each representation. Later analysis was done using classical ethological methods with "continuous focal sampling" (on the entire duration of the show) on 8 spectators (based on the number of spectators in the small audience), randomly selected for the medium and large audiences; i.e. total number of persons for the three shows: 16 women and 8 men. A "continuous focal sampling" consists in noting down all occurrences and durations of the behaviours performed by the observed individual during a given focal duration (see also Altmann, 1974). Each representation has been thus re-viewed one more time for each sampled individual. The behaviours recorded (number/hour) corresponded to potential indicators of emotions, such as self-directed behaviors (hand in hair gestures, self-scratching), agitation (number of arm movements), loss of attention (yawns), and mouth movements (i.e. smiling, laughing, talking). We also measured the percentage of time spent looking at the actors, at the other spectators and anywhere else.

- Questionnaires

At the end of the week (for actors) or at the end of each play (for spectators), the 15 actors and eight randomly selected spectators were asked to respond to a list of eight identical questions (Table 1, as in Lemasson et al. 2019). Spectators were asked to respond to the following additional question: « Did you feel at ease in the audience? ». Each spectator had to give a score going from 1 (absolutely not) to 5 (definitely yes) for each question. Each actor had to rank the three situations (i.e. small, medium and large audiences) from the least (Rank 3) to the most (Rank 1) concerned by the given question.

- Galvanic response score analysis

Each leading (role) actor and 8 random spectators per representation, were equipped with Galvanic Skin Response sensors (BodyMedia). The sensor is composed of two electrodes connected with direct current. Sensors were positioned on the palmar surface of three fingers (index, middle, ring) of the left hand, where eccrine glands are known to be important (Venables & Christie, 1980). The measurements on a given actor were conducted all along his/her own skit. The measurements on a given spectator was conducted all along the entire representation.

The Galvanic Skin Responses were quantified with the Ledalab V3.4.8 software implemented on Matlab (Benedek & Kaernbach, 2010). Data were extracted using a 1Hz low pass filter (Boucsein, 2012; Figner & Murphy, 2011) and according to the method of the continuous deconvolution that allows to separate tonic and phasic activity (Benedek & Kaernbach, 2010). The amplitude threshold was set at 0.05 μS (Boucsein, 2012; Venables & Christie, 1980). We counted the number of responses per minute (Schmidt & Walach, 2000). In order to reduce inter-individual amplitude differences of the response, the data were normalized using the following formula: $X' = \log (1 + |X|)$; where $|X|$ is the raw value of the Galvanic skin activity (Venables & Christie, 1980).

3. Statistical analysis

Given our small sample size, we chose to run only nonparametric statistics. We used Wilcoxon tests (for related samples) to compare the responses given to questionnaires by actors (using rankings as individual values) as well as their galvanic skin response rates in the three representations. We used Mann-Whitney tests (for unrelated samples) to compare the responses given to questionnaires by all spectators (using scoring as individual values) and to compare the galvanic skin response rates as well as behaviours of the selected spectators in the three representations. Statistics were done with Statistica 13.1 software using an alpha threshold set at 0.05.

RESULTS

- Influence of audience size on spectators

Spectators felt more at ease (Mann-Whitney test, U=14, Z=-1.99, P=0.046; Fig1a) in the large audience representation than in the small one. The audience size influenced none of the other responses to the spectators' questionnaires ($16<U<31.5$, $-0.65<Z<1.87$, $0.07<P<1$).

Audience size also influenced the spectators' galvanic response scores, with small- (U=13, Z=-1.94, P=0.049) and medium-size (U=13, Z=-1.94, P=0.049) audiences associated with lower scores than the large audience (Fig1b).

Audience size influenced spectators' behaviours (Fig2). Indeed, the medium sized audience was associated with more arm movements (U=11, Z=-2.15, P=0.028, U=12, Z=2.05, P=0.038 respectively compared to small and large), more time spent looking at actors (U=15, Z=-1.73, P=0.08/small, U=13, Z=1.94, P=0.049/large), more mouth movements (U=13, Z=-1.95, P=0.049/small) and less yawning (U=12, Z=-2.26, P=0.024/large). The small audience was associated with less hand in hair gestures (U=14, Z=-2.06, P=0.039) and less mouth

movements (U=12, Z=-2.05, P=0.038) than the large audience. All other comparisons were not significant (11<U<32, -1.95<Z<2.15, 0.07<P<0.87).

