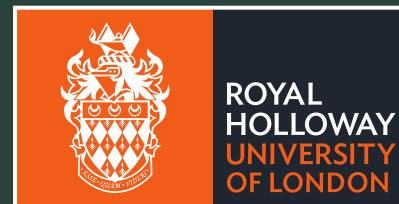


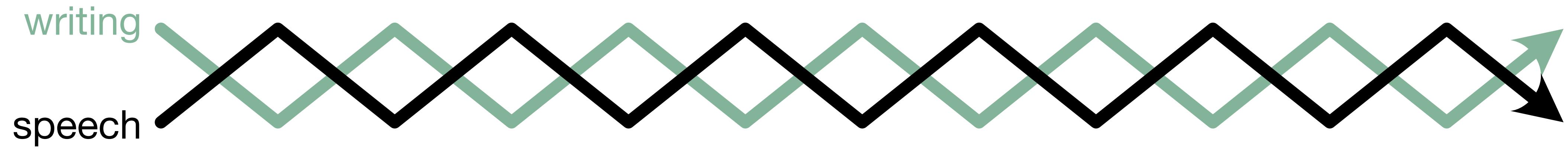
# The cultural evolution of informative writing systems

**Jon W. Carr & Kathleen Rastle**  
Royal Holloway, University of London

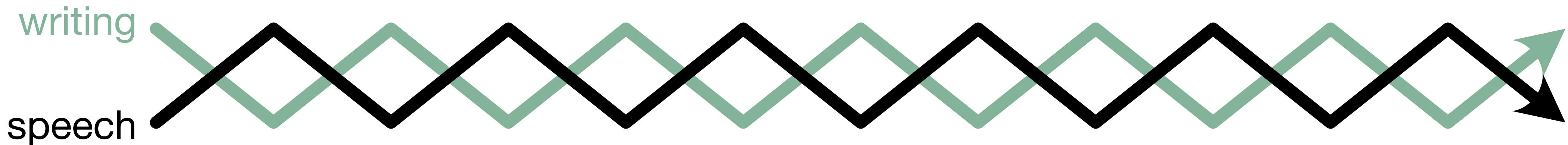


LEVERHULME  
TRUST

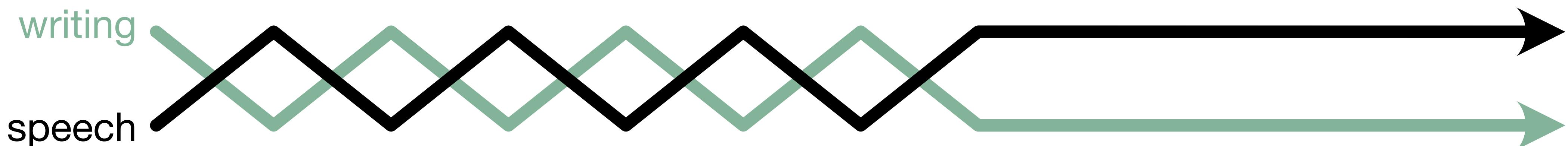
Writing usually tracks speech



Writing usually tracks speech



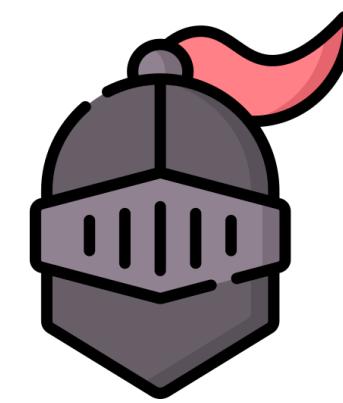
But speech and writing can become disentangled



