# Appendix

## Appendix A. Summary of fixed effects and random effects in logit mixed effect models

**A1. SVO Model**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **SVO\_Model** | | | | | | | |
| **Formula**: Target Response ~ Group × Prime × Verb +  (-1 + CM + AM + CM:SVO + AM:BA + CM:BEI + CM:Verbs + AM:Verbs + AM:SVO:Verbs + CM:BA:Verbs + AM:BA:Verbs + AM: BEI:Verbs | Participants) +  (1 + CM + SVO + BA + Verbs + CM:SVO + SVO:Verbs + CM: SVO:Verbs + CM:BEI:Verbs | Item) | | | | | | | |
| **Fixed effects** | | | | | **Random effects** | | |
|  | *Estimate* | *SE* | *Z* | *P* | ***Participants*** | | |
| Intercept | 0.493 | 0.057 | 8.680 | <0.001\*\*\* | Random | Variance | SD |
| ***Main effects*** | | | | | CM | 0.185 | 0.430 |
| CM | –0.448 | 0.106 | *–*4.221 | <0.001\*\*\* | AM | 0.286 | 0.534 |
| AM | –0.501 | 0.110 | –4.553 | <0.001\*\*\* | CM: SVO | 0.682 | 0.826 |
| SVO | 0.384 | 0.133 | 2.887 | <0.001\*\*\* | AM: BA | 0.666 | 0.816 |
| BA | –2.705 | 0.126 | –21.465 | <0.001\*\*\* | CM: BEI | 0.228 | 0.478 |
| BEI | –1.601 | 0.114 | –14.046 | <0.001\*\*\* | CM: Verbs | 0.401 | 0.634 |
| Verbs | –0.216 | 0.255 | –0.418 | 0.046\* | AM: Verbs | 1.480 | 1.217 |
| ***2-way interactions*** | | | | | AM: SVO: Verbs | 3.634 | 1.906 |
| CM: SVO | –0.216 | 0.255 | –0.848 | 0.400 | CM: BA: Verbs | 0.731 | 0.855 |
| AM: SVO | –0.098 | 0.234 | –0.418 | 0.676 | AM: BA: Verbs | 3.378 | 1.838 |
| CM: BA | 0.508 | 0.214 | 2.371 | 0.018\* | AM: BEI: Verbs | 1.010 | 1.005 |
| AM: BA | 0.010 | 0.230 | 0.431 | 0.666 |  |  |  |
| CM: BEI | –0.269 | 0.204 | –1.320 | 0.187 | ***Item*** | | |
| AM: BEI | –0.201 | 0.190 | –1.055 | 0.292 | Random | Variance | SD |
| CM: Verbs | –0.213 | 0.198 | –1.075 | 0.282 | Intercept | 0.053 | 0.230 |
| AM: Verbs | –0.200 | 0.229 | –0.875 | 0.382 | CM | 0.070 | 0.160 |
| SVO: Verbs | 0.764 | 0.252 | 3.030 | 0.003\*\* | SVO | 0.070 | 0.263 |
| BA: Verbs | –0.107 | 0.241 | –0.442 | 0.658 | BA | 0.050 | 0.222 |
| BEI: Verbs | –0.201 | 0.217 | –0.925 | 0.355 | Verbs | 0.193 | 0.440 |
| ***3-way interactions*** | | | | | CM: SVO | 0.034 | 0.188 |
| CM: SVO: Verbs | –0.713 | 0.493 | –1.447 | 0.148 | SVO: Verbs | 0.100 | 0.315 |
| AM: SVO: Verbs | –0.048 | 0.516 | –0.092 | 0.927 | CM: SVO: Verbs | 1.010 | 1.005 |
| CM: BA: Verbs | 1.012 | 0.444 | 2.278 | 0.023\* | CM: BEI: Verbs | 0.158 | 0.400 |
| AM: BA: Verbs | 0.628 | 0.478 | 1.313 | 0.189 |  |  |  |
| CM: BEI: Verbs | 0.257 | 0.392 | 0.655 | 0.513 |  |  |  |
| AM: BEI: Verbs | 0.063 | 0.395 | 0.159 | 0.874 |  |  |  |

Note: CM = Cognitive Matched Children; AM = Age Matched Children; Verbs = same verb.