- Influence of audience size on actors

Audience size influenced almost all responses to actors' questionnaires. Indeed, when faced to a small audience, actors felt more at ease (Wilcoxon test, T=17, Z=1.99, P=0.046), judged a lower public interest (T=13, Z=20.14, P=0.041 ,T=9, Z=2.35, P=0.019), felt the public to be less involved (T=8.5, Z=2.18, P=0.029, T=5.5, Z=2.45, P=0.014) and less emotionally expressive (T=10.5, Z=2.24, P=0.025), with less within-audience (T=0, Z=2.52, P=0.012 ,T=0, Z=2.52, P=0.012) and actor-spectators (T=9, Z=2.35, P=0.019, T=15, Z=1.88, P=0.056) interactions than in the large and medium audiences (Fig3). They also felt less competent (T=17, Z=1.99, P=0.046) in the small audience than in the medium one. At last, actors felt more at ease (T=11, Z=2.41, P=0.016) and tended to feel less within-audience interactions with the medium than with the large audience spectators (T=4.5, Z=1.89, P=0.059). Audience size did not influence any other comparison based on questionnaires (20<T<45, 0<Z<1.49, 0.14<P<1), nor actors' galvanic response scores (32<T<48, 0.68<Z<1.29, 0.2<P<0.5, Fig4).

DISCUSSION

The results obtained in this exploratory study confirm our expectations: actors and spectators differed in their perception of the effects of audience size, on both the cognitive and physiological components; the different components were affected differently by audience size, which was also modulated by the individual's status; actors and spectators differed in their representation of the others' emotional state.

Actors and spectators indeed diverged in several ways with respect to their emotional responses to audience size. First, in actors, the cognitive but not the physiological component of emotions was affected by audience size contrarily to spectators for which all three components were affected. Thus, on the cognitive side, extreme situations (large and small audiences) led to less positive feelings and self-perception of competency in actors, whereas spectators claimed to be more at ease in a large audience. The fact that actors felt less at ease in the large audience goes in line with previous findings that showed an increase of anxiety experienced by public speakers and performers when facing large rather than small audiences (Jackson & Latané, 1981; McKinney et al., 1983; Le Blanc et al., 1997; Lemasson et al., 2018). On the physiological side, audience size had no effect on the actors' galvanic response but this response was higher for the large audience in spectators.

The discrepancy between the cognitive and physiological responses to audience size in actors may give rise to at least two non-exclusive possible explanations: 1) actors are trained for divided attention as they are required to self-observe their own actions while facing a public, which is a pre-requisite for improving skills (Barker, 2002). 2) Actors are trained to mimic human emotional states without experiencing them fully, which may lead to a lowering of emotional physiological responses (Stern & Lewis, 1968). Cognitive, behavioural and physiological responses in spectators converged to some point: they felt more at ease, had higher galvanic responses (possibly more excitement) and more mouth movements (laugh, talk…) when the audience was large. Indeed, spectators were more reactive and expressive in the large audience condition than in the small one. It could be that the spectators' emotional responses may have been influenced by the well-known phenomenon of social 'emotional contagion' (Hatfield et al., 2011): spectators, that were highly impacted by the large audience size as shown in their behaviours, could have mutually influenced one another's affect.

Whereas spectators did not present any clear representation of the actors' feelings, the actors proved rather accurate in assessing the effects of audience size on the spectators' emotions. Indeed, actors' responses to questionnaires about spectators' feelings (emotions but also involvement, within-audience interactions) match most of our behavioural measures on spectators, with more emotional expressions and mobility in larger audience situations. It may be that actors develop more, through training, an "Emotional intelligence", that is a set of skills hypothesized to contribute to the accurate appraisal and expression of emotion in oneself and in others, (review by Salovey & Grewal, 2005). People notably vary in their predisposition to be self-attentive (Carver & Scheier, 1978). As mentioned above, actors are definitely trained for divided attention, involving their own actions but also a high sensitivity to the feedback received from spectators' reactions. Scherer (1987, 1993) has proposed the term of "subjective feeling" that would reflect in the central nervous system the changes in the central and peripheral systems during an emotional episode and indicates that this does not require subjective feelings to be conscious. Only a small part of them could in fact be verbalized (Kaiser & Scherer 1998). Because actors are at the center of attention of the public and possibly other actors, they may also have been more concentrated on their own and the public's feelings and become, though enhanced attention, more conscious of what happened. Beyond emotional responses, they expressed that the medium audience was the situation showing the highest level of spectators' concentration (confirmed when measuring the time spent looking at actors) and the highest scores of actors' self-expressed competence. In a previous study, we showed that both large and small audiences (and not medium size audiences) triggered an unconscious change of actors' postures (Lemasson et al., 2018). According to actors' experience and training, one could therefore think that there could be better settings (e.g. public size) than others.

