Emotional Face Processing in Hearing and Deaf Bilinguals

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BACKGROUND

Deafness has been reported to have a negative impact upon the understanding and processing of human emotional states. A large body of work, mostly in children has suggested that:

- Deaf children with cochlear implants have impaired facial expression recognition for emotional states [1, 2]
- Deaf children have impaired emotional socialization [3, 4]
- Deaf adults differ in their strategy for extracting emotional state information from faces [5,6]

Here, we report a study of how deaf adults extract emotional state information from face stimuli.

Some recent work in typically hearing populations has suggested that bilinguals may differ from monolinguals in how they process facial stimuli [7].

We therefore compared deaf sign-speech and hearing speech-speech bilingual adults recruited from RIT/NTID (alongside a comparison sample of hearing bilinguals from the University of Fribourg).

We predicted that deaf bilinguals would perform worse than hearing bilinguals because of the multiple ways in which facial expressions need to be decoded for users of a sign language. Specifically, in ASL the face is used for:

- Signaling affect and emotional state [8]
- As an obligatory component of some lexical items [9]
- Marking of wh- and yes/no questions [10]

PARTICIPANTS

Deaf sign-speech bilinguals (N = 39)

- 18-31 years of age
- Profoundly deaf (HL > 70dB)
- Acquired ASL before the age of 5 years
- Self-reported fluency in English (written or spoken)
- Undergraduate students at RIT or RIT/NTID

Hearing speech-speech bilinguals (N = 22)

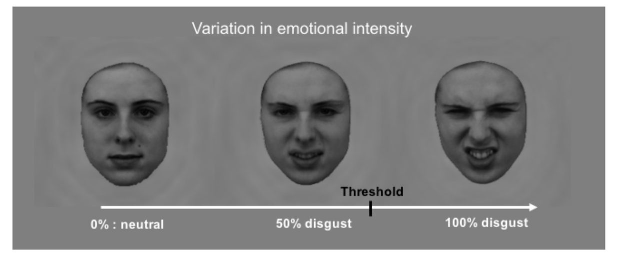
- 18-28 years of age
- Acquired English plus one other spoken language before the age of 5 years
- Undergraduate students registered at RIT

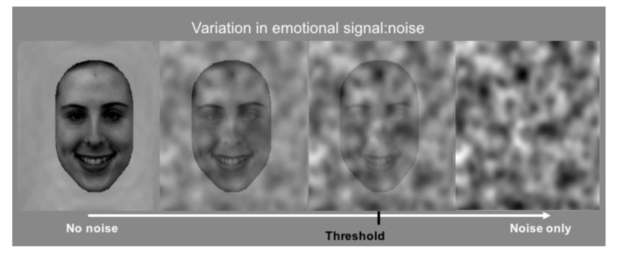
METHODS

EXPERIMENT 1: INTENSITY/SIGNAL

Morphed continua were generated between a neutral facial expression and six emotional face types (anger, disgust, fear, happy, sad, surprise).

Position along the morph continua determined the intensity of the signal, whereas the amount of noise superimposed upon a stimulus determined the amount of signal.