**A2. BA Model**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BA\_Model** | | | | | | | |
| **Formula**: Target Response ~ Group × Prime × Verb +  (-1 + CM + AM + CM:SVO + AM:BA + CM:BEI + CM:Verbs + AM:Verbs + AM:SVO:Verbs + CM:BA:Verbs + AM:BA:Verbs + AM: BEI:Verbs | Participants) +  (1 + CM + SVO + BA + Verbs + CM:SVO + SVO:Verbs + CM: SVO:Verbs + CM:BEI:Verbs | Item) | | | | | | | |
| **Fixed effects** | | | | | **Random effects** | | |
|  | *Estimate* | *SE* | *Z* | *P* | ***Participants*** | | |
| Intercept | –0.806 | 0.054 | –14.887 | <0.001\*\*\* | Random | Variance | SD |
| ***Main effects*** | | | | | CM | 0.174 | 0.417 |
| CM | 0.503 | 0.106 | 4.732 | <0.001\*\*\* | AM | 0.272 | 0.522 |
| AM | 0.513 | 0.110 | 4.649 | <0.001\*\*\* | BA | 0.050 | 0.224 |
| SVO | –0.386 | 0.124 | –3.123 | 0.002\*\* | CM: SVO | 0.388 | 0.623 |
| BA | 2.677 | 0.124 | 21.584 | <0.001\*\*\* | AM: BA | 0.710 | 0.842 |
| BEI | 0.448 | 0.110 | 4.072 | <0.001\*\*\* | AM: BEI | 0.285 | 0.534 |
| Verbs | 0.139 | 0.112 | 1.232 | 0.218 | CM: Verbs | 0.678 | 0.823 |
| ***2-way interactions*** | | | | | AM: Verbs | 0.983 | 0.991 |
| CM: SVO | 0.260 | 0.243 | 1.044 | 0.296 | AM: SVO: Verbs | 3.439 | 1.855 |
| AM: SVO | 0.118 | 0.237 | 0.497 | 0.619 | CM: BA: Verbs | 1.283 | 1.133 |
| CM: BA | –0.514 | 0.223 | –2.301 | 0.021\* | AM: BA: Verbs | 3.441 | 1.855 |
| AM: BA | –0.172 | 0.242 | –0.712 | 0.477 | CM: BEI: Verbs | 0.987 | 0.993 |
| CM: BEI | 0.571 | 0.210 | 2.726 | 0.006\*\* | AM: BEI: Verbs | 1.465 | 1.210 |
| AM: BEI | 0.359 | 0.213 | 1.685 | 0.092. |  |  |  |
| CM: Verbs | 0.410 | 0.208 | 1.966 | 0.049\* | ***Item*** | | |
| AM: Verbs | 0.237 | 0.214 | 1.106 | 0.269 | Random | Variance | SD |
| SVO: Verbs | –0.742 | 0.258 | –2.875 | 0.004\*\* | Intercept | 0.038 | 0.195 |
| BA: Verbs | 0.132 | 0.253 | 0.520 | 0.603 | CM | 0.027 | 0.164 |
| BEI: Verbs | –0.121 | 0.240 | –0.503 | 0.615 | SVO | 0.062 | 0.248 |
| ***3-way interactions*** | | | | | BA | 0.074 | 0.271 |
| CM: SVO: Verbs | 0.726 | 0.489 | 1.486 | 0.137 | Verbs | 0.238 | 0.488 |
| AM: SVO: Verbs | 0.156 | 0.514 | 0.304 | 0.761 | AM: SVO | 0.161 | 0.401 |
| CM: BA: Verbs | –0.982 | 0.464 | –2.117 | 0.034\* | CM: Verbs | 0.065 | 0.255 |
| AM: BA: Verbs | –0.541 | 0.483 | –1.122 | 0.262 | SVO: Verbs | 0.023 | 0.150 |
| CM: BEI: Verbs | 0.516 | 0.456 | 1.131 | 0.258 | CM: SVO: Verbs | 0.296 | 0.544 |
| AM: BEI: Verbs | –0.009 | 0.437 | –0.020 | 0.984 | CM: BEI: Verbs | 0.674 | 0.821 |

Note: CM = Cognitive Matched Children; AM = Age Matched Children; Verbs = same verb.

