

In the second block the stimuli were presented again once in a randomised order and participants were asked to give a categorical judgement by choosing which of the seven emotions they perceived using a 7 alternative forced choice task. We presented each display only once during each block because we wanted to avoid the possibility of participants having the time to learn that only five emotions out of seven were presented, and also to decrease the chance of participants having the time to acquire cognitive strategies with which to make their emotional judgements. The rating judgements were always asked for before the categorical judgements to avoid possible rating biases toward the chosen category.

4.3. Experiment 2

4.3.1. Participants

Sixteen further participants (10 females and 6 males) of UK nationality with no or little musical experience and an average age of 23 were recruited to participate in this experiment. The study received IRB approval and all participants gave informed consent to participate. Participants received a monetary incentive for their participation.

4.3.2. Apparatus and stimuli

The apparatus and stimuli were the same as for Experiment 1.

4.3.3. Procedure

In Experiment 2 the new group of participants was asked to judge the perceived emotion from a list of five categories (happiness, sadness, anger, surprise, and neutral). However, this time participants were requested to focus their attention on the visual information and disregard the auditory, or vice versa, and to be as fast as possible in giving their answer. This change of task was aimed to test whether the irrelevant information would affect the emotion communicated by the attended modality, and if so, whether this effect would change for the different stimuli (e.g. bimodal incongruent for instrument and emotion vs. bimodal incongruent only for emotion). In the visual block of the experiment participants saw stimuli displayed only visually, audiovisually congruently, and audiovisually incongruently. In the auditory block participants were presented with auditory, audiovisually congruent, and audiovisually incongruent stimuli. The order of the auditory and visual blocks was counterbalanced across participants. In each block 42 stimuli were presented, 6 unimodal, 6 bimodal congruent, 12 bimodal incongruent for emotion, and 18 bimodal incongruent for instrument and emotion.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.brainres.2010.02.012.

REFERENCES

- Arrighi, R., Alais, D., Burr, D., 2006. Perceptual synchrony of audiovisual streams for natural and artificial motion sequences. *J. Vis.* 6, 260–268.
- Behrens, G.A., Green, S.B., 1993. The ability to identify emotional content of solo improvisations performed vocally and on three different instruments. *Psychol. Music* 21, 20–33.
- Bertelson, P., De Gelder, B., 2004. The psychology of crossmodal attention. In: Spence, C., Driver, J. (Eds.), *Crossmodal Space and Crossmodal Attention*. Oxford University Press Inc., pp. 141–177.
- Broughton, M., Stevens, C., 2009. Music, movement and marimba: an investigation of the role of movement and gesture in communicating musical expression to an audience. *Psychol. Music* 37, 137–153.
- Campanella, S., Belin, P., 2007. Integrating face and voice in person perception. *Trends Cogn. Sci.* 11, 535–543.
- Castellano, G., Mortillaro, M., Camurri, A., Volpe, G., Scherer, K., 2008. Automated analysis of body movement in emotionally expressive piano performances. *Music Percept.* 26, 103–119.
- Collignon, O., Girard, S., Gosselin, F., Roy, S., Saint-Amour, D., Lassonde, M., Lepore, F., 2008. Audio-visual integration of emotion expression. *Brain Res.* 1242, 126–135.
- Dahl, S., Friberg, A., 2007. Visual perception of expressiveness in musicians' body movements. *Music Percept.* 24, 433–454.
- Davidson, J.W., 1993. Visual perception of performance manner in the movements of solo musicians. *Psychol. Music* 21, 103–113.
- Davidson, J.W., 1994. Which areas of a pianist's body convey information about expressive intention to an audience? *J. Hum. Mov. Stud.* 26, 279–301.
- De Gelder, B., Vroomen, J., 2000. The perception of emotions by ear and by eye. *Cogn. Emot.* 14, 289–311.
- Ekman, P., Friesen, W.V., 1975. *Unmasking the Face*. Englewood Cliffs, NJ, Prentice-Hall.
- Ernst, M.O., Banks, M.S., 2002. Humans integrate visual and haptic information in a statistically optimal fashion. *Nature* 415, 429–433.
- Ernst, M.O., Bühlhoff, H.H., 2004. Merging the senses into a robust percept. *Trends Cogn. Sci.* 8, 162–169.
- Hietanen, J.K., Leppänen, J.M., Illi, M., 2008. Evidence for the integration of audiovisual emotional information at the perceptual level of processing. *Eur. J. Cogn. Psychol.* 16, 769–790.
- Juslin, P.N., Laukka, P., 2003. Communication of emotions in vocal expression and music performance: different channels, same code? *Psychol. Bull.* 129, 770–814.
- Juslin, P., Sloboda, J.A., 2001. *Music and Emotion: Theory and Research*. Oxford Univ. Press, Oxford.
- Kreifelts, B., Ethofer, T., Grodd, W., Erb, M., Wildgruber, D., 2007. Audiovisual integration of emotional signals in voice and face: an event-related fMRI study. *NeuroImage* 37, 1445–1456.
- Landy, M.S., Maloney, L.T., Johnston, E.B., Young, M., 1995. Measurement and modeling of depth cue combination: in defense of weak fusion. *Vis. Res.* 35, 389–412.
- Laukka, P., Gabrielsson, A., 2000. Emotional expression in drumming performance. *Psychol. Music* 28, 181–189.
- Massaro, D.W., Egan, P.B., 1996. Perceiving affect from the voice and the face. *Psychon. Bull. Rev.* 3, 215–221.
- McGurk, H., MacDonald, J., 1976. Hearing lips and seeing voices. *Nature* 264, 746–748.
- Petrini, K., Dahl, S., Rocchesso, D., Waadeland, C.H., Avanzini, F., Pollick, F., Puce, A., 2009a. Multisensory integration of drumming actions: musical expertise affects perceived audiovisual asynchrony. *Exp. Brain Res.* 198, 339–352.