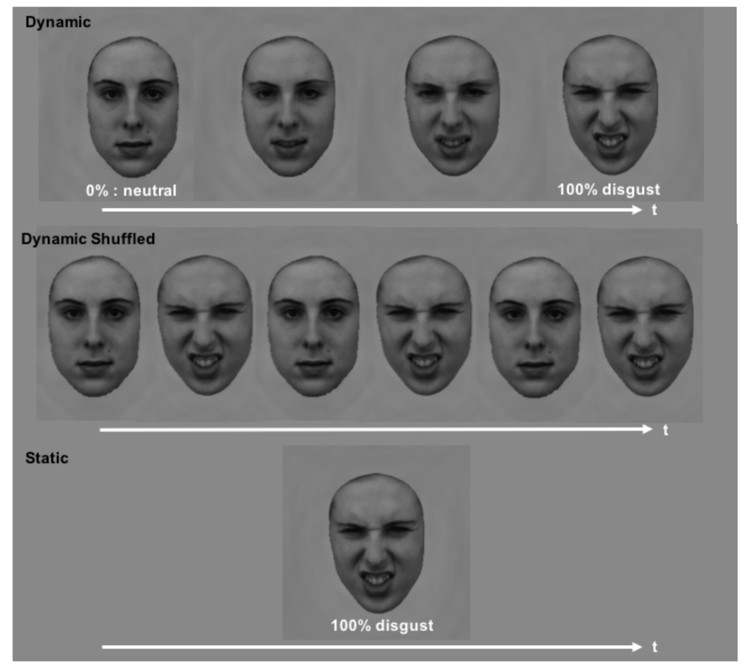


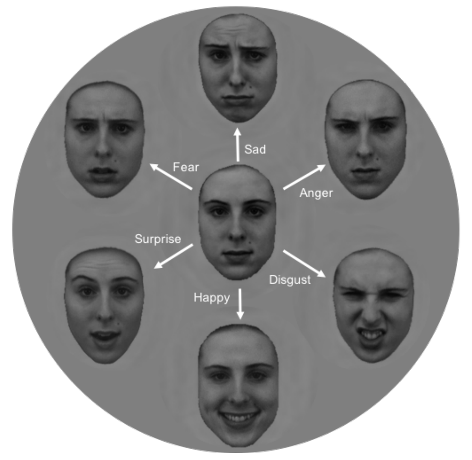
Participants viewed these face stimuli and decided which of the six emotions were being expressed (or indicated that they could not decide) with a key press.

Responses were used to compute 75% thresholds for an accurate decision. ROC curves were also computed for each emotional category, as were confusion matrices to determine which emotional faces were perceptually similar.

EXPERIMENT 2: STATIC/DYNAMIC

Identification of emotion from full intensity static faces was contrasted with identification performance when emotions were presented as animated GIFs (with scrambled animated GIFs as a dynamic control).

