# Supplementary Materials

**Table S1.** *Mean (± SD) Characteristics of Participants' Language Background*

| Item | L1 (Chinese) | L2 (English) | *t* | *p* |
|---|---|---|---|---|
| Quick Placement Test | -- | 34.24 ± 5.24 | -- | -- |
| Listening | 5.29 ± .71 | 3.55 ± 1.19 | -7.96 | < .001 |
| Speaking | 4.98 ± .64 | 3.67 ± 1.12 | -6.54 | < .001 |
| Reading | 4.76 ± .88 | 3.86 ± 1.39 | -4.50 | < .001 |
| Writing | 5.07 ± .81 | 3.62 ± 1.38 | -5.96 | < .001 |

**Table S2.** *English Proficiency Classification Criteria of QPT Scores*

| Alte | Paper and pen test score | Council of Europe Level |
| --- | --- | --- |
| 0 beginner | 0-17 | A1 |
| 1 elementary | 18-29 | A2 |
| 2 lower intermediate | 30-39 | B1 |
| 3 upper intermediate | 40-47 | B2 |
| 4 advanced | 48-54 | C1 |
| 5 very advanced | 54-60 | C2 |

**Table S3.** *Head Position Conditions of the Stimuli*

| Head-initial (noun-verb) | | Head-final (verb-noun) | |
|---|---|---|---|
| L1 | L2 | L1 | L2 |
| 日出 | Sunrise | 操场 | Playground |
| 心跳 | Heartbeat | 浴室 | Bathroom |
| 水滴 | Water-drop | 滑板 | Skateboard |
| 地震 | Earthquake | 生日 | Birthday |
| 枪战 | Gunfight | 玩伴 | Playmate |
| 梦游 | Sleepwalk | 爬树 | Climb tree |
| 被罩 | Bedcover | 跳绳 | Jump rope |
| 脚印 | Footprint | 画笔 | Paint pen |
| 气流 | Airflow | 舞厅 | Dance hall |
| 手写 | Hand write | 跑道 | Runway |
| 机洗 | Machine-wash | 搓板 | Washboard |
| 山崩 | Landslide | 转盘 | Turntable |
| 唇读 | Lip-read | 邮局 | Post office |
| 耳塞 | Earplug | 露天 | Open-air |

**Figure S1.** *Stimulus Pictures in the Joint Production-Comprehension Task.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Noun-verb | Sunrise | Heartbeat | Water-drop | Earthquake | Gunfight | Sleepwalk | Bedcover |
| | Footprint | Airflow | Hand write | Machine-wash | Landslide | Lip-read | Earplug |
| Verb-noun | Playground | Bathroom | Skateboard | Birthday | Playmate | Climb tree | Jump rope |
| | Paint pen | Dance hall | Runway | Washboard | Turntable | Post office | Open-air |
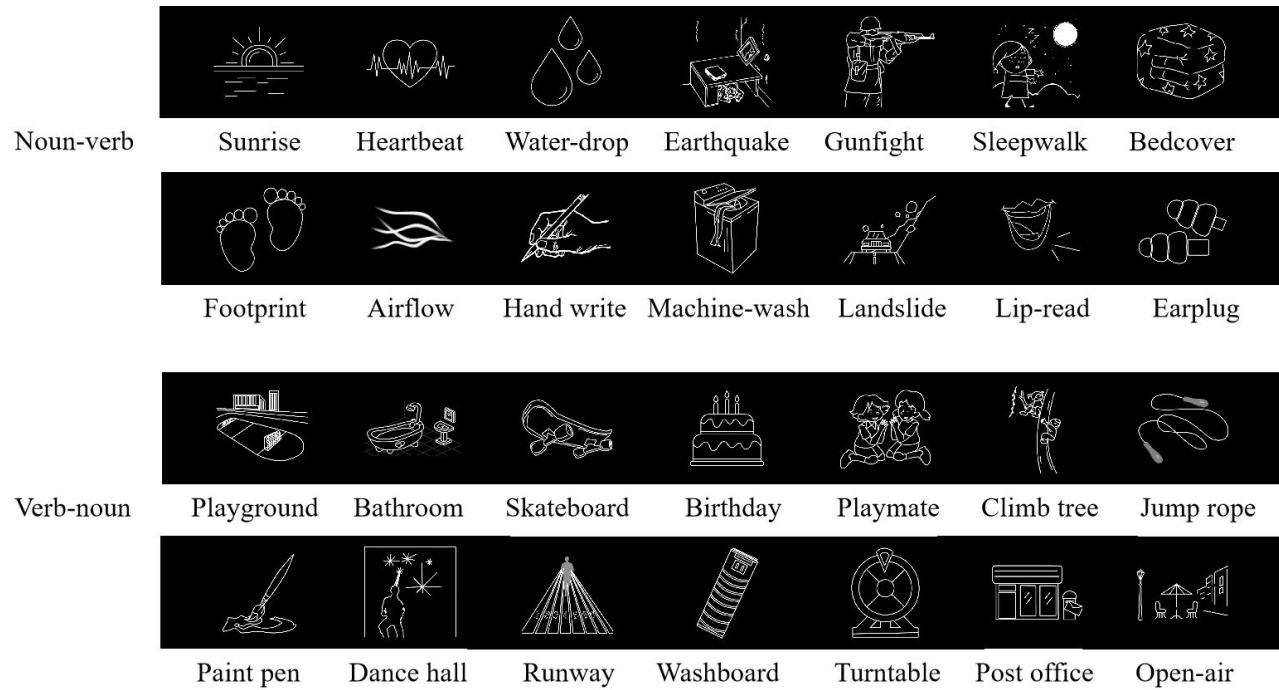
**Table S4.** *Characteristics of the Stimuli (Mean ± SD).*

