Appendix A

Table A1. Participant language information. Participants’ languages in order of dominance, along with age of acquisition and self-rated speaking, listening, and reading proficiencies for each language. Note the age of acquisition question was likely interpreted by some participants as the age of onset of speaking, given that some participants do not report age 0 for any language. Proficiencies range from 0-none to 10-perfect.

| Participant | Order of Language Dominance | Age of Acquisition | Speaking Proficiency | Listening Proficiency | Reading Proficiency |
|-------------|-----------------------------|--------------------|----------------------|-----------------------|---------------------|
| 1           | English                     | 0                  | 10                   | 10                    | 10                  |
|             | Cantonese                   | 0                  | 5                    | 7                     | 5                   |
|             | Mandarin                    | 5                  | 5                    | 6                     | 5                   |
|             | French                      | 10                 | 1                    | 0                     | 1                   |
| 2           | English                     | 3                  | 10                   | 10                    | 10                  |
|             | Cantonese                   | 0                  | 10                   | 10                    | 10                  |
|             | Mandarin                    | 9                  | 7                    | 8                     | 7                   |
|             | French                      | 10                 | 3                    | 3                     | 3                   |
| 3           | English                     | 2                  | 10                   | 10                    | 10                  |
|             | Cantonese                   | 0                  | 4                    | 5                     | 4                   |
|             | French                      | 9                  | 1                    | 1                     | 1                   |
|             | American Sign Language      | 22                 | 2                    | 2                     | 2                   |
| 4           | English                     | 4                  | 10                   | 10                    | 10                  |
|             | Cantonese                   | 0                  | 7                    | 8                     | 7                   |
|             | Mandarin                    | 16                 | 2                    | 4                     | 2                   |
| 5           | English                     | 3                  | 9                    | 9                     | 9                   |
|             | Cantonese                   | 1                  | 8                    | 8                     | 8                   |
|             | Mandarin                    | 5                  | 4                    | 5                     | 4                   |
|             | French                      | 10                 | 2                    | 2                     | 2                   |
| 6           | English                     | 1                  | 9                    | 10                    | 9                   |
|             | Mandarin                    | 1                  | 7                    | 8                     | 7                   |
|             | Cantonese                   | 6                  | 2                    | 3                     | 2                   |
|             | Hakka                       | 1                  | 2                    | 3                     | 2                   |
| 7           | English                     | 0                  | 10                   | 10                    | 10                  |
|             | Cantonese                   | 0                  | 3                    | 4                     | 3                   |
|             | Japanese                    | 15                 | 2                    | 1                     | 2                   |
| 8           | Cantonese                   | 0                  | 10                   | 10                    | 10                  |
|             | Mandarin                    | 6                  | 8                    | 9                     | 8                   |
|             | English                     | 3                  | 7                    | 9                     | 7                   |
|             | Shanghaiese                 | 17                 | 1                    | 3                     | 1                   |
|             | Korean                      | 15                 | 1                    | 2                     | 1                   |
| 9           | English                     | 2                  | 10                   | 10                    | 10                  |
|             | Cantonese                   | 0                  | 10                   | 10                    | 10                  |
|             | Mandarin                    | 3                  | 9                    | 9                     | 9                   |
|             | French                      | 9                  | 7                    | 7                     | 7                   |
| 10          | English                     | 4                  | 10                   | 10                    | 10                  |
|             | Cantonese                   | 0                  | 8                    | 8                     | 8                   |
|             | Mandarin                    | 0                  | 5                    | 5                     | 8                   |
|   | French | English | Cantonese | Mandarin | German |
|---|--------|---------|-----------|----------|--------|
| 11 | 9      | 3       | 3         | 3        | 3      |
| 12 | 3      | 8       | 8         | 8        | 3      |
| 13 | 0      | 10      | 10        | 10       | 0      |
| 14 | 3      | 7       | 8         | 7        | 3      |
| 15 | 13     | 1       | 3         | 1        | 18     |
| 16 | 4      | 10      | 10        | 10       | 4      |
| 17 | 6      | 7       | 7         | 7        | 6      |
| 18 | 0      | 10      | 10        | 10       | 0      |
| 19 | 15     | 6       | 6         | 6        | 16     |
| 20 | 0      | 3       | 3         | 3        | 2      |
| 21 | 4      | 10      | 10        | 10       | 4      |
| 22 | 1      | 9       | 8         | 9        | 1      |
| 23 | 2      | 8       | 8         | 8        | 2      |
| 24 | 5      | 5       | 5         | 5        | 5      |
| Participant | Age at Time of Study | Level of Education | Place of Residence       |
|-------------|----------------------|--------------------|--------------------------|
| 1           | 25                   | Graduate degree    | Vancouver, BC, Canada    |
|   |   | Degree Type          | Location                  |
|---|---|----------------------|---------------------------|
| 2 | 23| Undergraduate degree | BC, Canada                |
| 3 | 24| Undergraduate degree | Vancouver, BC, Canada     |
| 4 | 23| Undergraduate degree | Coquitlam, BC, Canada     |
| 5 | 23| Undergraduate degree | Vancouver, BC, Canada     |
| 6 | 24| Graduate degree      | Hamilton, ON, Canada      |
| 7 | 22| Undergraduate degree | Vancouver, BC, Canada     |
| 8 | 25| Undergraduate degree | Richmond, BC, Canada      |
| 9 | 22| Undergraduate degree | Vancouver, BC, Canada     |
|10 | 23| Undergraduate degree | Richmond, BC, Canada      |
|11 | 25| Graduate degree      | Westmount, Quebec, Canada |
|12 | 36| Graduate degree      | Richmond, BC, Canada      |
|13 | 29| Undergraduate degree | Vancouver, BC, Canada     |
|14 | 20| Undergraduate degree | Vancouver, BC, Canada     |
|15 | 30| Graduate degree      | Vancouver, BC, Canada     |
|16 | 19| Undergraduate degree | Richmond, BC, Canada      |
|17 | 27| Graduate degree      | Vancouver, BC, Canada     |
|18 | 19| Undergraduate degree | Richmond, BC, Canada      |
|19 | 23| Undergraduate degree | Vancouver, BC, Canada     |
|20 | 26| Graduate degree      | Vancouver, BC, Canada     |
|21 | 24| Undergraduate degree | Victoria, BC, Canada      |
|22 | 23| Graduate degree      | Vancouver, BC, Canada     |
|23 | 26| Undergraduate degree | Toronto, ON, Canada       |
|24 | 31| Undergraduate degree | Honolulu, HI, USA         |
|     |     |                                      |                                      |
|-----|-----|--------------------------------------|--------------------------------------|
| 25  | 22  | Undergraduate degree                  | Vancouver, BC, Canada                |
| 26  | 21  | Undergraduate degree                  | BC, Canada                           |
| 27  | 23  | Graduate degree                       | Vancouver, BC, Canada                |
| 28  | 23  | Undergraduate degree                  | Vancouver, BC, Canada                |
| 29  | 23  | Diploma                               | Vancouver, BC, Canada                |
| 30  | 40  | Graduate degree                       | Honolulu, HI, USA                    |
| 31  | 22  | Undergraduate degree                  | Vancouver, BC, Canada                |
| 32  | 39  | Undergraduate degree                  | Burnaby, BC, Canada                  |
| 33  | 23  | Undergraduate degree                  | Richmond, BC, Canada                 |
### Materials