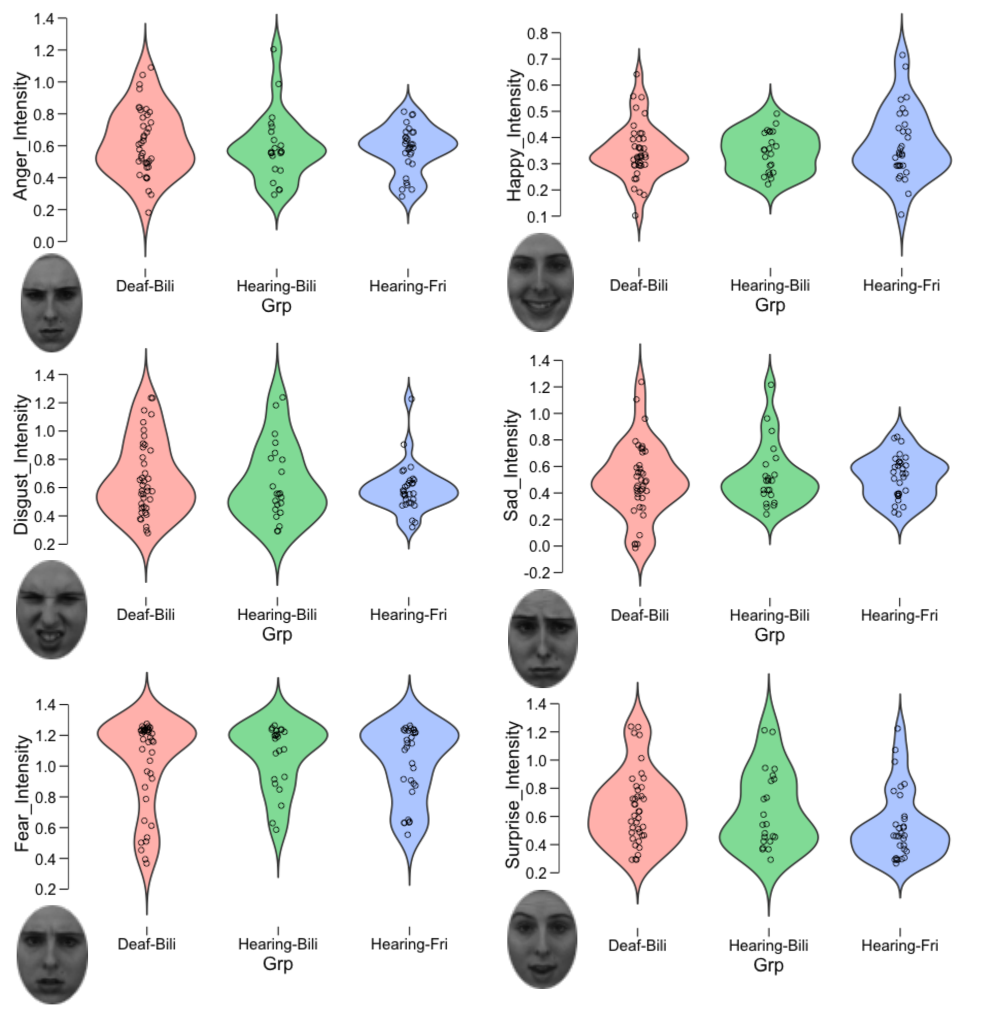




RESULTS

EXPERIMENT 1: INTENSITY/SIGNAL

Intensity Thresholds



Bayesian repeated measures ANOVA (conducting using JASP) revealed that the data strongly supports the null over the alternative model that intensity thresholds vary as a function of deafness.

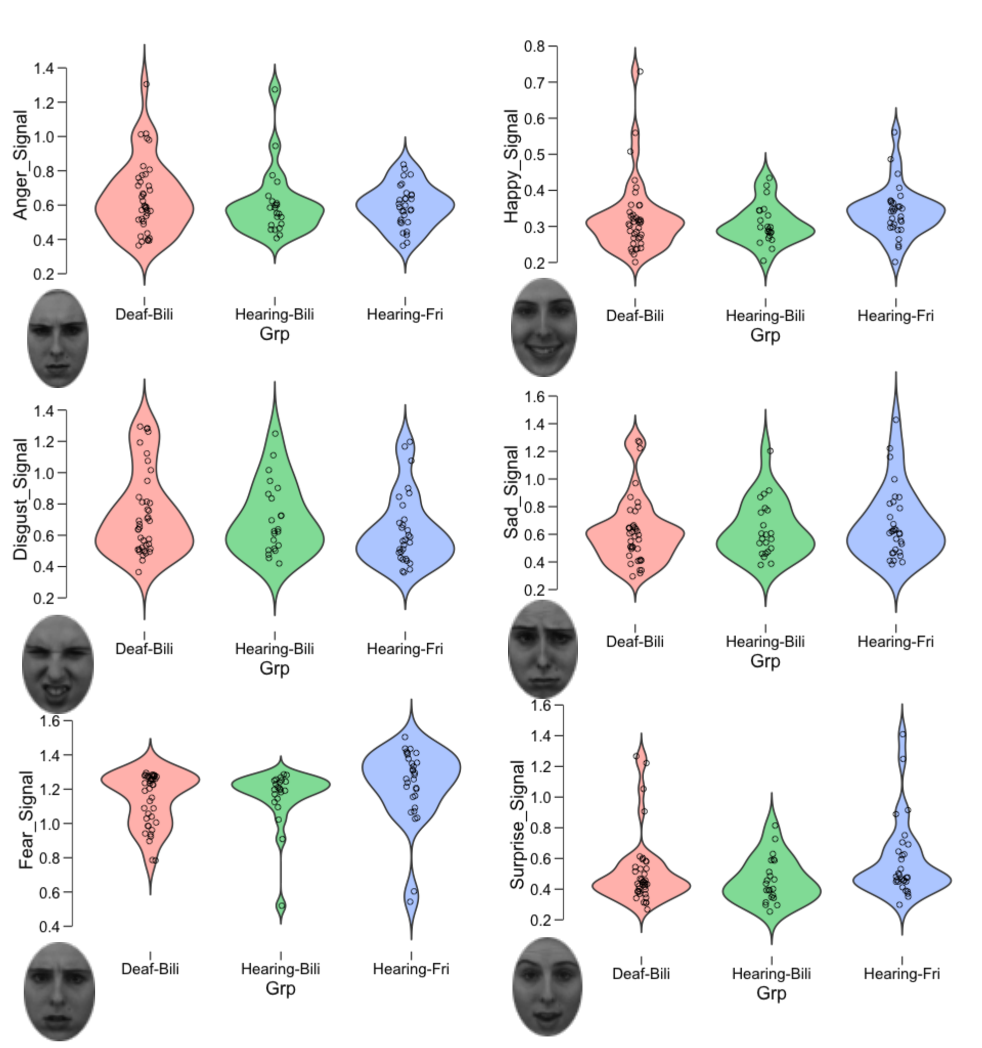
Models	P(M)	P(M|data)	BF_M	BF_{10}	% error
Null model (incl. subject)	0.200	4.854e -45	1.941e -44	1.000	
Emotion	0.200	0.853	23.228	1.758e +44	1.575
Grp	0.200	7.694e -46	3.078e -45	0.159	5.646
Emotion + Grp	0.200	0.144	0.672	2.963e +43	1.951
Emotion + Grp + Emotion * Grp	0.200	0.003	0.012	6.385e +41	1.779