|  | Item | Head-initial | | Head-final | |
|---|---|---|---|---|---|
|  |  | L1 | L2 | L1 | L2 |
| Familiarity | Compound | 7.99 ± .47 | 7.97 ± .49 | 8.07 ± .33 | 8.05 ± .46 |
|  | Head | 7.58 ± .43 | 7.59 ± .41 | 7.44 ± .26 | 7.46 ± .34 |
| Transparency | Modifier | 6.88 ± .37 | 6.86 ± .45 | 6.87 ± .39 | 6.91 ± .38 |
|  | Head | 8.28 ± .19 | 8.26 ± .23 | 8.21 ± .15 | 8.21 ± .20 |

**Figure S2.** *Normal Probability-Probability Plot of EEG Data under Each Time Window.*
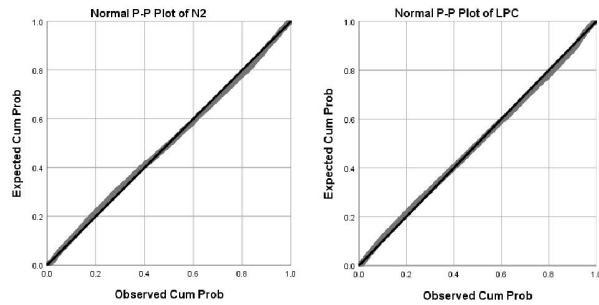
a. Cue-locked naming epochs
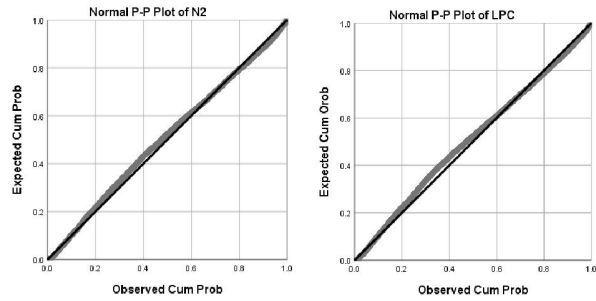
b. Picture-locked naming epochs
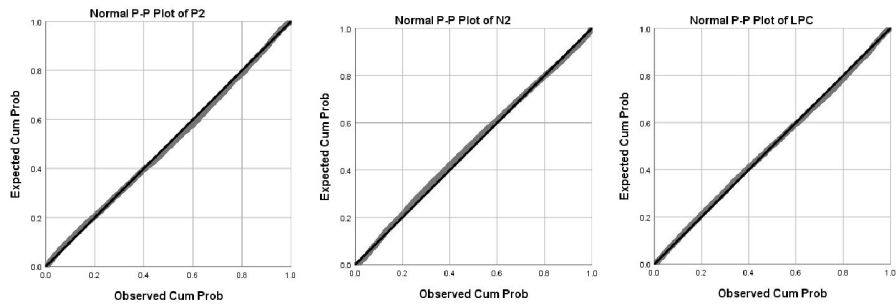
c. Cue-locked listening epochs
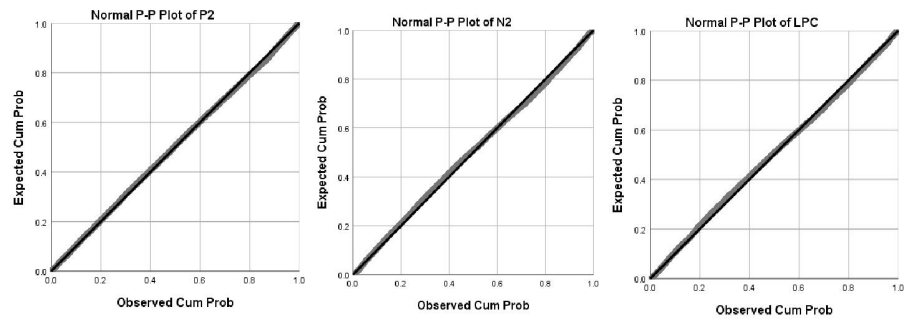
d. Judgement-locked listening epochs