Table A3.

*Production Word List*

| Chinese Character | English Gloss | Jyutping Romanization |
|-------------------|--------------|-----------------------|
| 雞                | chicken      | gai1                  |
| 機                | machine      | gei1                  |
| 街                | street       | gaai1                 |
| 揮                | to wave      | fail                  |
| 飛                | to fly       | fei1                  |
| 多                | many         | do1                   |
| 刀                | knife        | dou1                  |
| 歌                | song         | go1                   |
| 高                | tall         | gou1                  |
| 梳                | comb         | sol                   |
| 鬚                | beard/mustache | soul              |
| 波                | ball         | bo1                   |
| 煲                | pot          | bou1                  |
| 踦                | to squat     | mau1                  |
| 貓                | cat          | maaau1                |
| 秋                | autumn       | cau1                  |
| 抄                | to copy      | caau1                 |
| 咳                | cough        | kat1                  |
| 咭                | card         | kaat1                 |
| 心                | heart        | sam1                  |
| 衫                | shirt        | saam1                 |
| 西                | west         | sai1                  |
| 嘲                | to waste     | saai1                 |
| 龜                | turtle       | gwai1                 |
| 乖                | well-behaved | gwaai1                |
| 拗                | drive        | zaal                  |
| 叉                | fork         | caal                  |
| 遮                | umbrella     | zel                   |
| 車                | car          | cel                   |
| 鐘                | clock        | zung1                 |
| 蔥                | onion        | cung1                 |
| 追                | to chase     | zeoi1                 |
| 吹                | to blow      | ceoi1                 |
### Figure A1 Picture Stimuli.
Picture stimuli for the production task with characters, Jyutping, and an English gloss. A subset of these items was used in the perception task.

| Character (Traditional) | Character (Simplified) | Jyutping | English Gloss |
|------------------------|------------------------|----------|---------------|
| 尖                     | sharp                  | zim1     |               |
| 簽                     | to sign                | cim1     |               |
| 獅                     | lion                   | si1      |               |
| 鷹                     | to stick               | ci1      |               |
| 星                     | star                   | sing1    |               |
| 蜻                     | dragonfly              | cing1    |               |
| 沙                     | sand                   | saa1     |               |
| 鬆                     | loose                  | sung1    |               |