## Heterographic homophony



⟨night⟩

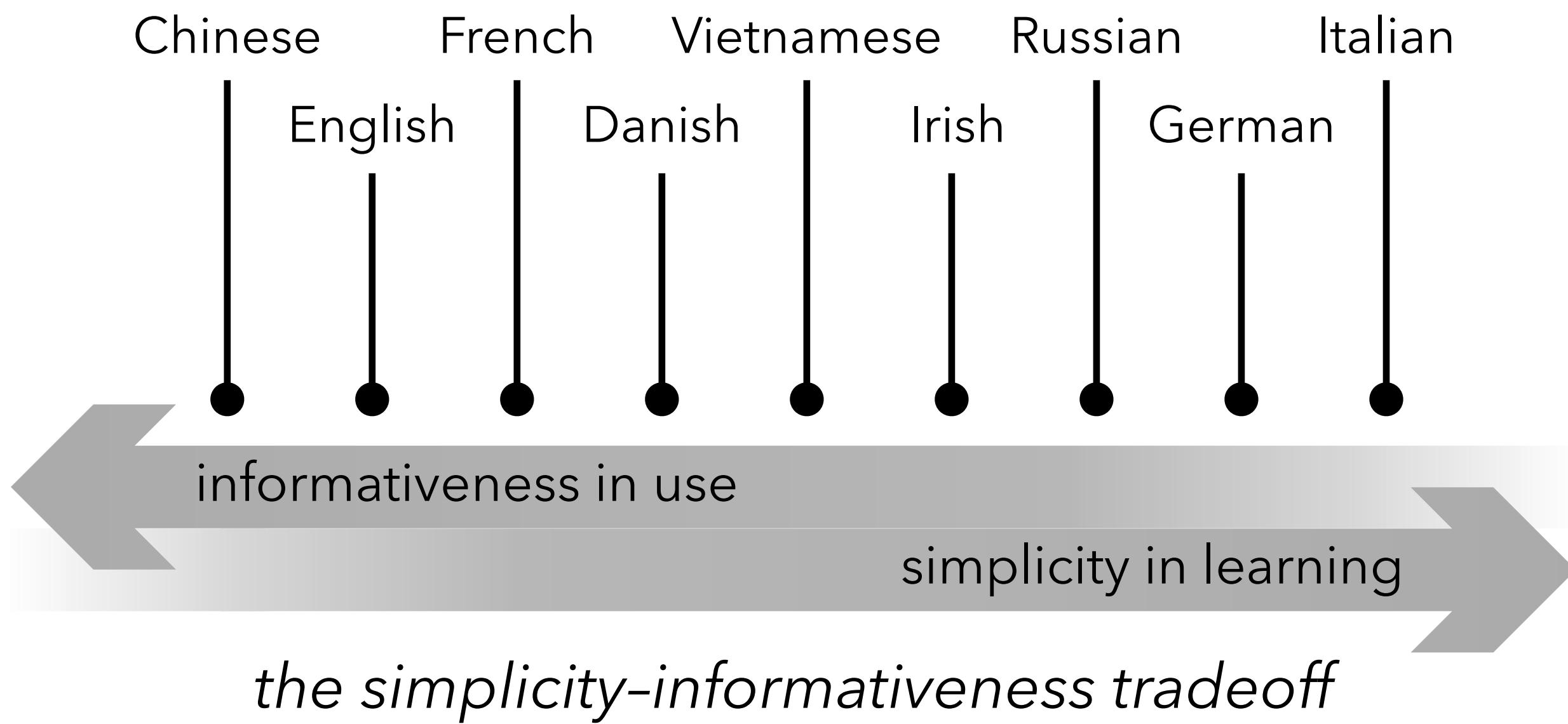


⟨knight⟩

# Heterographic homophony is informative

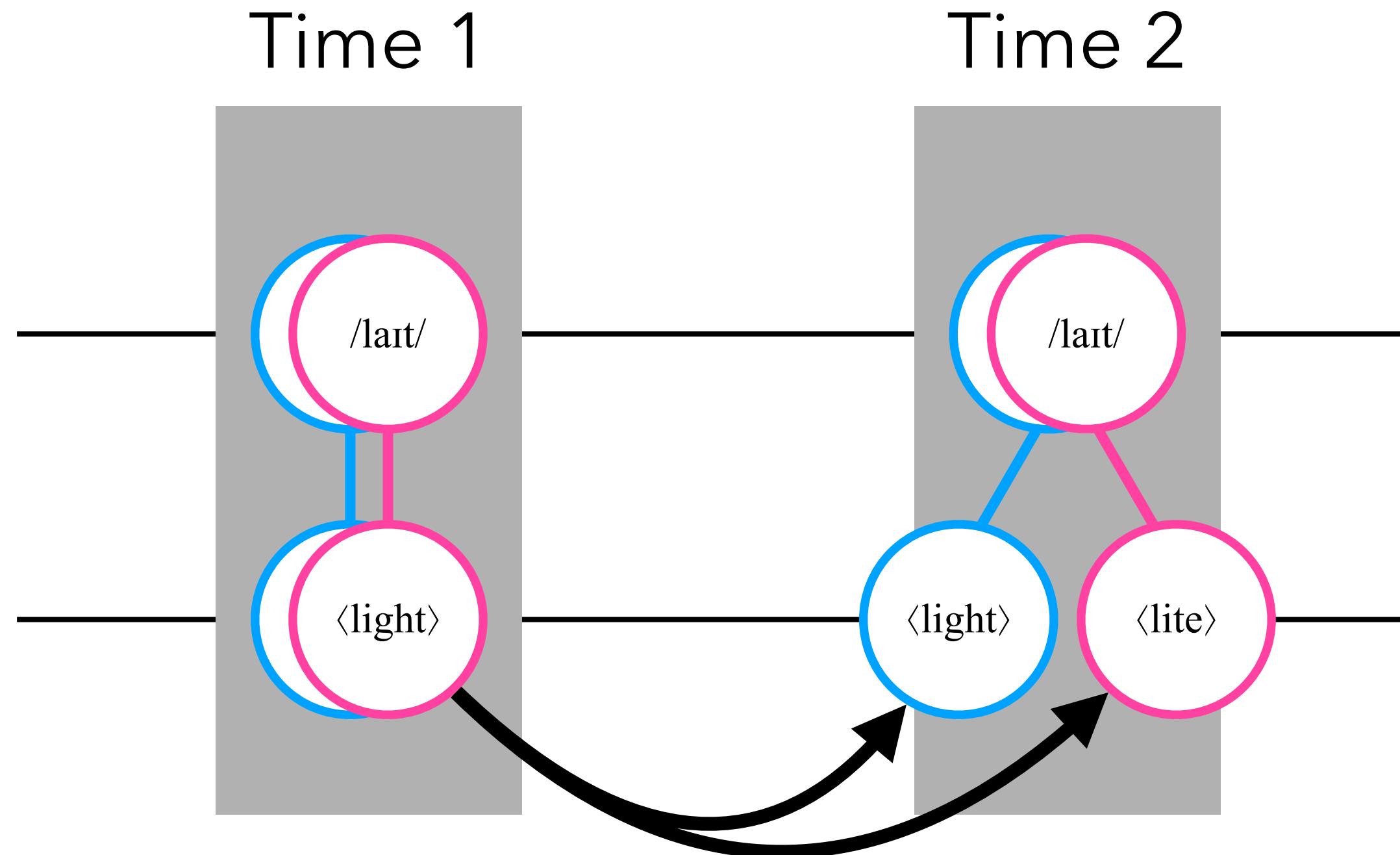


French	/sã/	⟨cent⟩ (hundred)	⟨sang⟩ (blood)	⟨sans⟩ (without)	⟨sens⟩ (feel)		
Danish	/vɛ²ã/	⟨hver⟩ (every)	⟨vejr⟩ (weather)	⟨vær⟩ (be)	⟨værd⟩ (worth)		
Vietnamese	/zāw/	⟨dao⟩ (knife)	⟨giao⟩ (delivery)	⟨rao⟩ (advertise)			
German	/va:g̩n/	⟨Wagen⟩ (car)	⟨wagen⟩ (dare)				
Irish	/baʃti/	⟨bpaístí⟩ (children)	⟨báistí⟩ (rain)				
Russian	/pristupjít/	⟨приступить⟩ (start)	⟨преступить⟩ (transgress)				
Italian	/anno/	⟨hanno⟩ (have)	⟨anno⟩ (year)				
Chinese	/tán/	⟨糖⟩ (sugar)	⟨塘⟩ (embankment)	⟨塘⟩ (pond)	⟨塘⟩ (block)	⟨唐⟩ (Tang)	⟨堂⟩ (hall)

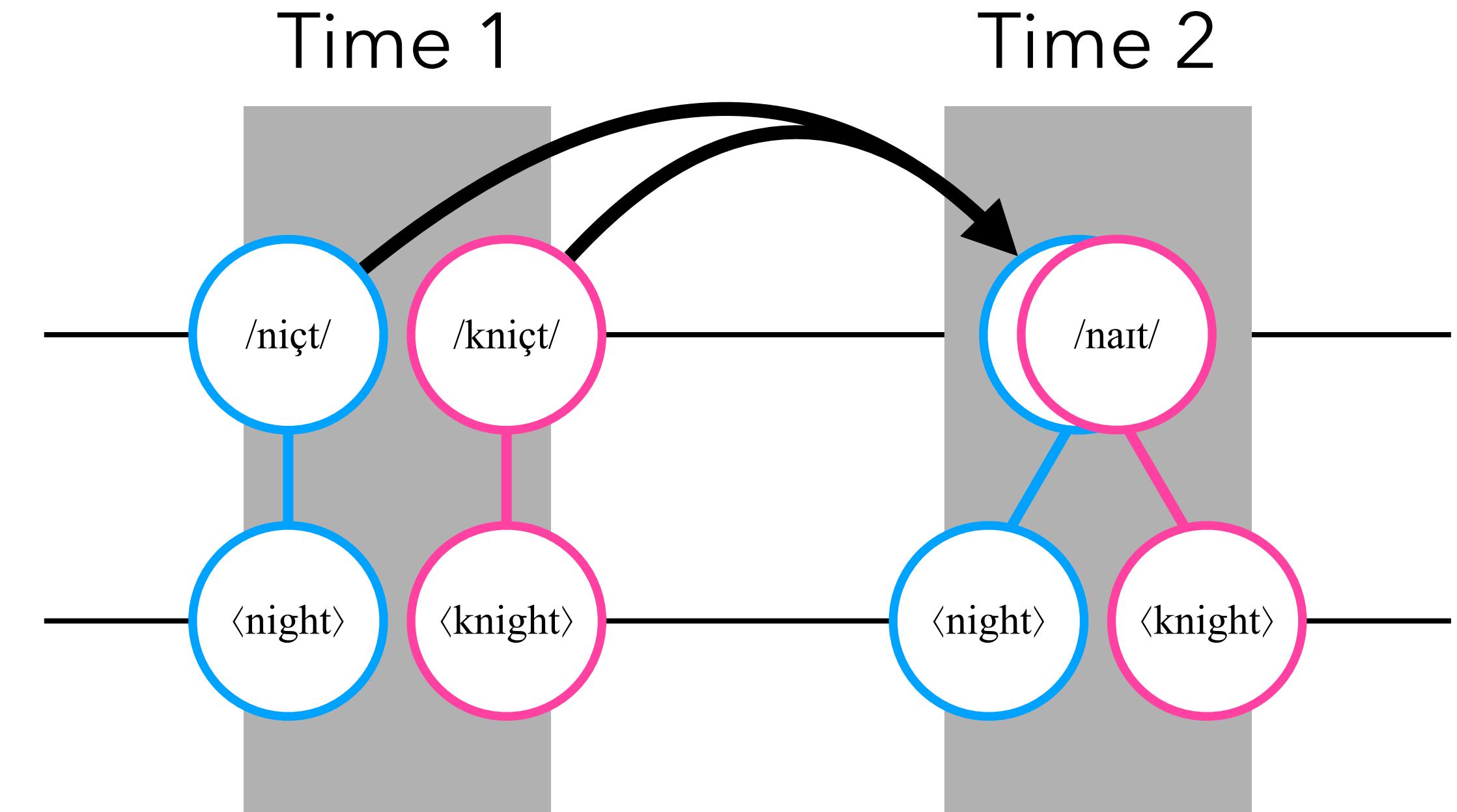


*Left to evolve freely, do writing systems sometimes forego some simplicity for the sake of informativeness?*

