Generalising from ambiguous data

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Introduction

- How do learners generalise from data that is ambiguous between multiple different generalisations?
  - Single *vs.* multiple compatible generalisations?
  - Simplest *vs.* most precise generalisation?
- The above questions lead to some of the possibilities that have been argued for.
  - *Subset Principle* (**SP**; Berwick 1985; Hale and Reiss 2003)
  - *Simplest Generalisation* (**SG**; Chomsky and Halle 1968)
  - *Multiple Simple(st) Generalisations* (**MSG**; Chomsky and Halle 1968; Hayes and Wilson 2008)
  - Learn all compatible generalisations, but simplest preferred (**PropSimple**; Linzen and Gallagher 2014; Linzen and O'Donnell 2015)
  - Learning proportional to specificity (**PropSpec**; Tenenbaum and Griffiths 2001)
- Previous work is inconsistent on this:
  - **SP** (Gerken 2006)
  - **PropSimple** (Linzen and Gallagher 2014)
- For ambiguous input, learners:
  - learn multiple generalisations.
  - don't seem to track more complex generalisations.

General Exp. Design

Training Phase

- Participants listened to and silently mouthed 100 CVCV nonce words (2 repetitions each).
- C=/p,b,t,d,f,v,s,z/   V=/a,i,u/.
- C obeyed both voicing and stop harmony simultaneously.
  - e.g., ✓[tipa, bida, fisa], *[tisa,bipa,fida].

Testing Phase

- Participants were asked if word was possible in the "language" they learned.
- CVCV nonce words of the following types:
  - 12 OldStims
  - 12 NewStims
  - 12 OnlyVoicing
  - 12 OnlyStop
  - 12 NoPattern

Experiment 1

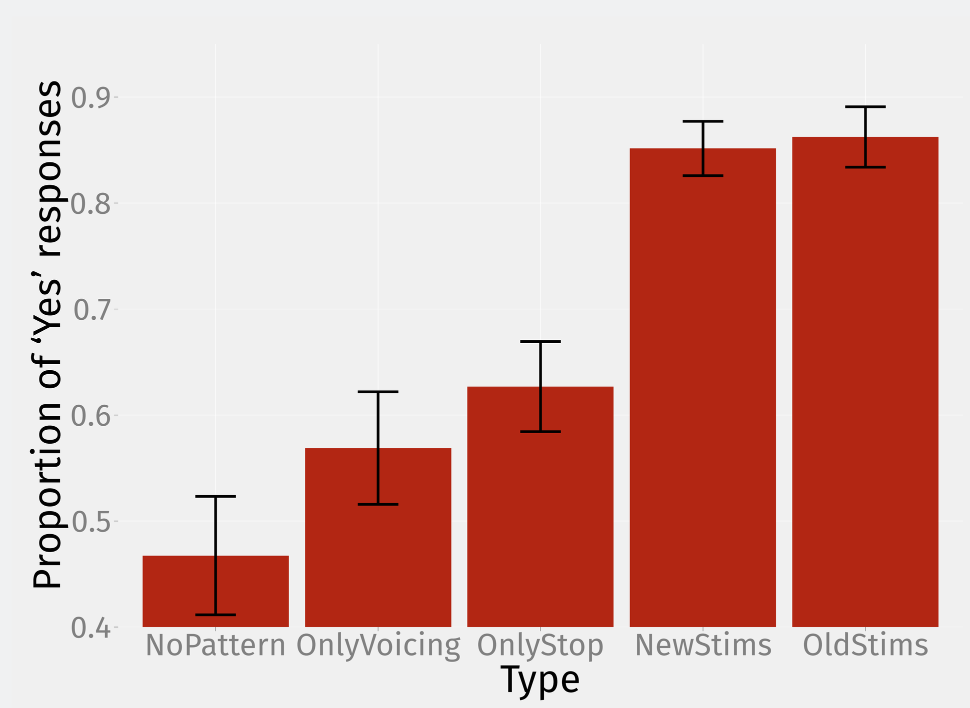
Methods

- 25 English-speaking undergraduates, and 3 were excluded due to non-learning.
- NewStims: C sequences possibly heard in *Training*.