In sum, our findings highlight the complexity of audience effect when comparing observers' and performers' emotions. It also highlights the feasibility to investigate such questions in more "naturalistic" frameworks than what is typically done. There are, however, some limitations to our study, and notably the fact that we did not control any potential memory effect given that actors responded to questionnaires at the end of the three representations while spectators did it immediately after each representation. We must also acknowledge that our findings are based on a unique experiment and should thus be considered as an exploratory study that requires further investigation.

Our results are a good illustration of the tight mutual relationship between emotions and cognition, as the effects of audience size, including on the appraisal of the quality of the actor's performance, appeared to be linked to how these situations were emotionally perceived. Scherer (2000) clearly stated the thorny issues that come with the definition, the conceptualization and operationalization of the phenomenon called emotion. He highlighted the need to focus on this interaction between cognition and emotion rather than trying to separate the two. In terms of social cognition, investigations in non-experimental contexts may be a key aspect for understanding this phenomenon. We believe that in this respect, our study contributes to the idea that, even if they are difficult to set up and interpret, studies in ecological contexts are very promising and should be encouraged for future research.

Compliance with ethical standards

The procedure performed in our study is in accordance with the French ethical standards and with the 1964 Helsinki declaration and its later amendments. Since our study was only observational, no further ethical authorization was requested according to the French law. Authors declare no conflict of interest. Informed consent was obtained from all participants

included in the study. Data (questionnaires and videos) are all securely stored in a locked cabinet in EthoS lab.

REFERENCES

Abel, J. L., & Larkin, K. T. (1990). Anticipation of Performance among Musicians: Physiological Arousal, Confidence, and State-Anxiety. Psychology of Music, 18(2), 171-182. https://doi.org/10.1177/0305735690182006

Altmann, J. (1974). Observational study of behavior: sampling methods. Behaviour, 49(3-4), 227-266.

André, V., Jost, C., Hausberger, M., Le Pévédic, B., Jubin, R., Duhaut, D., & Lemasson, A. (2014). Ethorobotics applied to human behaviour: can animated objects influence children's behaviour in cognitive tasks? Animal Behaviour, 96, 69–77. https://doi.org/10.1016/j.anbehav.2014.07.020

Baldwin, S. F., & Clevenger, T. (1980). Effect of Speakers' Sex and Size of Audience on Heart-Rate Changes during Short Impromptu Speeches. Psychological Reports, 46(1), 123-130. https://doi.org/10.2466/pr0.1980.46.1.123

Barker, S. (2002). The Alexander technique: an acting approach. Theatre Topics, 12(1), 35-48. https://doi.org/10.1353/tt.2002.0002

Benedek, M., & Kaernbach, C. (2010). A continuous measure of phasic electrodermal activity. Journal of Neuroscience Methods, 190(1), 80-91. https://doi.org/10.1016/j.jneumeth.2010.04.028

Bode, D. L., & Brutten, E. J. (1963). A palmar sweat investigation of the effect of audience variation upon stage fright. Speech Monographs, 30(2), 92-96. https://doi.org/10.1080/03637756309375363

Bodie, G. D. (2010). A Racing Heart, Rattling Knees, and Ruminative Thoughts: Defining, Explaining, and Treating Public Speaking Anxiety. Communication Education, 59(1), 70-105. https://doi.org/10.1080/03634520903443849

Boissy, A., Erhard, H.W. (2014). How studying interactions between animal emotions, cognition, and personality can contribute to improve farm animal welfare. Genetics and the Behavior of Domestic Animals, Academic Press, pp.81-113, 2014, 978-0-12-394586-0.

Boissy, A., Manteuffel, G., Jensen, M.B., Moe, R.O., Spruijt, B., Keeling, L.J., Winckler, C., Forkman, B., Dimitrov, I., Langbein, J., Bakken, M., Veissier, I., Aubert, A. (2007). Assessment of positive emotions in animals to improve their welfare. Physiol. Behav. 92, 375–397. https://doi.org/10.1016/J.PHYSBEH.2007.02.003

Bond, C. F., & Titus, L. J. (1983). Social facilitation: A meta-analysis of 241 studies. Psychological Bulletin, 94(2), 265–292. https://doi.org/10.1037/0033-2909.94.2.265

Boucsein, W. (2012). Electrodermal Activity [2nd Edition]. Springer Science & Business Media.