## Differentiation

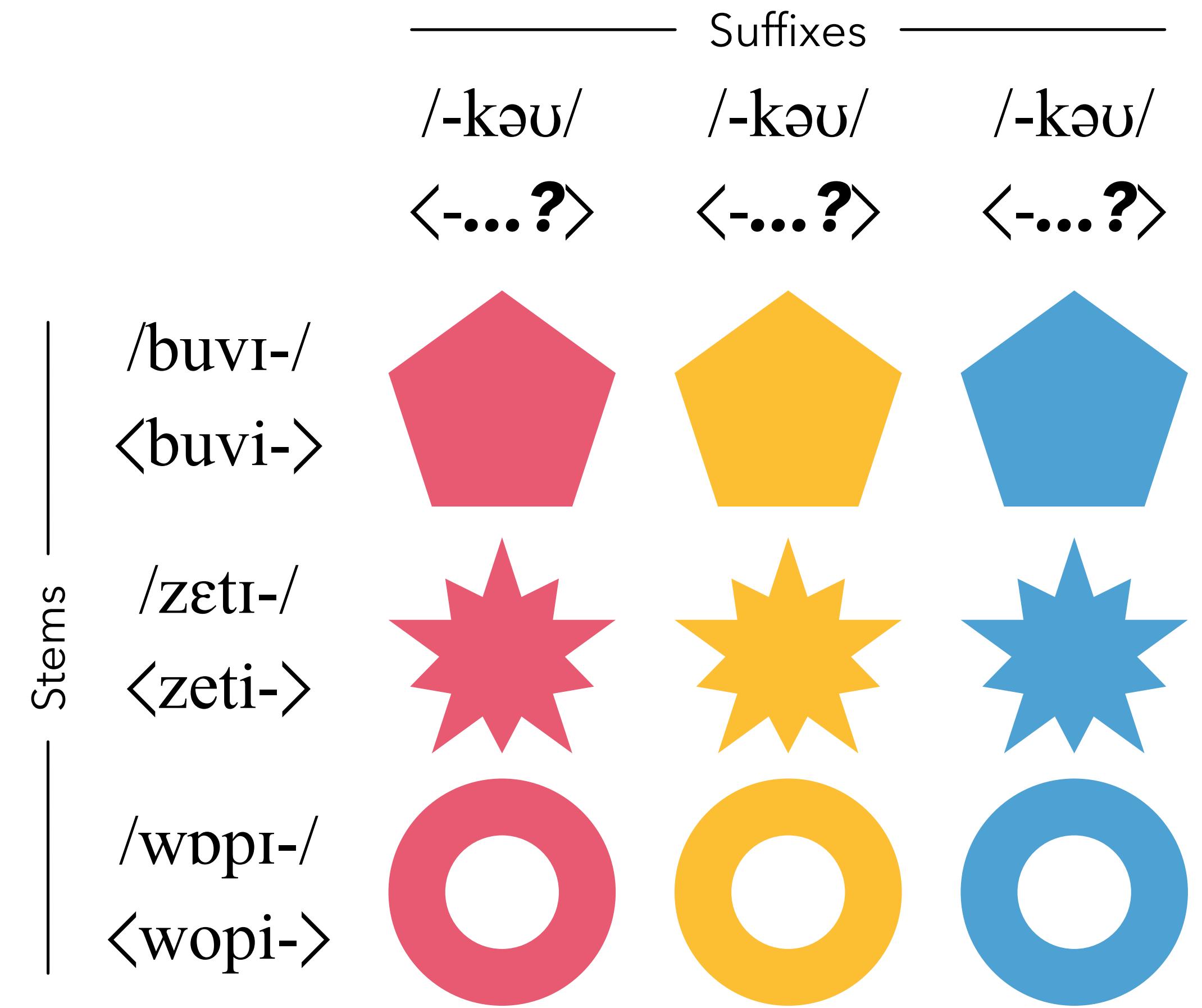


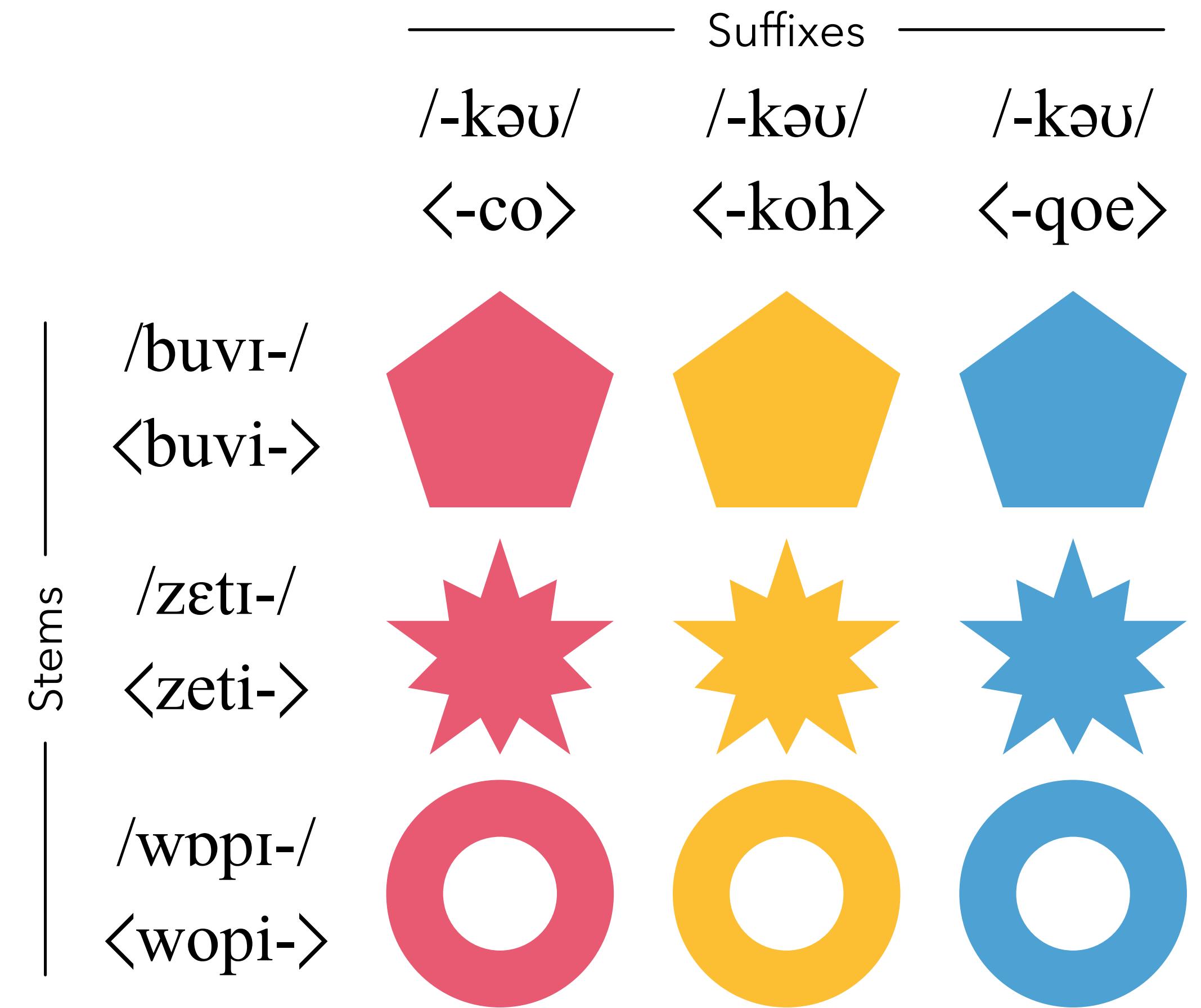
## Conservation



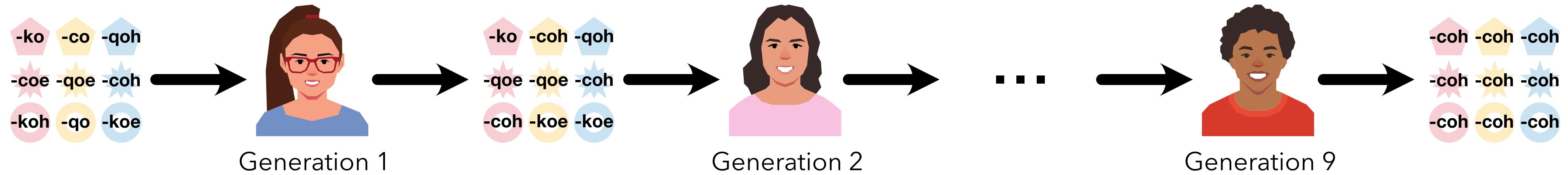
# *Experiment 1:*

# *Differentiation*

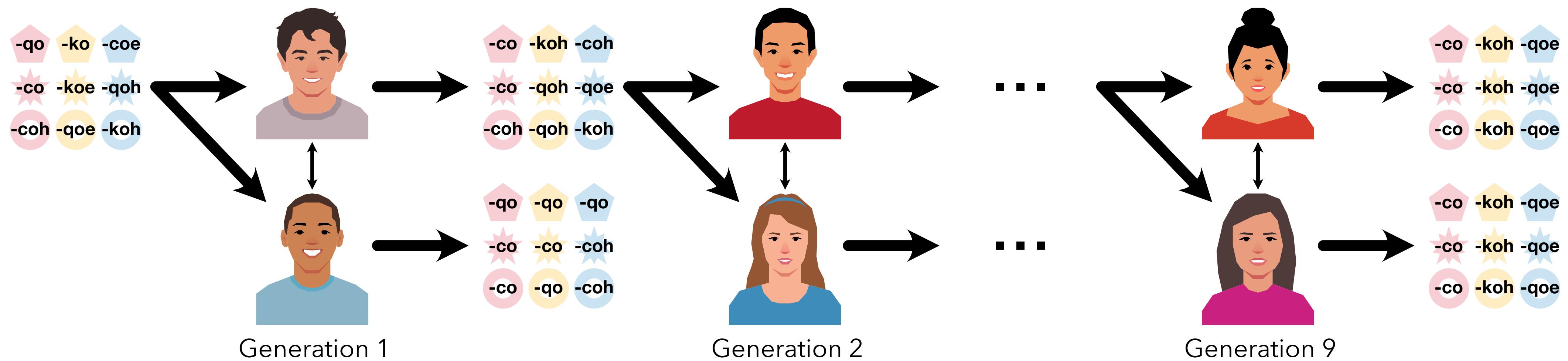




### Transmission-only



### Transmission + Communication



Transmission-only

0 1 2 3 4 5 6 7 8 9

A

ko	co	qoh
coe	qoe	coh
koh	qo	koe

ko	coh	qoh
qoe	qoe	coh
coh	ko	koe

coh	coh	coh
qoe	co	coh
coh	coh	coh

coh	coh	coh
qoe	co	coh
coh	coh	coh

coh	coh	coh
qoe	co	coh
coh	coh	coh

coh	coh	coh
qoe	co	coh
coh	coh	coh

coh	coh	coh
qoe	co	coh
coh	coh	coh

B

koh	qoe	coh
koe	co	coh
co	qoh	ko

coh	coh	coh
co	qoe	coh
co	co	coh

coh	coh	coh
co	co	coh
co	co	coh

coh	coh	coh
co	co	coh
co	co	coh

coh	coh	coh
co	co	coh
co	co	coh

C

qoe	co	coh
qoh	koe	koh
go	ko	co

aoe	co	coh
qoh	koh	koh
ko	ko	ko

coe	co	coe
koh	koh	koh
ko	ko	ko

coe	co	coe
koh	koh	koh
ko	ko	ko

coe	co	coe
koh	koh	koh
ko	ko	ko

D

goe	koe	qoh
co	ko	koh
coh	qo	coe

koe	koe	qoh
koe	ko	koe
coh	co	coh

koe	koe	qoh
koh	ko	ko
co	co	co

koe	koe	qoh
ko	ko	ko
co	co	co

koe	koe	qoh
