Categorical Perception in French Sign Language (LSF)

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Goals. Signs are composed of four phonological classes (handshape (HS), place of articulation (POA), orientation and movement), and it is still unclear whether these sign subcategories are stored categorically or continuously in the signers mind. We use a new experimental design to investigate categorical perception (CP) in two major dimensions in LSF, namely HS and POA. Differently from previous studies, we exploit the visual-gestural modality of sign language (SL) by presenting our stimuli simultaneously instead of sequentially, in addition to recording reaction times (RTs) to test for differences across participants.

Background. In spoken languages, stops tend to be perceived categorically (Liberman et al., 1957), vowels more continuously (Fry et al., 1962) while fricatives tend to fall in between (Fujisaki and Kawashima, 1970). In a CP experiment, participants sort the different steps of a (speech) continuum into two categories during a *categorization* task. Step(s) that are not categorized in one or the other represent the boundary between the two, i.e. participants sometimes sort these steps into one category and sometimes into the other. In a *discrimination* task, participants perform better in discriminating between a pair of stimuli when they belong to two different categories rather than to the same category. But this is true only (1) for participants who are sensitive to the phonological contrast of the tested language (i.e. native users), (2) for pairs that are contrastive, not for the allophonic ones, and (3) for stimuli that are actually stored categorically, not continuously (e.g. stops). Studies on CP in American SL (ASL) show contradictory results: some report an effect of CP in HS (Emmorey et al., 2003; Baker et al., 2005), while others do not (Newport, 1982; Morford et al., 2008; Best et al., 2010). In POA, no CP effect was found (Newport, 1982; Emmorey et al., 2003). As for LSF, only one study has been conducted on CP in HS and showed no CP effect (Boutora, 2008). This variation in results is partly explained by the fact that these studies adopt various experimental designs (e.g. see Gerrits and Schouten, 2004, in spoken language).

Hypotheses. If we find a difference across signer/nonsigner groups, we expect to find a CP effect in signers, but not in nonsigners, and only in the phonemic pairs. In this case, we would replicate in part for LSF the results of Emmorey et al. (2003). If no CP effect is observed (regardless of the phonological dimension or contrast), then results would be in line with Boutora (2008). In this case, results could be explained by either a potential difference in perception across SL (i.e. maybe there is CP in ASL but not in LSF), or methodological issues. Alternatively, we may not find differences in the analysis of accuracy, but in the analysis of RTs, a measure that we record for the first time in CP studies with SL.

Our study. We largely follow the structure of the CP experiment on ASL described in Emmorey et al. (2003) while implementing new crucial adjustments to their design:
Materials: We created four pairs of static pseudo-signs to build 11-step continua with an avatar (*Poser Pro*, Bondware v.11). One phonemic continuum (based on existing contrast), and one allophonic continuum (no contrast) were built to test for CP in both HS and POA (Fig.1).
Participants and procedure: 21 deaf early signers (LSF acquired < 6 y.o.), and 24 hearing nonsigners participated via the online experiment platform *Labvanced* (Finger et al., 2017). First, participants were tested on HS, one week later on POA. They started with

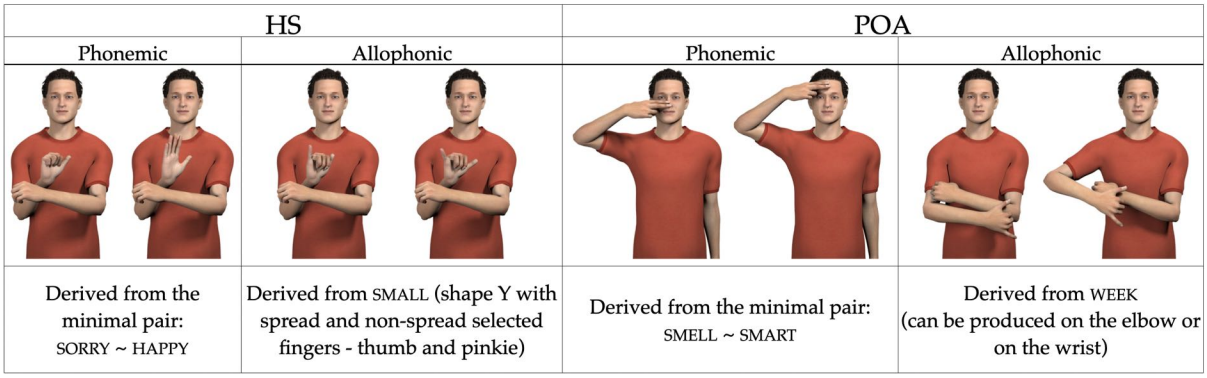

Figure 1: Extremes of the continua for both pairs in HS and POA.