Carver, C. S., & Scheier, M. F. (1978). Self-focusing effects of dispositional self-consciousness, mirror presence, and audience presence. Journal of Personality and Social Psychology, 36(3), 324–332. https://doi.org/10.1037/0022-3514.36.3.324

Chevrolet, D., & Le Calve, G. (1975). Influence de la présence et de la position d'un observateur sur le comportement scolaire d'élèves de l'enseignement élémentaire. Revue française de pédagogie, (31), 16–33.

Clark, M. S., Milberg, S., & Erber, R. (1984). Effects of arousal on judgments of others' emotions. Journal of Personality and Social Psychology, 46(3), 551-560. https://doi.org/10.1037/0022-3514.46.3.551

Cohen, J. L., & Davis, J. H. (1973). Effects of audience status, evaluation, and time of action on performance with hidden-word problems. Journal of Personality and Social Psychology, 27(1), 74–85. https://doi.org/10.1037/h0034447

Dantzer, R. (1988). Les émotions. Presses Universitaires de Paris.

Detweiler-Bedell, B., Detweiler-Bedell, J., & Salovey, P. (2006). Mood-congruent perceptions of success depend on self-other framing. Cognition and Emotion, 20(2), 196-216. https://doi.org/10.1080/02699930500294996

Du, S., Schu, E., Tong, F., Ge, Y., Li, L., Qiu, J, Guillotel, P., Fleureau, J., Danieau, F., & Muller, D. (2016). Visualizing the emotional journey of a musueum. Proceedings of EmoVis 2016 Workshop, March 10, 2016, Sonoma, USA. DOI:10.3384/ecp10302

Figner, B., & Murphy, R. O. (2011). Using skin conductance in judgment and decision making research. In M. Schulte-Mecklenbeck, A. Kühberger, & R. Ranyard (Eds.), Society for Judgment and Decision Making series. A handbook of process tracing methods for decision research: A critical review and user's guide (p. 163–184). Psychology Press.

Fleureau, J., Penet, C., Guillotel, P., & Demarty, C. H. (2012). Electrodermal activity applied to violent scenes impact measurement and user profiling. IEEE International Conference on Systems, Man, and Cybernetics, Seoul, South Corea, October 2012. DOI: 10.1109/ICSMC.2012.6378302

Furbay, A. L. (1965). The influence of scattered versus compact seating on audience response. Speech Monographs, 32(2), 144–148. https://doi.org/10.1080/03637756509375444

Garland, H., & Brown, B. R. (1972). Face-Saving as Affected by Subjects' Sex, Audiences' Sex and Audience Expertise. Sociometry, 35(2), 280. https://doi.org/10.2307/2786623

Hatfield, E., Rapson, R. L., & Le, Y.-C. L. (2011). Emotional contagion and empathy. In The social neuroscience of empathy. (p. 19-30), J. Decety, W. Ickes (Eds.), Cambridge: MIT Press.

Heritage, J., & Greatbatch, D. (1986). Generating Applause: A Study of Rhetoric and Response at Party Political Conferences. American Journal of Sociology, 92(1), 110-157. https://doi.org/10.1086/228465

Hofmann, S. G., & DiBartolo, P. M. (2000). An instrument to assess self-statements during public speaking: Scale development and preliminary psychometric properties. Behavior Therapy, 31(3), 499-515. https://doi.org/10.1016/S0005-7894(00)80027-1

Jackson, J. M., & Latané, B. (1981). All alone in front of all those people: Stage fright as a function of number and type of co-performers and audience. Journal of Personality and Social Psychology, 40(1), 73–85. https://doi.org/10.1037/0022-3514.40.1.73

Kaiser, S., & Scherer, K. R. (1998). Models of "normal" emotions applied to facial and vocal expression in clinical disorders. In W. F. Flack, Jr. & J. D. Laird (Eds.), Series in affective science. Emotions in psychopathology: Theory and research (p. 81–98). Oxford University Press.