Predictions

- **SP**: NewStims and OldStims preferred over other three (which are undifferentiated).
- **SG**: Some prefer OnlyVoicing, some OnlyStop; NewStims are as acceptable as either. Thus, all three are equally good.
- **MSG**: Both OnlyVoicing and OnlyStop are preferred; additive effect on NewStims.
- **PropSimple**: OnlyVoicing, OnlyStop, and StopVoicing are all learnt; therefore, interactive effect on NewStims. However, interaction effect smaller than either OnlyVoicing or OnlyStop.
- **PropSpec**: OnlyVoicing, OnlyStop, and StopVoicing are all learnt; therefore, interactive effect on NewStims. However, interaction effect larger than either OnlyVoicing or OnlyStop.

Results



Fixed Effect	MeanYes (%)	Estimate	z-value	Pr(>z)
(Intercept)	0.4674	−0.1223	−0.534	0.2968
OnlyVoicing	0.5688	0.4801	2.485	0.0065 **
OnlyStop	0.6268	0.7664	3.897	<0.0001 ***
NewStims	0.8514	2.142	9.05	<0.0001 ***
OldStims	0.8623	2.2292	9.331	<0.0001 ***

Table 1: Logistic mixed-effects models

Fixed Effect	Estimate	z-value	Pr(>z)
(Intercept)	−0.1231	−0.544	0.2934
Voicing	0.4758	2.513	0.0059 **
Stopping	0.7574	3.920	<0.0001 ***
Voicing:Stopping	0.8881	3.032	0.0012 **

Table 2: Logistic mixed-effects model—Interaction effects for new test stimuli

Discussion

- Multiple simple generalisations are learnt for ambiguous data.
- Furthermore, interaction effect suggests potential support for **PropSimple** and **PropSpec**.
- However:
  - Perhaps phonological generalisations can also directly access segmental representations (i.e., segmental primitives) without making reference to the featural content.
  - If so, a generalisation based on a single segment might be as "simple" as a generalisation based on a single feature.
  - Therefore, **MSG** could also account for the interaction effect.

Conclusion

- We found that learners keep track of multiple compatible generalisations in the face of ambiguous data.
- Furthermore, there is evidence that participants keep track of segmental generalisations.
- However, there's no evidence that participants keep track of the "complex" featural generalisations.
- This suggests that "simple":
  - has to be seen as representationally simple (Chomsky and Halle 1968; Hayes and Wilson 2008).
  - has to include both featural and segmental representations.