ko	ko	ko
co	co	co

E

qoe	coe	qo
ko	co	qoh
koh	co	ko

qoe	qu	qo
co	co	co
ko	qu	qu

qu	qu	qu
co	co	co
ko	qu	qu

qu	qu	qu
co	co	co
ko	qu	qu

qu	qu	qu
co	co	co
ko	qu	qu

F

coe	qo	qoe
coh	koh	qoh
koe	co	ko

qoe	qoe	qoe
qoh	koh	qoh
ko	qoh	qoh

qoe	qoe	qoe
qoh	qoh	qoh
ko	qoh	qoh

qoe	qoe	qoe
qoh	qoh	qoh
ko	qoh	qoh

qoe	qoe	qoe
qoh	qoh	qoh
ko	qoh	qoh

G

koe	koh	qoh
que	coh	coe
go	co	ko

koh	koh	koh
coh	co	co
co	co	co

coe	co	coe
co	co	co
co	co	co

coe	co	coe
co	co	co
co	co	co

coe	co	coe
co	co	co
co	co	co

H

qoh	qoe	ko
qoh	koh	ko
coe	koh	co

qoh	koh	ko
qoh	ko	qoh
coe	co	qoh

qoh	qoh	qoh
qoh	qoh	qoh
ko	qoh	qoh

qoh	qoh	qoh
ko	qoh	qoh
ko	qoh	qoh

qoh	qoh	qoh
ko	qoh	qoh
ko	qoh	qoh

I

coe	co	koh
coh	co	co
koh	co	co

coe	co	co
coe	co	co
coe	co	co

coe	co	co
coe	co	co
coe	co	co

coe	co	co
coe	co	co
coe	co	co

coe	co	co
coe	co	co
coe	co	co

J

qoh	co	co
koh	co	co
co	co	co

koh	koe	co
koh	koe	co
co	koe	co

koh	koe	co
koh	koe	co
co	koe	co

koh	koh	co
koh	koh	co
co	koh	co

koh	koh	co
koh	koh	co
co	koh	co

Transmission + Communication

0 1 2 3 4 5 6 7 8 9

K

coe	ko	qoe