Kelly, O., Matheson, K., Martinez, A., Merali, Z., & Anisman, H. (2007). Psychosocial Stress Evoked by a Virtual Audience: Relation to Neuroendocrine Activity. CyberPsychology & Behavior, 10(5), 655-662. https://doi.org/10.1089/cpb.2007.9973

LeBlanc, A., Jin, Y. C., Obert, M., & Siivola, C. (1997). Effect of Audience on Music Performance Anxiety. Journal of Research in Music Education, 45(3), 480-496. https://doi.org/10.2307/3345541

Lemasson, A., André, V., Boudard, M., Lippi, D., Cousillas, H., & Hausberger, M. (2019). Influence of theatre hall layout on actors' and spectators' emotions. Animal Cognition. https://doi.org/10.1007/s10071-019-01249-2

Lemasson, Alban, André, V., Boudard, M., Lippi, D., & Hausberger, M. (2018). Audience size influences actors' anxiety and associated postures on stage. Behavioural Processes, 157, 225-229. https://doi.org/10.1016/j.beproc.2018.10.003

Lemasson, A., Lippi, D., Hamelin, L., Louazon, S., Hausberger, M. (*In press*). Public attitude influences actors' visual orientation: a pilot experimental study. Interaction Studies.

Lerner, J.S., Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgement and choice. Cogn. Emot. 14, 473–493. https://doi.org/10.1080/026999300402763

MacIntyre, P. D., & MacDonald, J. R. (1998). Public speaking anxiety: Perceived competence and audience congeniality. Communication Education, 47(4), 359-365. https://doi.org/10.1080/03634529809379142

McKinney, M. E., Gatchel, R. J., & Paulus, P. B. (1983). The Effects of Audience Size on High and Low Speech-Anxious Subjects During an Actual Speaking Task. Basic and Applied Social Psychology, 4(1), 73-87. https://doi.org/10.1207/s15324834basp0401_6

Panksepp, J. (2005). Affective neuroscience: The foundations of human and animal emotions. Series in Affective Science, Oxford University Press, Oxford, UK.

Panksepp, J. (2011a). The basic emotional circuits of mammalian brains: Do animals have affected lives? Neuroscience and Behavioral Reviews, 35, 1791-1804.

Panksepp, J., Fuchs, T., Iacobucci, P. (2011b). The basic neuroscience of emotional experiences in mammals: The case of subcortical FEAR circuitry and implications for clinical anxiety. Applied Animal Behaviour Science, 129, 1-17. Doi: 10.1016/j.applanim.2010.09.014.

Paul, E.S., Harding, E.J., Mendl, M. (2005). Measuring emotional processes in animals: the utility of a cognitive approach. Neurosci. Biobehav. Rev. 29, 469–491. https://doi.org/10.1016/J.NEUBIOREV.2005.01.002

Paulmann, S., Furnes, D., Bøkenes, A. M., & Cozzolino, P. J. (2016). How Psychological Stress Affects Emotional Prosody. PLoS ONE, 11(11). https://doi.org/10.1371/journal.pone.0165022

Russell, J.A. (1980). A circumplex model of affect. J. Pers. Soc. Psychol. 39, 1161‑1178.

Salovey, P., & Grewal, D. (2005). The Science of Emotional Intelligence. Current Directions in Psychological Science, 14(6), 281-285. https://doi.org/10.1111/j.0963-7214.2005.00381.x

Scherer, K.R. (1987) “Toward a Dynamic Theory of Emotion: The Component Process Model of Affective States” , Geneva Studies in Emotion and Communication 1: 1-98

Scherer, K. R. (1993) “Studying the Emotion-Antecedent Appraisal Process: An Expert System Approach” , Cognition and Emotion 7: 325-355

Scherer, K.R. (2005). What are emotions? And how can they be measured? Soc. Sci. Inf. 44, 695–729. https://doi.org/10.1177/0539018405058216

Scherer, K.R. (1984). On the nature and function of emotion: a component process approach, in: KR, S., P, E. (Eds.), Approaches to Emotion. Hillsdale: Lawrence Erlbaum, pp. 297–

317.Scherer, K. R. (2000). Psychological models of emotion. In J. C. Borod (Ed.), Series in affective science. The neuropsychology of emotion (p. 137–162).

Schmidt, S., & Walach, H. (2000). Electrodermal activity (EDA): State-of-the-art measurement and techniques for parapsychological purposes. Journal of Parapsychology, 64(2), 139-163.

Stern, M. R., & Lewis, N. L. (1968). Ability of actors to control their GSRS and express emotions. Psychophysiology, 4(3), 294-299.

Sumter, S. R., Bokhorst, C. L., Miers, A. C., Van Pelt, J., & Westenberg, P. M. (2010). Age and puberty differences in stress responses during a public speaking task: Do adolescents grow more sensitive to social evaluation? Psychoneuroendocrinology, 35(10), 1510-1516. https://doi.org/10.1016/j.psyneuen.2010.05.004

Venables, P. H., & Christie, M. J. (1980). Electrodermal activity. In Martin, I & Venables, PH. (Eds) Techniques in Psychophysiology, 3-67. Chichester, UK. Wiley.