Experiment 2

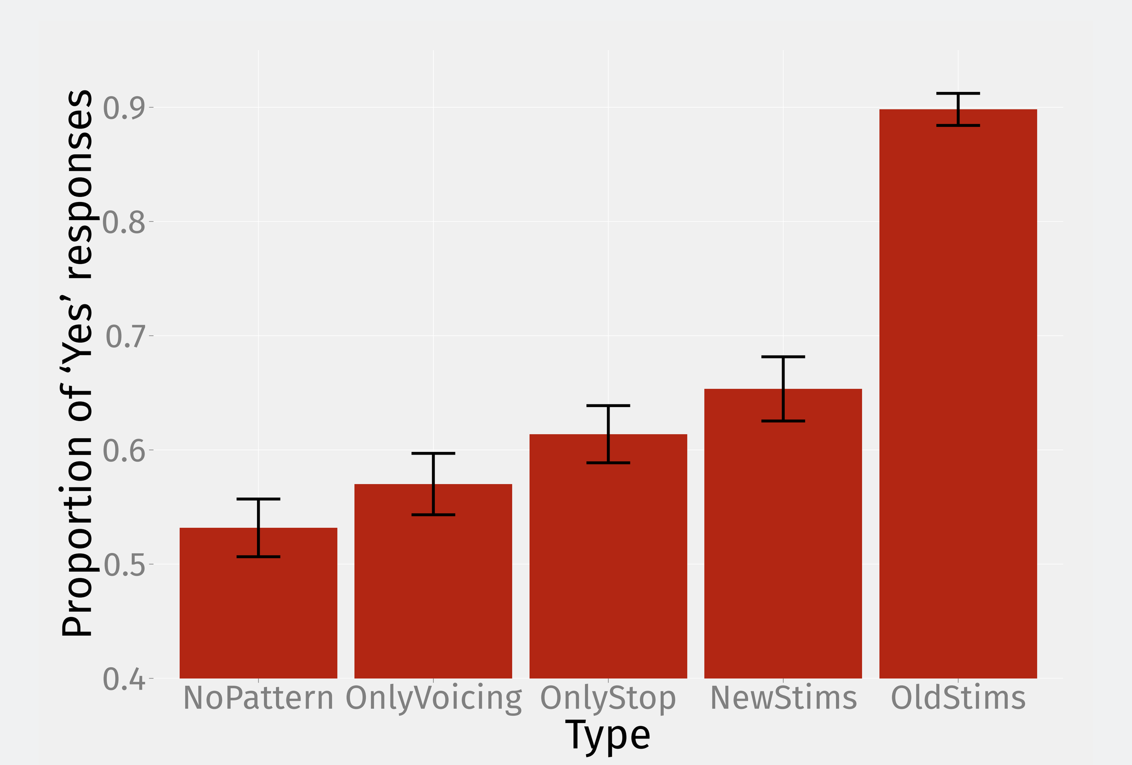
Methods

- 78 English-speaking undergraduates, and 15 were excluded due to non-learning.
- NewStims: C sequences **not** heard in *Training*.
  - Therefore, segmental generalisations will not help with the harmony patterns.

Predictions

- Similar to Exp. 1, but:
  - All three (**MSG**, **PropSimple**, and **PropSpec**) predict a drop in NewStim preference.
  - However, **PropSimple** and **PropSpec** still predict an interactive effect.

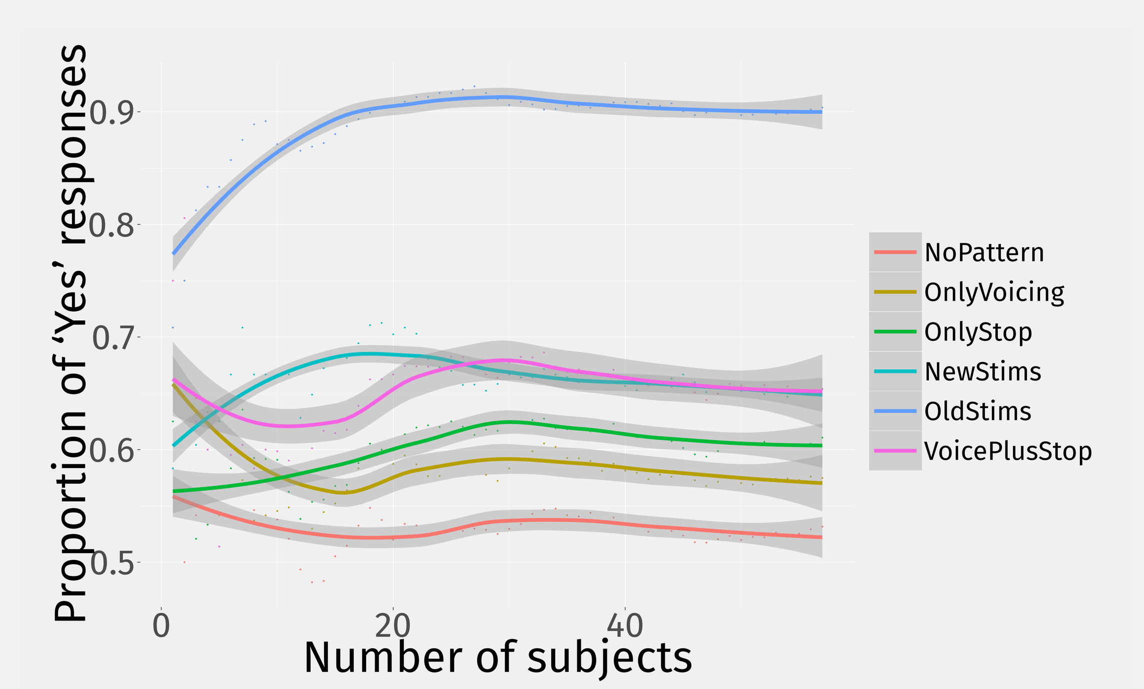
Results



Fixed Effect	MeanYes (%)	Estimate	z-value	Pr(>z)
(Intercept)	0.5317	0.1628	1.273	0.1014
OnlyVoicing	0.5701	0.1735	1.387	0.0825 .
OnlyStop	0.6138	0.3889	3.087	0.0010 **
NewStims	0.6534	0.5836	4.433	<0.0001 ***
OldStims	0.8981	2.2820	14.274	<0.0001 ***

Table 3: Logistic mixed-effects models

- OnlyVoicing+OnlyStop vs. NewStim responses (with increasing number of participants).



Discussion

- Noticeable drop in preference for NewStims.
- No evidence of interaction effect.
- The results are only consistent with **MSG**.

References

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