**Table S5.** *Mean Number of Trials for Each Condition per Participant after Independent*

*Component Analyses.*

| Item | L1 | | L2 | |
|------|-----------|-------|-----------|-------|
| | **Non-switch** | **Switch** | **Non-switch** | **Switch** |
| Head-initial | 35.19 ± 4.24 | 35.29 ± 4.21 | 36.33 ± 3.41 | 36.38 ± 3.98 |
| Head-final | 35.76 ± 4.69 | 36.24 ± 4.02 | 37.52 ± 3.72 | 35.71 ± 4.83 |

**Table S6.** *Model Parameters for the Best-Fitting Generalized Linear Mixed Model of RTs for Naming and Listening.*

| | Naming RTs | | | | Listening RTs | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Contrast | | | | Contrast | |
| | *b* | *SE* | *t* | *p* | *b* | *SE* | *t* | *p* |
| **Fixed effects** | | | | | | | | |
| Intercept | **6.80** | **.021** | **330.03** | **< .001*** ** | **6.73** | **.038** | **175.47** | **< .001*** ** |
| Language | **.10** | **.006** | **17.43** | **< .001*** ** | **.18** | **.006** | **31.70** | **< .001*** ** |
| Switching | **.03** | **.005** | **5.84** | **< .001*** ** | **.01** | **.006** | **2.10** | **.036*** |
| Head | -.01 | .005 | -1.75 | .080 | **-.01** | **.006** | **-2.17** | **.030*** |
| Language × Switching | .02 | .011 | 1.63 | .104 | -.0002 | .011 | -.02 | .988 |
| Language × Head | **-.03** | **.011** | **-2.47** | **.014*** | **.05** | **.011** | **-4.40** | **< .001*** ** |
| Switching × Head | -.01 | .011 | -1.32 | .186 | -.001 | .011 | -.09 | .929 |
| Language × Switching × Head | < -.001 | .022 | < 0.001 | 1.000 | -.02 | .022 | -.83 | .407 |
| **Random effects** | | | | | | | | |
| Participants | .01 | .093 | | | .03 | .175 | | |

*Notes.* model=lmer(logRT~data$language*data$switching*data$Head+(1|participant)). Bold words mean significant results.

* *p* < .05, *** *p* < .001.

**Appendix S1. Testing Practice Effects**

We divided the behavioral data into two equal parts and conducted a language (L1, L2) ×

switching (non-switch, switch) × head position (head-initial, head-final) mixed-effects model for

both parts.