雞 gail “chicken”

機 geil “machine”
揮 fail “to wave (one’s hand)”
飛 feil “to fly”

d 多 do1 “many”
刀 doul “knife”

g 歌 gol “song”
高 goul “tall”

梳 sol “comb”
鬚 soul “beard/mustache”
波 bol “ball”
煲 bou1 “pot”
跼 mau1 “to squat”
貓 maaul “cat”
秋 caul “autumn”
抄 caaul “to copy”
咯 katlı “to cough”

心 saml “heart”

西 sail “west”

龜 gwail “turtle”

咭 kaatlı “card”

衫 saaml “shirt”

暹 saail “to waste”

乖 gwaail “well-behaved”
揸 zaal “to drive”
叉 caal “fork”
遮 zel “umbrella”
車 cel “car”
鐘 zungl “clock”
蔥 cunl “green onion”
追 zeoil “to chase”
吹 ceoil “to blow”
尖 ziml “sharp”
簽 ciml “to sign”
獅 sil “lion”
黏 ci “to stick”
星 sing1 “star”
蜻 cing1 “dragonfly”
沙 saal “sand”
鬆 sung1 “loose”
街 gaail “street”
Figure A2 The following pictures were used for practice trials in the perception task.

書 syu1 “book”

狗 gau2 “dog”

山 saan1 “mountain”

紙 zi2 “paper”

水 seoi2 “water”

蚊 man1 “mosquito”
**Perception Task Audio Manipulation**

*Modification parameters and pitch measurement parameters used with the Change-Gender function in Praat.*

| Participant | Pitch range factor | Formant shift ratio | Pitch floor | Pitch ceiling |
|-------------|--------------------|---------------------|-------------|--------------|
| 1           | 0.57               | 0.8                 | 150 Hz      | 300 Hz       |
| 2           | 0.75               | 0.83                | 150 Hz      | 300 Hz       |
| 3           | 0.65               | 0.79                | 150 Hz      | 300 Hz       |
| 4           | 0.6                | 0.83                | 150 Hz      | 300 Hz       |
| 5           | 0.65               | 0.8                 | 150 Hz      | 500 Hz       |
| 6           | 0.6                | 0.82                | 150 Hz      | 300 Hz       |
| 7           | 0.65               | 0.8                 | 150 Hz      | 500 Hz       |
| 8           | 0.75               | 0.83                | 150 Hz      | 300 Hz       |
| 9           | 0.6                | 0.82                | 150 Hz      | 300 Hz       |
| 10          | 0.6                | 0.8                 | 150 Hz      | 300 Hz       |
| 11          | 0.55               | 0.8                 | 150 Hz      | 300 Hz       |
| 12          | 0.65               | 0.82                | 150 Hz      | 300 Hz       |
| 13          | 0.55               | 0.8                 | 150 Hz      | 300 Hz       |
| 14          | 0.6                | 0.8                 | 150 Hz      | 300 Hz       |
| 15          | 0.6                | 0.83                | 150 Hz      | 500 Hz       |
| 16          | 0.55               | 0.79                | 150 Hz      | 300 Hz       |
| 17          | 0.6                | 0.82                | 150 Hz      | 300 Hz       |
| 18          | 0.55               | 0.79                | 150 Hz      | 300 Hz       |
| 19          | 0.6                | 0.83                | 150 Hz      | 300 Hz       |
| 20          | 0.65               | 0.8                 | 150 Hz      | 300 Hz       |
| 21          | 0.57               | 0.81                | 150 Hz      | 300 Hz       |
| 22          | 0.58               | 0.8                 | 150 Hz      | 300 Hz       |
| 23          | 0.7                | 0.83                | 150 Hz      | 300 Hz       |
| 24          | 0.69               | 0.83                | 150 Hz      | 300 Hz       |
|   | Frequency 1 | Frequency 2 | Frequency 3 | Frequency 4 |
|---|-------------|-------------|-------------|-------------|
| 25 | 0.57        | 0.79        | 150 Hz      | 300 Hz      |
| 26 | 0.56        | 0.79        | 150 Hz      | 300 Hz      |
| 27 | 0.58        | 0.79        | 150 Hz      | 300 Hz      |
| 28 | 0.60        | 0.82        | 150 Hz      | 300 Hz      |
| 29 | 0.65        | 0.83        | 150 Hz      | 300 Hz      |
| 30 | 0.68        | 0.80        | 150 Hz      | 300 Hz      |
| 31 | 0.60        | 0.80        | 150 Hz      | 300 Hz      |
| 32 | 0.63        | 0.81        | 150 Hz      | 300 Hz      |
| 33 | 0.70        | 0.81        | 150 Hz      | 300 Hz      |