Zajonc, R. B. (1965). Social facilitation. Science, 149, 36381, 269-274.

Zajonc, R. B., & Sales, S. M. (1966). Social facilitation of dominant and subordinate responses. Journal of Experimental Social Psychology, 2(2), 160-168. https://doi.org/10.1016/0022-1031(66)90077-1

Zuberbühler, K. (2008). Audience effects. Current Biology, 18, 5, 189-190.

Table 1 – Questions asked to spectators and actors

Questions for spectators	Questions for actors
Did you like the show?	Which show did the public like?
Did you feel involved during the show?	In which show did the public feel involved?
Did you feel any emotion?	In which show did the public feel any emotion?
Did you interact with other spectators?	In which show did the public interact with one another?
Did you feel the actors at ease?	In which show did you feel at ease?
Did you feel the actors competent?	In which show did you feel competent?
Did the actors interact with you?	In which show did the public interact with you?
Did the actors use the space on stage?	In which show did you use the space on stage?

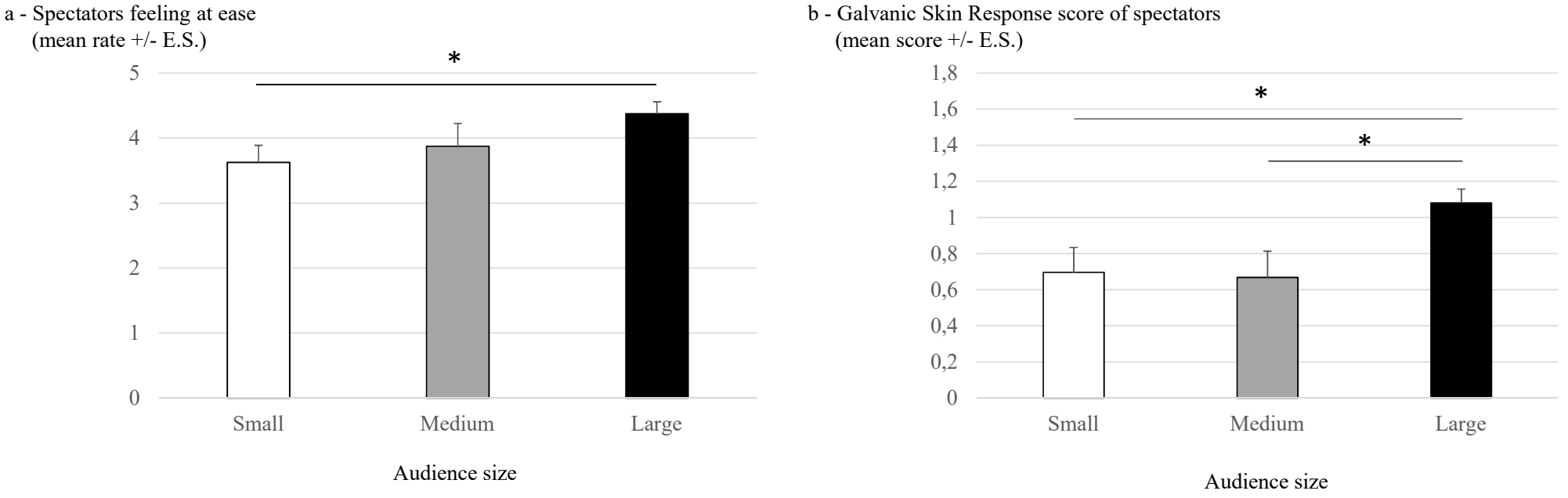
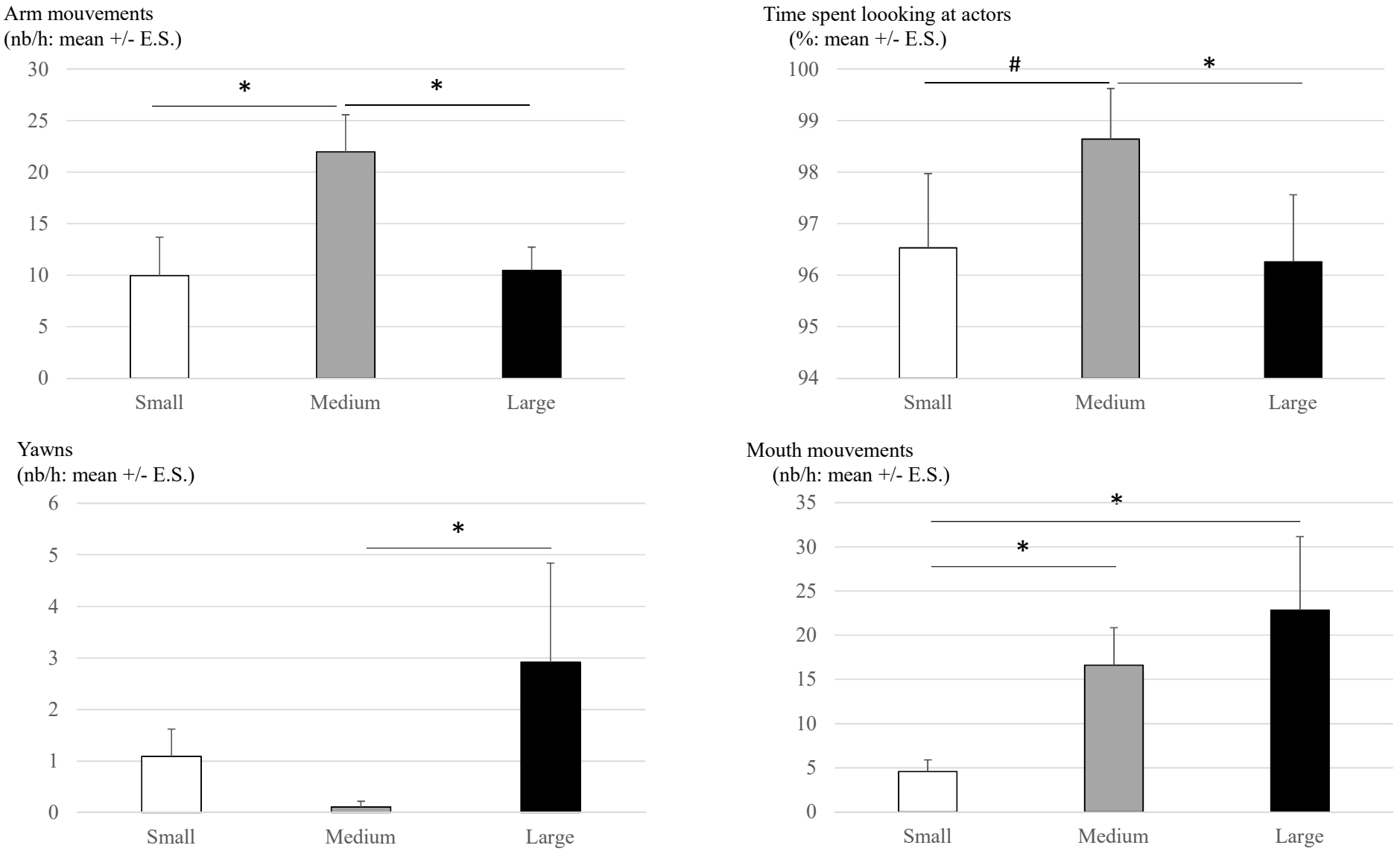