qoh	koh	coh
ko	co	qo

coe	co	ko
qoh	qoe	qoh
ko	qoh	qoh

coe	co	ko
qoh	qoh	qoh
ko	co	co

coe	co	ko
qoh	qoh	qoh
ko	co	co

coe	co	ko
qoh	qoh	qoh
ko	co	co

L

koh	coe	ko
co	co	co
qu	qoe	co

co	co	co
ko	qoh	ko
qo	co	qo

co	co	co
ko	qoh	ko
qo	co	qo

co	co	co
ko	qoh	ko
qo	co	qo

co	co	co
ko	qoh	ko
qo	co	qo

M

qoe	co	ko
qoh	ko	koh
co	qo	co

coe	co	co
ko	ko	koh
co	qo	qoh

coe	co	co
ko	ko	koh
co	qo	qoh

coe	co	co
ko	ko	koh
co	qo	qoh

coe	co	co
ko	ko	koh
co	qo	qoh

N

coh	ko	qoe
ko	qo	qoh
ko	ko	ko

ko	ko	ko
ko	ko	ko
ko	ko	ko

ko	ko	ko
ko	ko	ko
ko	ko	ko

ko	ko	ko
ko	ko	ko
ko	ko	ko

ko	ko	ko
ko	ko	ko
ko	ko	ko

O

coe	ko	ko
qoh	qoe	ko
ko	ko	ko

coe	ko	ko
qoh	ko	ko
ko	ko	ko

coe	ko	ko
qoh	ko	ko
ko	ko	ko

coe	ko	ko
qoh	ko	ko
ko	ko	ko

coe	ko	ko
qoh	ko	ko
ko	ko	ko

P

co	co	co
qoh	co	qoh
co	co	co

co	co	co
qoh	co	qoh
co	co	co

co	co	co
qoh	co	qoh
co	co	co

co	co	co
qoh	co	qoh
co	co	co

co	co	co
qoh	co	qoh
co	co	co

Q

coh	co	co
ko	qoh	ko
co	co	co

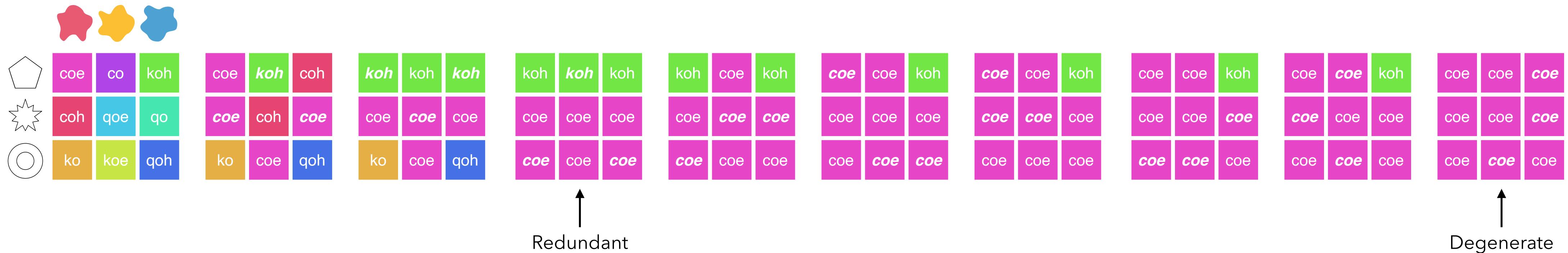
coh	co	co
ko	qoh	ko
co	co	co

coh	co	co
ko	qoh	ko
co	co	co

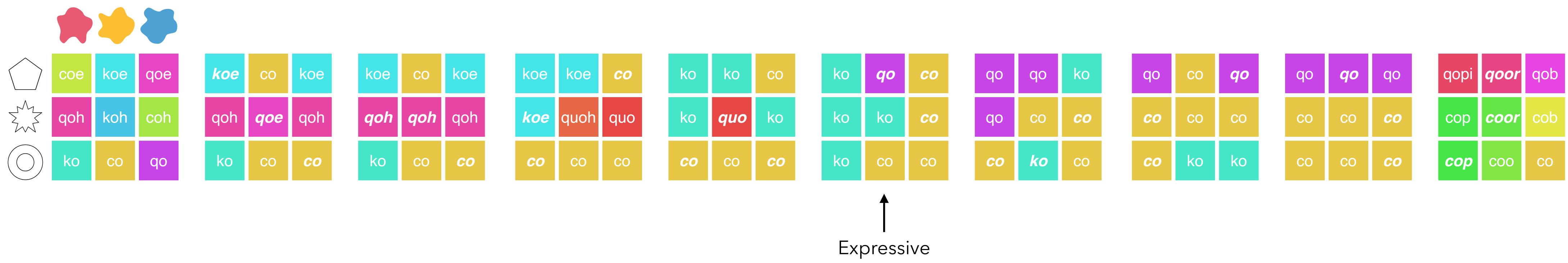