Note. All models include subject.

Models	P(M)	P(M|data)	BF_M	BF_{10}	% error
Null model (incl. Emotion, subject)	0.333	0.853	11.579	1.000	
Grp	0.333	0.144	0.336	0.169	3.166
Grp + Grp * Emotion	0.333	0.004	0.007	0.004	9.683

Note. All models include Emotion, subject.

Signal Thresholds



Bayesian repeated measures ANOVA (conducting using JASP) revealed that the data strongly supports the null over the alternative model that signal thresholds vary as a function of deafness.

Models	P(M)	P(M|data)	BF_M	BF_{10}	% error
Null model (incl. subject)	0.200	2.192e -84	8.766e -84	1.000	
Emotion	0.200	0.812	17.229	3.703e +83	0.511
Grp	0.200	3.436e -85	1.375e -84	0.157	0.850
Emotion + Grp	0.200	0.184	0.900	8.384e +82	0.890
Emotion + Grp + Emotion * Grp	0.200	0.005	0.019	2.131e +81	1.018

Note. All models include subject.

Models	P(M)	P(M|data)	BF_M	BF_{10}	% error
Null model (incl. Emotion, subject)	0.333	0.812	8.624	1.000	
Grp	0.333	0.184	0.450	0.226	1.162
Grp + Grp * Emotion	0.333	0.005	0.009	0.006	1.376

Note. All models include Emotion, subject.

DISCUSSION

EXPERIMENT 1: INTENSITY/SIGNAL

Emotion identification thresholds were computed to assess the intensity of stimulus and amount of signal required to successfully decode emotion from faces.

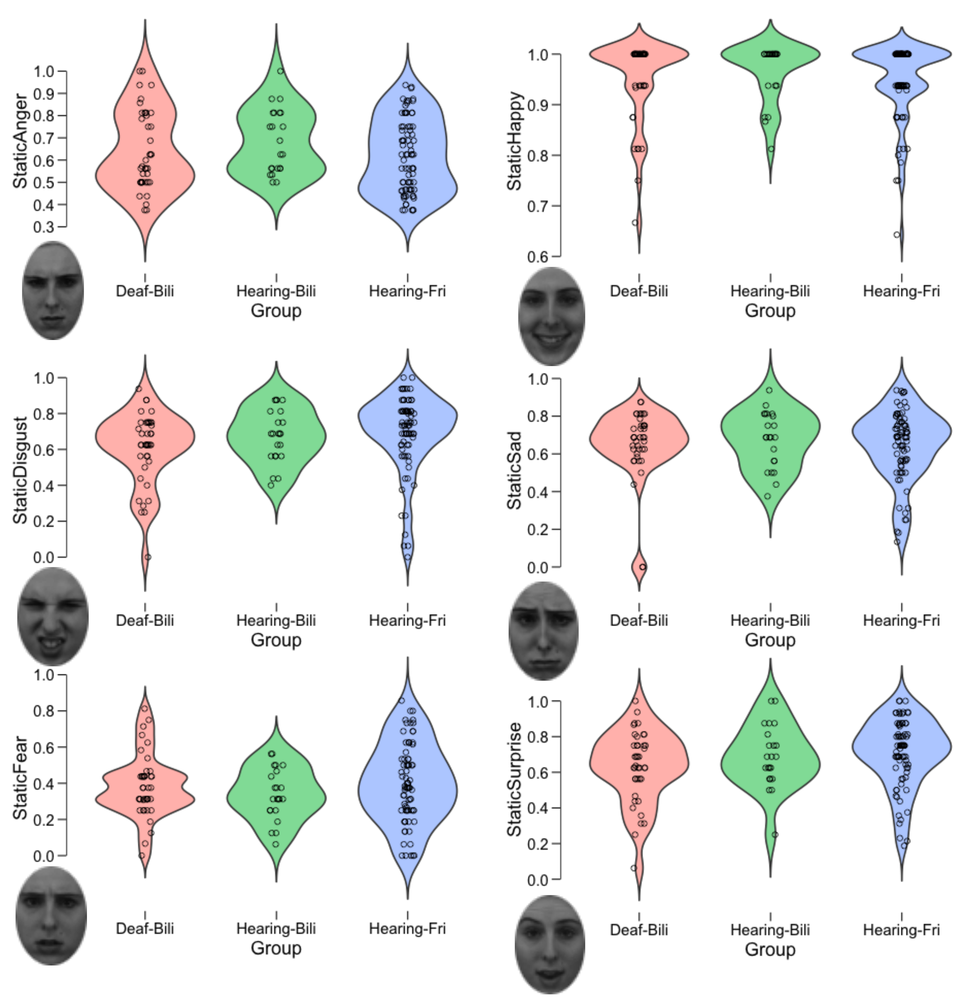
Based upon both measures, some emotions (happy, sad) easier to decode than others (fear).