an XAB discrimination task, then an ABX categorization task, but contrary to previous studies, A and B are shown **simultaneously**. The two designs are shown in Fig.2.

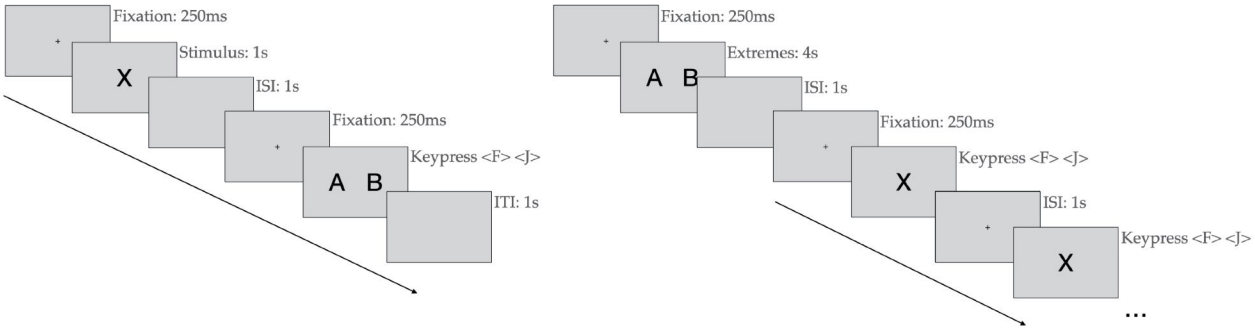

Figure 2: Designs with durations: discrimination task (left) and categorization task (right).

Results and discussion. We ran generalized linear regressions and we found a CP effet in the phonemic pair of HS in signers, but not in the allophonic pair, and no effect was found in nonsigners. No effect was observed in POA, neither in signers nor nonsigners. Our results are thus in line with Emmorey et al. (2003): HS is perceived categorically in LSF, and the absence of effect in POA support the claim that POA is perceived more gradually than HS (as in the other studies). Results are more surprising for our analysis of RTs: a CP effect is observed in the phonemic pair of HS in nonsigners, but none is observed in signers. In POA, an effect is observed in both phonemic and allophonic pairs in signers, none in nonsigners. The difference in results between accuracy and RTs can be explained by the fact that RTs do not allow the observation of the same mechanisms underlying CP as they might tap more into the the perceptual (i.e. visual) system rather than the linguistic one. Also, models that do not show any effects have singularity issues, suggesting that participants' results do not vary enough to capture any effect. Additionally, the experiment was conducted online, the analysis of RTs has to be interpreted with some caution. We also expect to find differences across participant groups in our upcoming within-category analysis, i.e. signers being more accurate within categories compared to nonsigners (see Morford et al., 2008; Best et al., 2010).

References. **Baker et al.**, Memory & cognition, 2005. **Best et al.** Attention, Perception, & Psychophysics, 2010. **Boutora**, Ph.D. dissertation, 2008. **Emmorey et al.**, Language and Cognitive Processes, 2003. **Finger et al.**, IC^{2}S^2, 2017. **Fry et al.**, Language and Speech, 1962. **Fujisaki & Kawashima**, J. Acoust. Soc. Am., 1970. **Gerrits & Schouten**, Perception & psychophysics, 2004. **Liberman et al.**, J. Exp. Psycho., 1957. **Morford et al.**, Cognition, 2008. **Newport**, Language acquisition, CUP, 1982. **Pisoni**, Perception & psychophysics, 1974.