coh	co	co
ko	qoh	ko
co	co	co

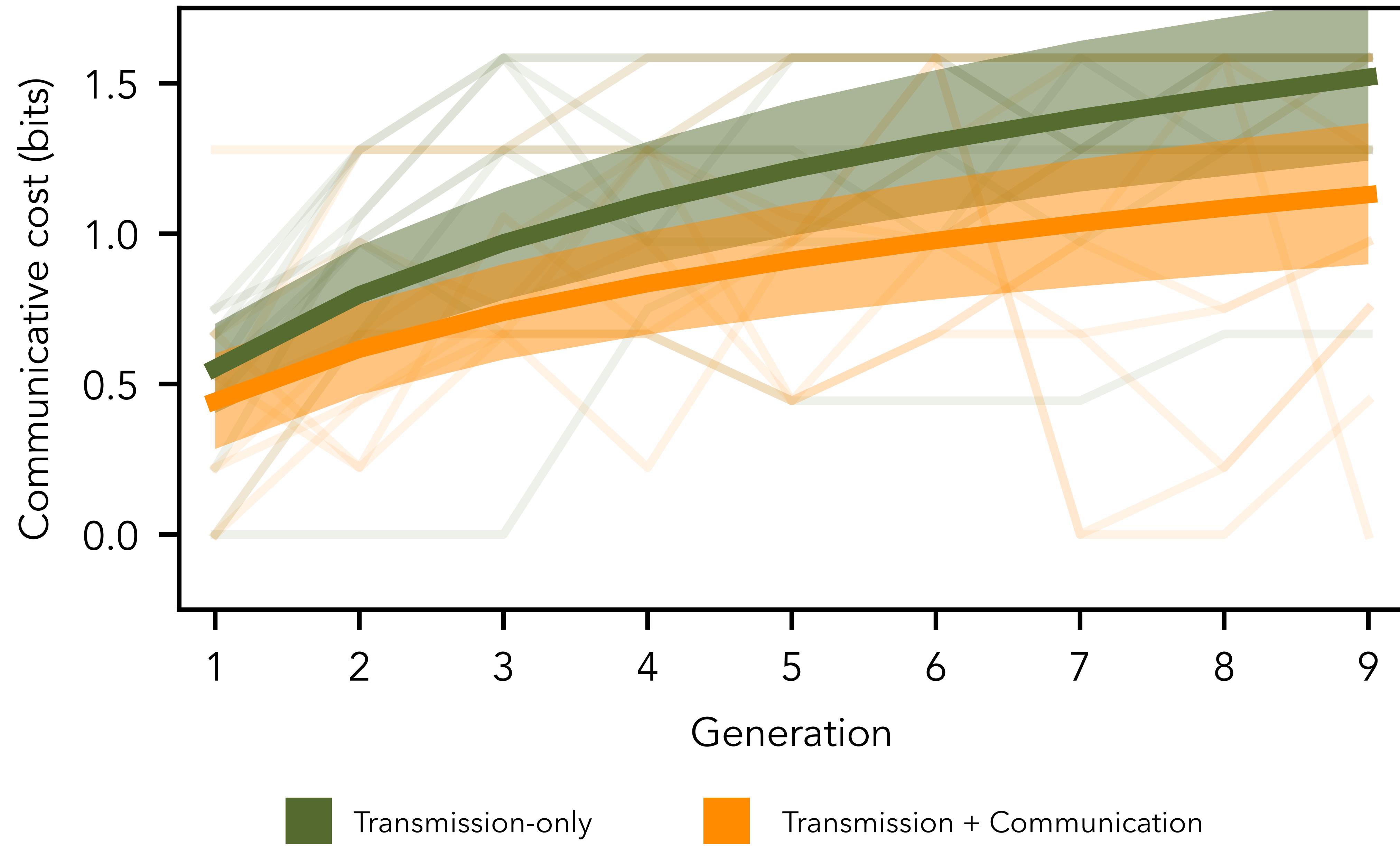
coh	co	co
ko	qoh	ko
co	co	co

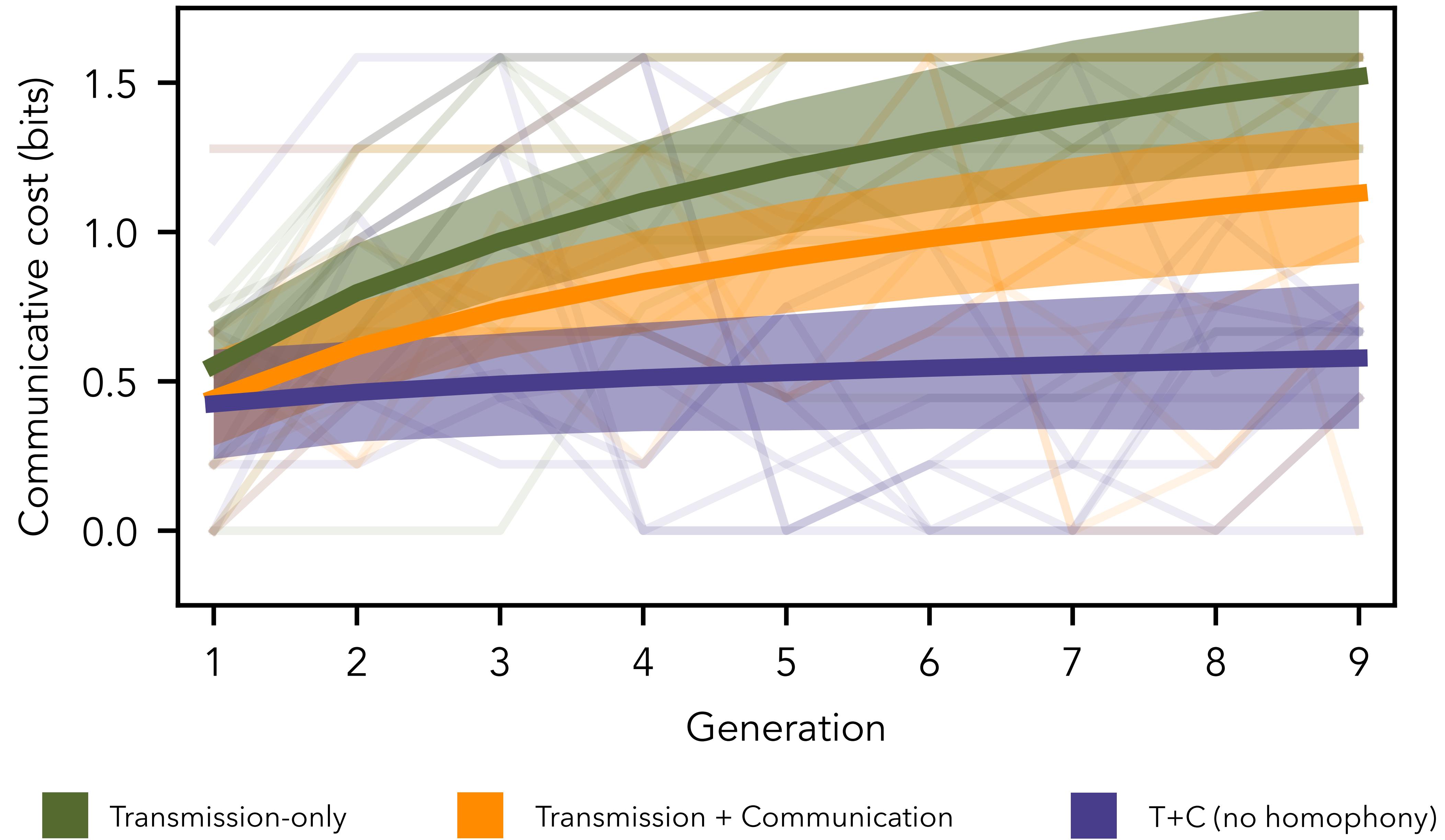
## Transmission-only



## Transmission + Communication



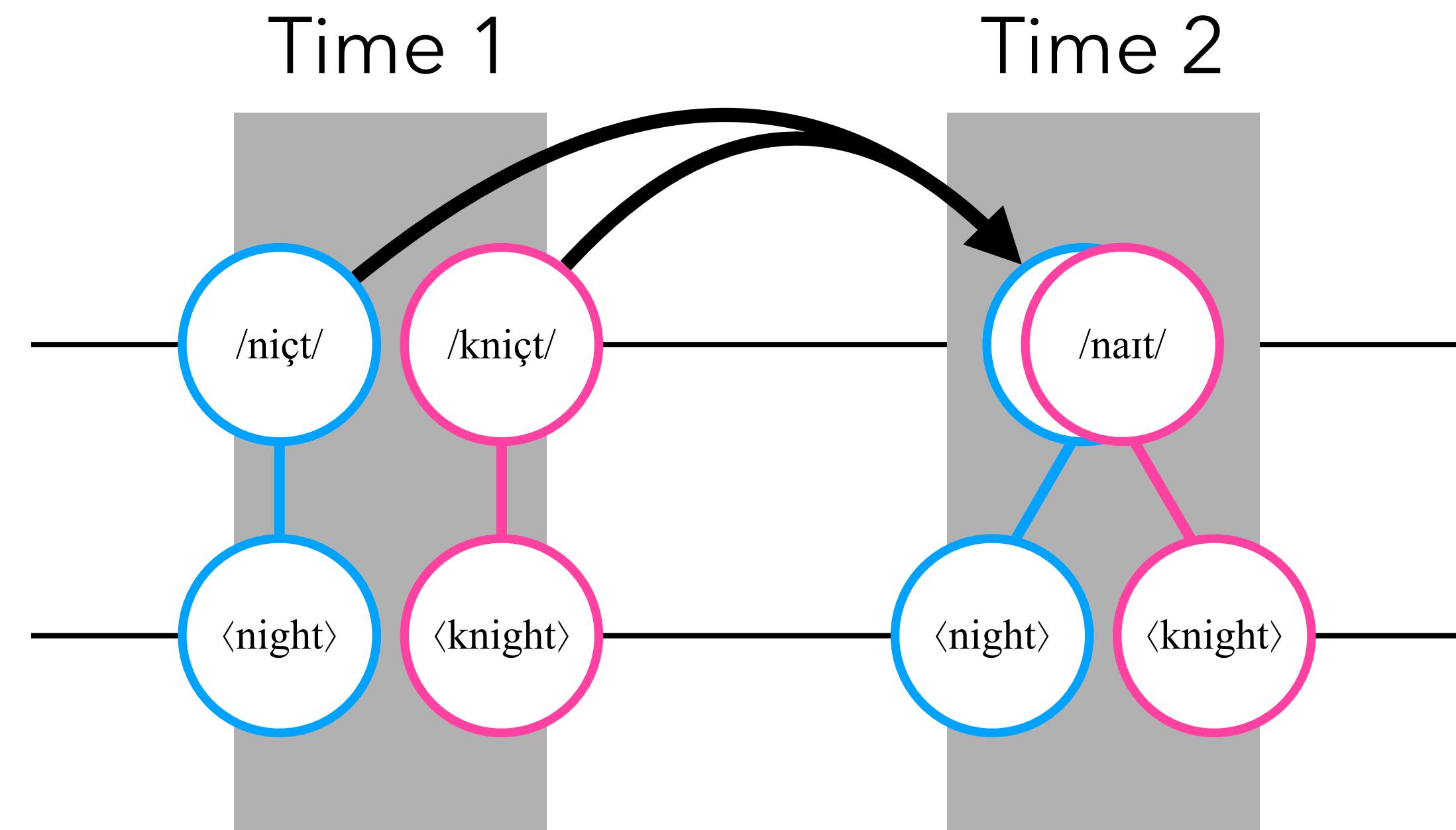


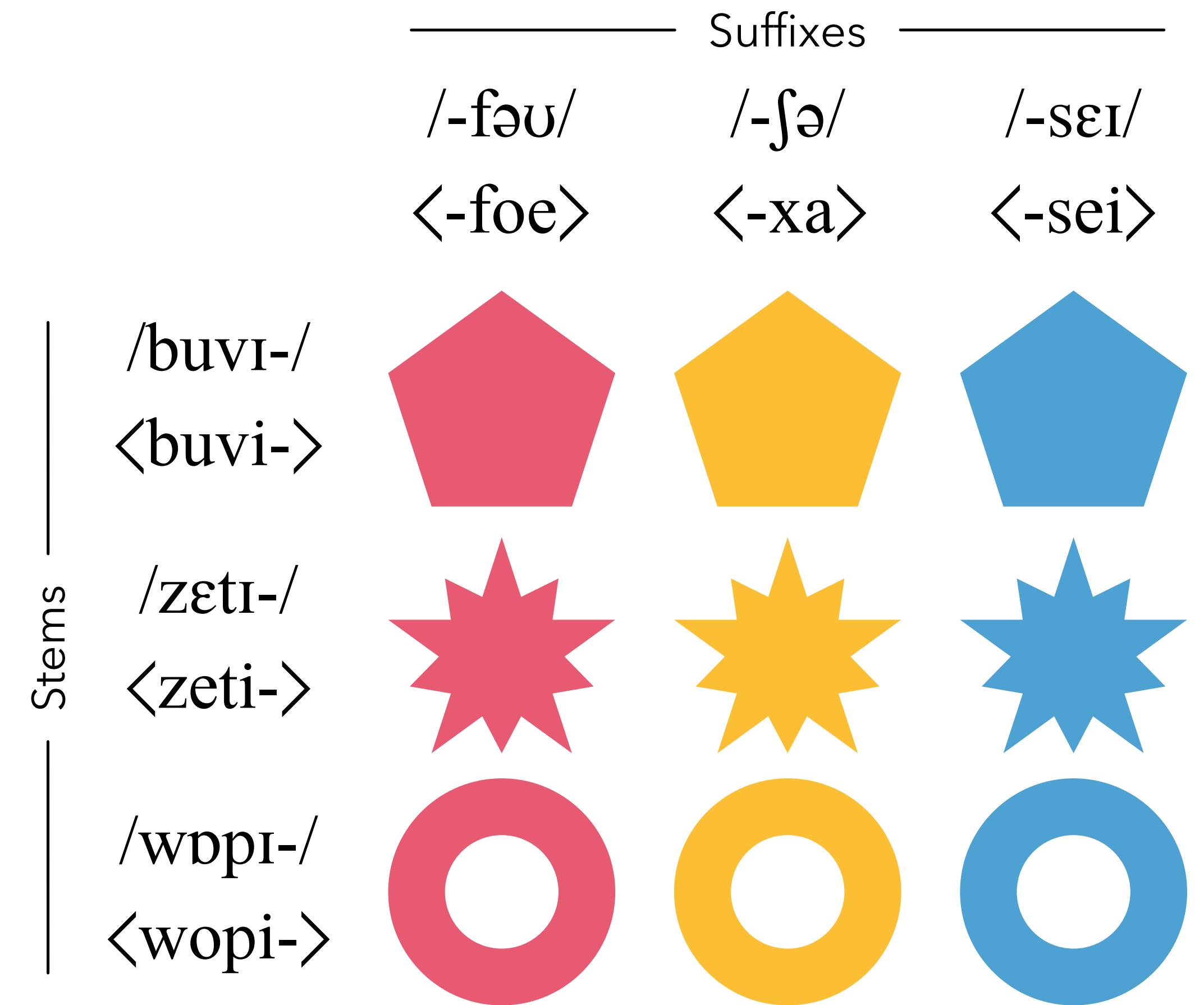


# *Experiment 2:*

# *Conservation*

## Conservation mechanism





Epoch I  
Generations 1-3

Epoch II  
Generations 4-6

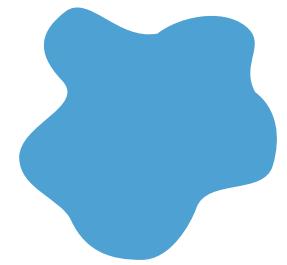
Epoch III  
Generations 7-9



/-fəʊ/ → /-fɛɪ/ → /-fə/



/-ʃə/ → /-ʃə/ → /-fə/



/-sɛɪ/ → /-fɛɪ/ → /-fə/

Sound change 1

/s/ → /f/, /əʊ/ → /ɛɪ/

Sound change 2

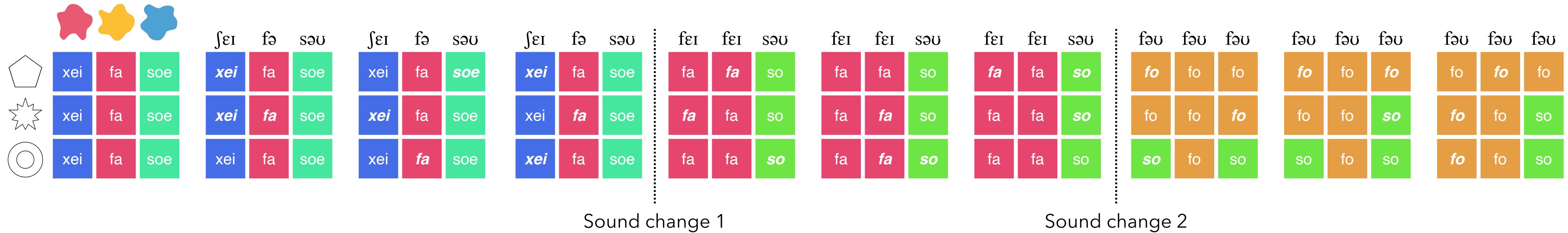
/ʃ/ → /f/, /ɛɪ/ → /ə/

# Transmission-only

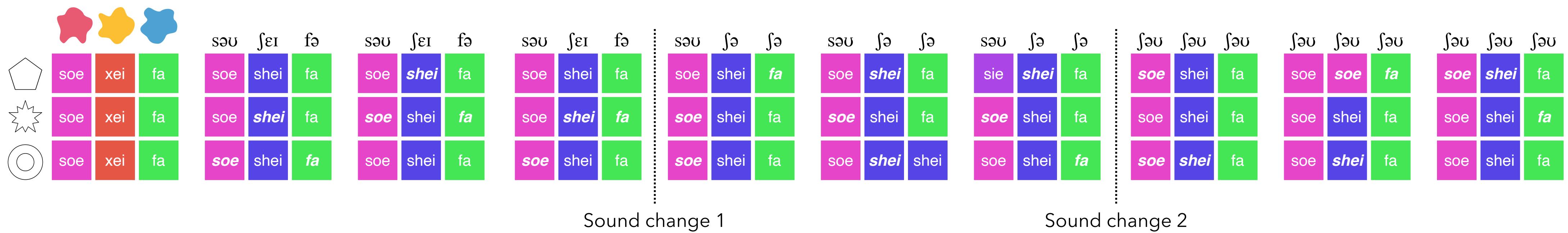
# Transmission + Communication

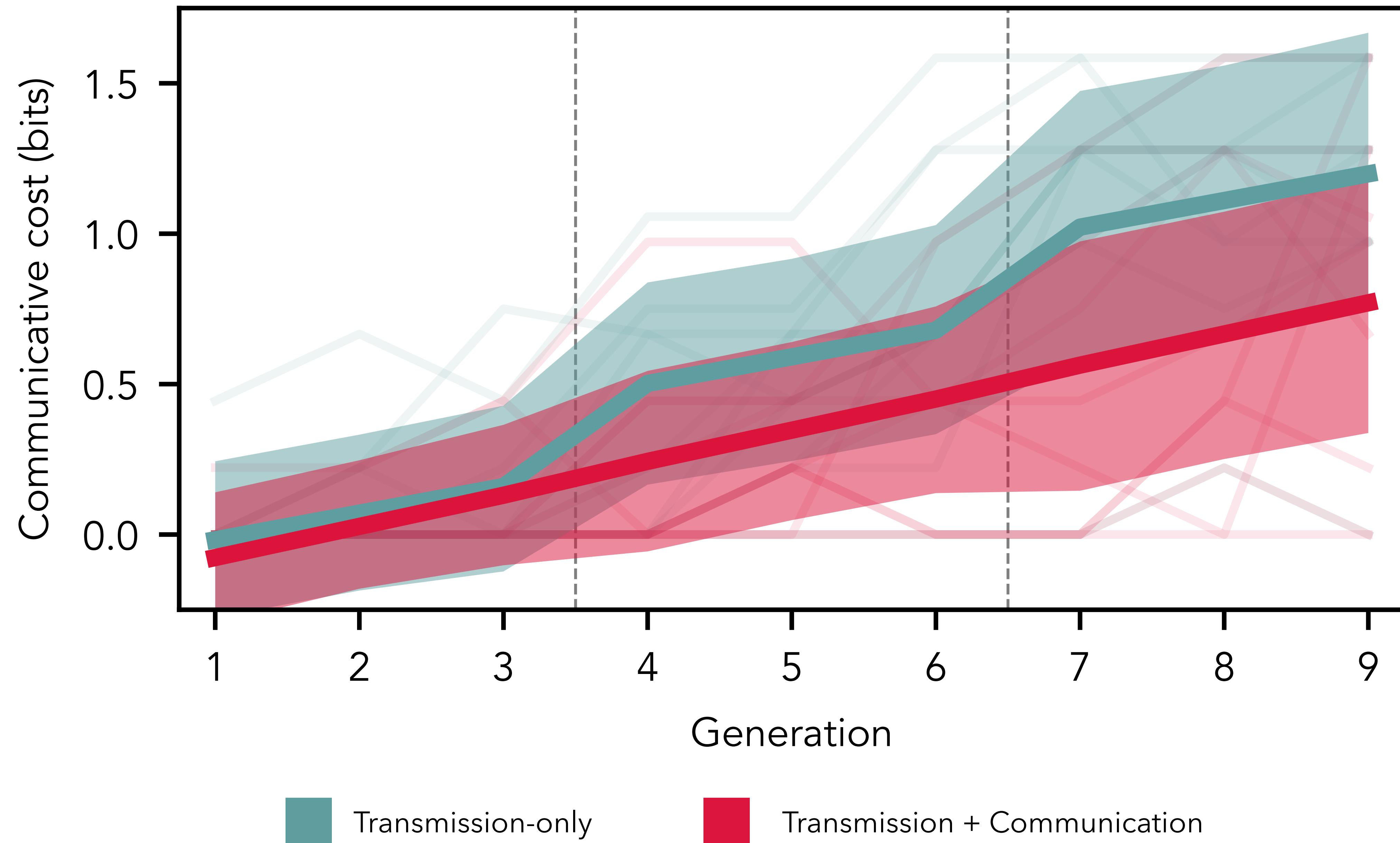
	0	1	2	3	4	5	6	7	8	9
K	soe fa xei	soe fa xei	soe fa xei	soe fa xei	soe fa feix	soe fei fei	soe fei fei	fei fei fei	fei fei fei	fei fei fei
L	fa soe xei	fa soe xei	fa soe xei	fa soe xei	so fa fei	so fey fei	so fei fei	fei fei fei	fei fei fei	fei fei fei