**1.1 Results**

**1.1.1 Reaction Times**

**Naming.** In the first and second parts of the data, the results both showed significant

main fixed effects of language and switching. There were faster RTs in the L1 compared to the

L2 (first part: L1 $M = 897 \pm 237$ ms $<$ L2 $M = 981 \pm 253$ ms, $b = .09$, $SE = .008$, $t = 11.25$, $p$

$< .001$; second part: L1 $M = 852 \pm 220$ ms $<$ L2 $M = 938 \pm 225$ ms, $b = .10$, $SE = .007$, $t = 13.78$,

$p < .001$), and faster RTs in non-switch trials than in switch trials (first part: non-switch $M = 922$

$\pm 240$ ms $<$ L2 $M = 955 \pm 256$ ms, $b = .03$, $SE = .008$, $t = 4.17$, $p < .001$; second part: L1 $M =$

$880 \pm 214$ ms $<$ L2 $M = 910 \pm 239$ ms, $b = .03$, $SE = .007$, $t = 4.18$, $p < .001$). No other

significant main fixed effects or interactions emerged in the two sections.

**Listening.** In the first and second parts of the data, the results showed a significant main

fixed effect of language. There were faster RTs in the L1 compared to the L2 (first part: L1 $M =$

$885 \pm 280$ ms $<$ L2 $M = 1021 \pm 282$ ms, $b = .15$, $SE = .007$, $t = 19.69$, $p < .001$; second part: L1

$M = 738 \pm 208$ ms $<$ L2 $M = 901 \pm 232$ ms, $b = .21$, $SE = .007$, $t = 28.99$, $p < .001$). However, in

the first part, the results revealed a main fixed effect of switching and head position. There were

faster RTs in non-switch trials ($M = 940 \pm 288$ ms) than in switch trials ($M = 965 \pm 289$ ms, $b$

$= .03$, $SE = .007$, $t = 3.64$, $p < .001$), and faster RTs for head-final trials ($M = 939 \pm 283$ ms)

compared to head-initial trials ($M = 966 \pm 295$ ms, $b = .02$, $SE = .007$, $t = -2.81$, $p < .005$). In the

second part, there was a significant interaction between language and head position. Further

analyses showed faster RTs in head-initial trials ($M = 727 \pm 211$ ms) compared to head-final

trials in the L1 ($M = 749 \pm 204$ ms), $b = -.04$, $SE = .010$, $z = -3.55$, $p < .001$. However, in the L2,

there were faster RTs in head-final trials ($M = 885 \pm 231$ ms) compared to head-initial trials in

the L1 ($M = 919 \pm 231$ ms), $b = .04$, $SE = .010$, $z = 3.47$, $p < .001$.

### 1.1.2 Accuracy

**Naming.** In the first and second parts of the data, there was no significant effect or

interaction.

**Listening.** In the first part, the results showed a main fixed effect of head position, such

that head-final trials were more accurate ($M = .978 \pm .15$) than head-initial trials ($M = .959 \pm .20$),

$b = .72$, $SE = .210$, $z = 3.41$, $p < .005$. There was no other significant main fixed effect or

interaction in the two parts.

To sum, in production, the results of the first and second parts of the data collected were

similar, indicating that there was no practice effect. Nonetheless, we found an interesting result

in the second partof comprehension in which there was a significant interaction between

language and head position. The results indicated that head-initial compounds were processed

faster than head-final compounds in the L1, while head-final compounds were processed faster than head-initial compounds in the L2. However, the main effect of language, switching, and head position was found in the first part. This may be because the bilinguals were unable to successfully integrate various factors when making head language judgments at the beginning of the task, but in the later stages, they may be able to better process different head positions in language switching. This again confirmed that Chinese-English bilinguals prefer head-initial compounds rather than head-final compounds when switching to Chinese. Contrarily, when switching to Chinese, head-initial compounds tend to be more dominant than head-finial compounds. Although there are slight differences in the results obtained from the two parts of the comprehension data, we believe that this is a beneficial superposition of experimental effects, rather than practical effects.

**2. Electrophysiological Results (LPC in the posterior sites: CP3, CP1, CPz, CP2, CP4, P3, P1, Pz, P2, P4, PO3, POz, PO4)**

**2.1 Naming**

**Cued-locked naming phase.** As shown in Table S7, a language (L1, L2) × switching (non-switch, switch) × head position (head-initial, head-final) mixed-effects model on the cued-locked naming phase showed no significant main fixed effect or interaction.