Contrary to prediction, deaf and hearing bilinguals did not differ in their intensity of signal thresholds.

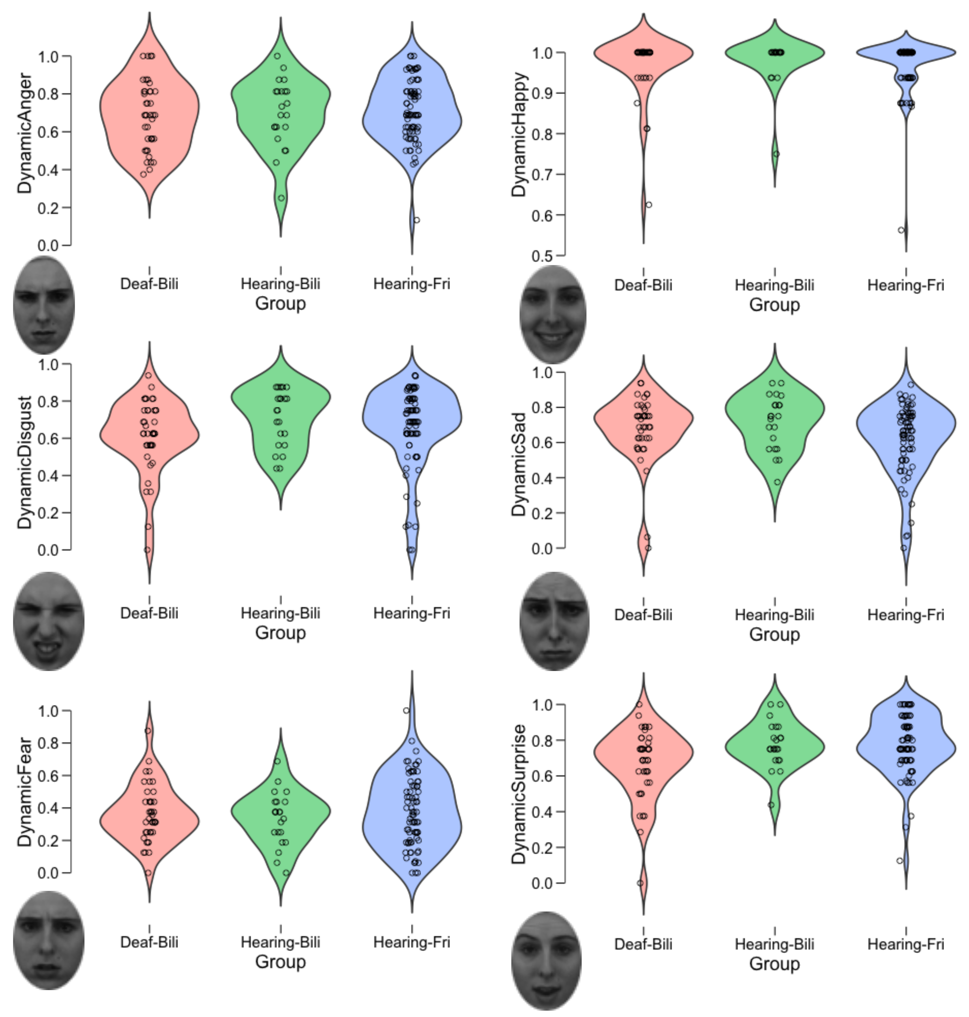
RESULTS

EXPERIMENT 2: STATIC/DYNAMIC

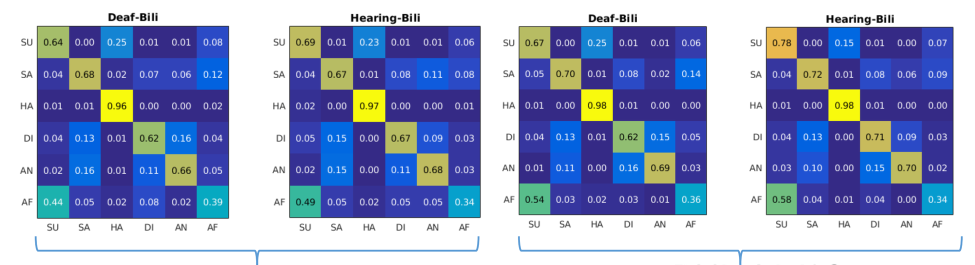
Static Thresholds



Dynamic Thresholds



Bayesian repeated measures ANOVA (conducting using JASP) revealed that the data strongly supports the null over the alternative model that dynamic facial expressions provide a boost to deaf observers over hearing observers.



DISCUSSION

EXPERIMENT 2: STATIC/DYNAMIC

Emotion identification thresholds were obtained in conditions where the face was a static image, or a dynamic sequences of images.

The data favored a model that did not include deafness or any interaction between deafness and static vs. dynamic presentation of facial emotion.

Contrary to prediction, deaf and hearing bilinguals did not differ in how they extracted emotional information from faces, static or dynamic.

Anger was often miscategorized as surprise, although this was true for both deaf and hearing bilinguals. The use of dynamic expressions seemed to mitigate this for hearing bilinguals, but not for deaf bilinguals.

CONCLUSION

Deaf ASL-English bilinguals did not differ from hearing bilinguals in the intensity of signal nor signal-to-noise ratio required for successful emotion identification from faces.

Previous research has suggested that Deaf adult signers are able to distinguish between affective facial expressions and linguistic facial expressions [11].

Future research should focus on children and on facial expressions that may be similar in both the affective and linguistic domains [8].

REFERENCES

[1] Wang et al. (2011) *Res Dev Dis*; [2] Ludlow et al. (2010) *J Clin Exp Neuropsychol*; [3] Rieffe & Terwogt (2006) *Cogn Emot*; [4] Bachara et al. (1980) *Amer Ann Deaf*; [5] Watanabe et al. (2011) *PLOS ONE*; [6] Letourneau & Mitchell (2011) *Percept*; [7] Kandel et al. (2016) *Front Psychol*; [8] Reilly & Bellugi (1996) *J Child Lang*; [9] Pfau & Quer. In Brentari (2010) *Sign Languages*; [10] Baker & Cokely (1981) *ASL – A Student Text*; [11] McCullough & Emmorey (2009) *Cogn*.

Models	P(M)	P(M|data)	BF_M	BF_{10}	% error
Null model (incl. Emotion, Display, Group, Emotion * Display, Emotion * Group, subject)	0.333	0.882	15.000	1.000	
Display * Group	0.333	0.116	0.261	0.131	6.901
Display * Group + Display * Group * Emotion	0.333	0.002	0.004	0.002	6.072

Note. All models include Emotion, Display, Group, Emotion * Display, Emotion * Group, subject.