M	fa soe xei	fa soe xei	soe fa xei	soe fa xei	fa so fa	fa so fa	fa so fa	fa sol fa	fa fa fa	fa sol fa
N	soe fa xei	soe fa xei	soe fa xei	soe fa xei	soe fei fei	soe fei fei	soe fei fei	soe fei fei	soe zie soe	soe zie soe
O	sa foe xei	sa foe xei	sa foe xei	sa foe xei	sa soe xie	soe fei fei	soe fei fei	soe zie soe	fie fie soe	fie fie soe
P	fa xoe sei	fa xoe sei	fa xoe sei	fa xoe sei	fa xoe sei	fa xoe sei	fa xoe sei	fa xoe sei	soe soe soe	soe soe soe
Q	xa fei soe	sha fe soe	sha fa soe	sha soe soe	sha fa soe					
R	xa fei soe	sha fei soe	sha fei soe	sha fei soe	sha fay soe	sha fa soe	sha fa soe	sha fa soe	sha fa soe	sha fa soe
S	fei sa xoe	fei sa xoe	fei sa xoe	fei sa xoe	fei sa xoe	fei sa xo	fei sa xo	fei sa xo	fei fe so	fe fe fe
T	xoe sa fei	xoe sa fei	xoe sa fei	xoe sa fei	xoe sa fei	xoe sa fei	xoe sa fei	xoe sa fei	fei fei fei	fei fei fei

# Transmission-only

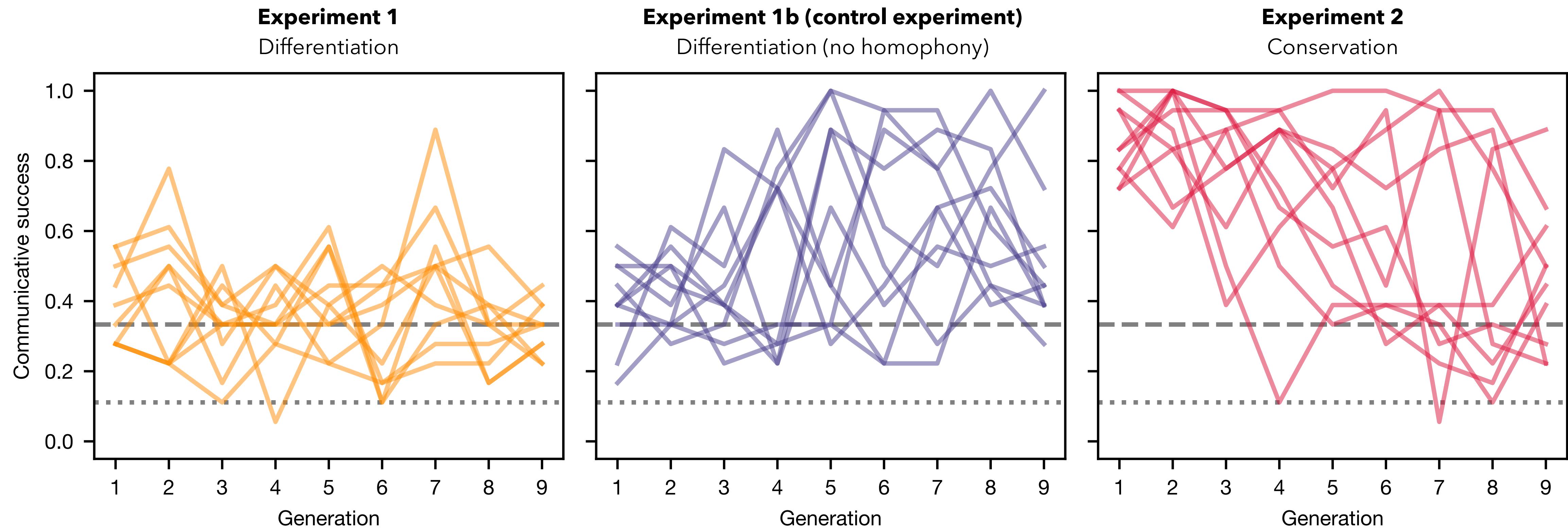


# Transmission + Communication





# *Conclusions*



## Hurdles in differentiation

**The apprehension problem:** Participants must grasp the mechanics of the game and its incentive structure

**The theory of mind problem:** Participants must be able to put themselves in the shoes of their partners

**The innovation problem:** Participants must be capable of devising linguistic solutions

**The alignment problem:** Participants must be able to align with an interlocutor separated in time and space

**The social problem:** Participants must be prepared to rebel against their input, overcoming various social stigmas in the process

## Hurdles in conservation

**The learnability problem:** Participants must be able to learn a spelling system that is not transparent

Heterographic spelling permits greater informativeness at the expense of simplicity.

Left to evolve freely, might writing systems sometimes forego some simplicity for the sake of informativeness?

Heterography is sometimes favoured in response to communicative pressure.

*Differentiation* is difficult; it's hard to introduce new spellings in the face of homophony.

*Conservation* is easy; heterography emerges as a by-product of sound merger.



[doi.org/k3v4](https://doi.org/k3v4)