Fig1 Spectators' emotions based on responses to questionnaires (a) and Galvanic Skin Response measures (b) in relation with audience size (Mann-Whitney tests *P<0.05)

Fig2 Spectators' behaviours displayed in the different audiences (Mann-Whitney tests #P<0.1, *P<0.05)



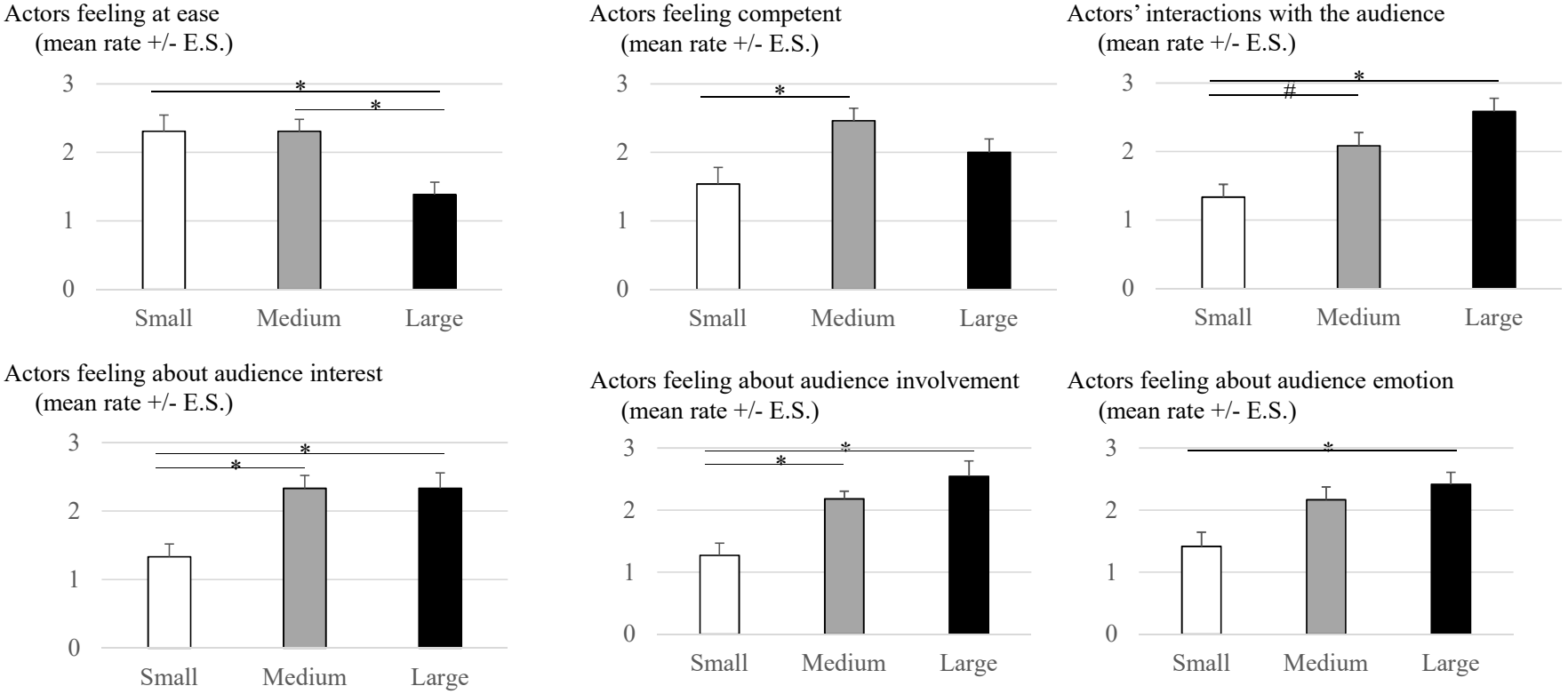


Fig3 Actors' emotions based on responses to questionnaires in relation with audience size (Wilcoxon tests #P<0.1, *P<0.05)

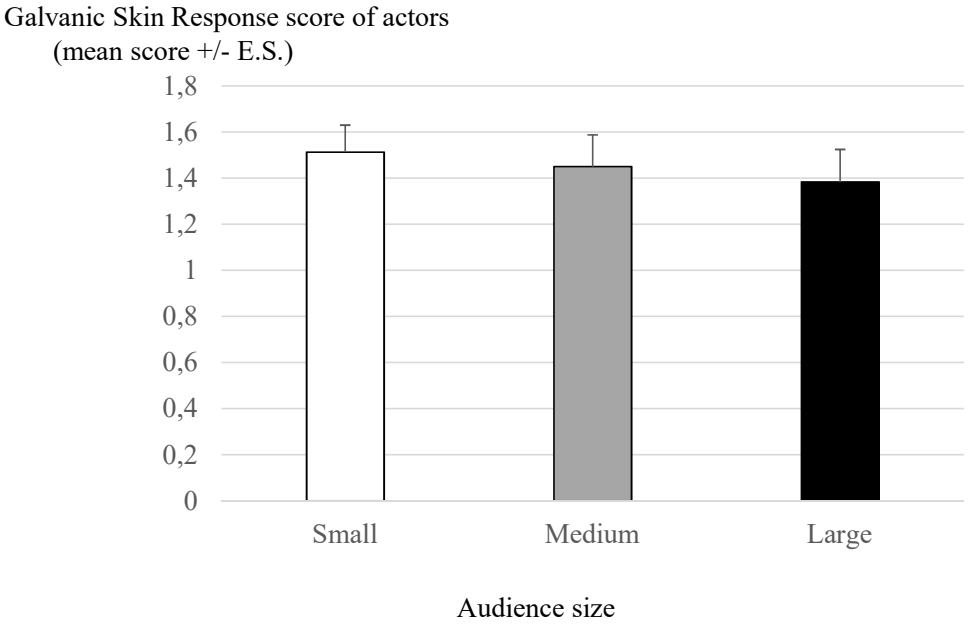


Fig4 Actors' emotions based on Galvanic Skin Response measures in relation with audience size.