**Picture-locked naming phase.** A language (L1, L2) × switching (non-switch, switch) × head position (head-initial, head-final) mixed-effects model on the picture-locked naming phase

showed a significant main fixed effect of language, switching, and head position. The L2 ($M =$ 6.84 ± 9.03 µV) elicited greater amplitude than the L1 ($M = 5.53 ± 8.75$ µV), non-switch trials ($M = 6.57 ± 9.02$ µV) elicited greater amplitude than switch trials ($M = 5.83 ± 8.79$ µV), and head-initial trials ($M = 6.54 ± 8.83$ µV) elicited greater amplitude than head-final trials ($M = 5.86$ ± 8.99 µV). There was no significant interaction (also see Table S7).

## 2.2 Listening

**Cued-locked listening phase.** As shown in Table S8, there was no significant main fixed effect or interaction.

**Judgement-locked listening phase.** A similar mixed-effects model was used to analyze the listening data from the judgement-locked listening phase. We found a main fixed effect of language, indicating that the L1 ($M = 3.65 ± 8.25$ µV) elicited greater amplitude than the L2 ($M = 2.57 ± 7.98$ µV). A three-way interaction of language, switching, and head position reached significance. Follow-up analyses for this three-way interaction were split by language. There were no main fixed effects or interactions in L1 or L2 (also see Table S8).

**Table S7.** *Model Parameters for the Best-fitting Generalized Linear Mixed Model in Picture Naming Task (LPC in the posterior sites).*

| | Cued-locked naming phase | | | | Picture-locked naming phase | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Contrast | | | | Contrast | |
| | *b* | *SE* | *t* | *p* | *b* | *SE* | *t* | *p* |
| **Fixed effects** | | | | | | | | |
| Intercept | -.37 | .643 | -.58 | .571 | **6.12** | **.963** | **6.35** | **< .001*** ** |
| Language | .19 | .193 | .98 | .327 | **1.32** | **.208** | **6.34** | **< .001*** ** |
| Switching | -.20 | .193 | -1.04 | .297 | **-.75** | **.208** | **-3.61** | **< .001*** ** |
| Head | -.070 | .193 | -.36 | .717 | **-.75** | **.208** | **-3.64** | **< .001*** ** |
| Language × Switching | 1.20 | .386 | 3.11 | < .05 | -.19 | .415 | .47 | .641 |
| Language × Head | -.11 | .386 | -.29 | .771 | -.56 | .405 | -1.36 | .175 |
| Switching× Head | .452 | .385 | 1.17 | .241 | .05 | .405 | .12 | .905 |
| Language × Switching × Head | .234 | .771 | .30 | .761 | .82 | .830 | .99 | .324 |
| **Random effects** | | | | | | | | |
| Participants | 8.49 | 2.913 | | | 19.26 | 4.388 | | |

*Notes.* model=lmer(Amplitude~data$language*data$switching*data$Head+(1|participant)). Bold words mean significant results.

*** *p* < .001

**Table S8.** *Model Parameters for the Best-fitting Generalized Linear Mixed Model in the Judgement Listening Task (LPC in the Posterior Sites).*

| | Cued-locked listening phase | | | | Judgement-locked listening phase | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Contrast | | | | Contrast | |
| | *b* | *SE* | *t* | *p* | *b* | *SE* | *t* | *p* |
| **Fixed effects** | | | | | | | | |
| Intercept | -.58 | .394 | -1.47 | .156 | **3.14** | **.476** | **6.59** | **< .001*** ** |
| Language | **-.40** | **.198** | **-2.01** | **.044*** | **-1.11** | **.195** | **-5.69** | **< .001*** ** |
| Switching | -.30 | .198 | -1.51 | .132 | .094 | .195 | -.48 | .630 |
| Head | .17 | .198 | .84 | .401 | .18 | .195 | .93 | .351 |
| Language × Switching | -.25 | .395 | -.64 | .521 | -.15 | .391 | .39 | .696 |
| Language × Head | -.69 | .395 | -1.75 | .080 | .39 | .391 | .99 | .322 |
| Switching× Head | .43 | .395 | 1.08 | .280 | -.06 | .391 | .144 | .885 |
| Language × Switching × Head | -.88 | .791 | -1.11 | .267 | **1.55** | **.781** | **1.99** | **.047*** |
| **Random effects** | | | | | | | | |
| Participants | 3.05 | 1.747 | | | | | | |

*Notes.* model=lmer(Amplitude~data$language*data$switching*data$Head+(1|participant)). Bold words mean significant results.

* *p* < .05, ** *p* < .01, *** *p* < .001.