**A3. BEI Model**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BEI\_Model** | | | | | | | |
| **Formula**: Target Response ~ Group × Prime × Verb +  (-1 + CM:SVO + CM:BA + CM:BEI + CM:Verbs + AM:SVO:Verbs + CM:BA:Verbs + AM:BA:Verbs | Participants) +  (-1 + SVO + BA + CM:Verbs + CM:BA:Verbs + AM:BA:Verbs | Item) | | | | | | | |
| **fixed effects** | | | | | **random effects** | | |
|  | *Estimate* | *SE* | *Z* | *P* | ***Participants*** | | |
| Intercept | –4.395 | 0.153 | –28.817 | <0.001\*\*\* | *Random* | *Variance* | *SD* |
| ***Main effects*** | | | | | CM:SVO | 0.864 | 0.930 |
| CM | 0.346 | 0.391 | 0.886 | 0.376 | CM:BA | 4.248 | 2.061 |
| AM | 0.464 | 0.385 | 1.204 | 0.229 | CM:BEI | 1.061 | 1.030 |
| SVO | –0.147 | 0.533 | –0.277 | 0.782 | CM:Verbs | 0.669 | 0.817 |
| BA | 0.600 | 0.490 | 1.219 | 0.223 | AM:SVO:Verbs | 0.330 | 5.748 |
| BEI | 4.356 | 0.381 | 11.441 | <0.001\*\*\* | CM:BA:Verbs | 1.512 | 1.230 |
| Verbs | 0.148 | 0.303 | 0.489 | 0.625 | AM:BA:Verbs | 0.105 | 3.243 |
| ***2-way interactions*** | | | | |  |  |  |
| CM: SVO | 0.025 | 1.326 | 0.019 | 0.985 |  |  |  |
| AM: SVO | –0.378 | 1.314 | –0.288 | 0.773 | ***Item*** | | |
| CM: BA | 0.701 | 1.274 | 0.550 | 0.582 | *Random* | *Variance* | *SD* |
| AM: BA | 1.151 | 1.216 | 0.947 | 0.344 | SVO | 0.286 | 0.535 |
| CM: BEI | –0.485 | 0.957 | –0.506 | 0.613 | BA | 0.339 | 0.582 |
| AM: BEI | –0.471 | 0.929 | –0.507 | 0.612 | CM:Verbs | 0.137 | 0.371 |
| CM: Verbs | 0.082 | 0.790 | 0.104 | 0.918 | CM:BA:Verbs | 0.010 | 0.314 |
| AM: Verbs | –0.131 | 0.767 | –0.171 | 0.864 | AM:BA:Verbs | 0.489 | 0.700 |
| SVO: Verbs | –0.746 | 1.086 | –0.687 | 0.492 |  |  |  |
| BA: Verbs | –0.830 | 0.952 | –0.873 | 0.383 |  |  |  |
| BEI: Verbs | –0.260 | 0.743 | –0.351 | 0.726 |  |  |  |
| ***3-way interactions*** | | | | |  |  |  |
| CM: SVO: Verbs | 0.027 | 2.703 | 0.010 | 0.992 |  |  |  |
| AM: SVO: Verbs | –2.280 | 2.736 | –0.834 | 0.405 |  |  |  |
| CM: BA: Verbs | –0.809 | 2.500 | –0.324 | 0.746 |  |  |  |
| AM: BA: Verbs | –1.651 | 2.447 | –0.675 | 0.500 |  |  |  |
| CM: BEI: Verbs | –1.634 | 1.897 | –0.861 | 0.389 |  |  |  |
| AM: BEI: Verbs | –1.139 | 1.850 | –0.616 | 0.538 |  |  |  |

Note: CM = Cognitive Matched Children; AM = Age Matched Children; Verbs = same verb.

## Appendix B. Experimental materials

Materials are presented as Prime-Target pairs. For example, a pragmatically appropriate, grammatical response could be either “老虎拔掉了牙齿, LaoHu BaDiao le YaChi. (The tiger pulled out tooth)”, “老虎把牙齿拔掉了, LaoHu ***Ba*** Yachi BaDiao le. (The tiger ***ba*** tooth pulled out)” or “牙齿被老虎拔掉了, YaChi ***Bei*** LaoHu BaDiao le. (The tooth ***bei*** (was) the tiger pulled out.)”. Each image is composed of three elements: agent, verb, and patient, with the agent being a living entity and the patient being an inanimate object. The table below provides the details.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| id | verb | prime | | target | |
| agent | patient | agent | patient |
| 1 | put down / 放下 | calf / 小牛 | bag / 书包 | puppy / 小狗 | pistol / 手枪 |
| 2 | break / 打破 | kitten / 小猫 | egg / 鸡蛋 | puppy / 小狗 | cup / 杯子 |
| 3 | put on / 穿上 | puppy / 小狗 | shoe / 鞋子 | rabbit / 兔子 | clothing / 衣服 |
| 4 | put up / 挂起 | dad / 爸爸 | lantern / 灯笼 | police / 警察 | flag / 红旗 |
| 5 | eat up / 吃掉 | monkey / 猴子 | banana / 香蕉 | puppy / 小狗 | bone / 骨头 |
| 6 | take-off / 摘下 | grandpa /爷爷 | apple / 苹果 | grandma / 奶奶 | glasses / 眼镜 |
| 7 | put on / 戴上 | grandma / 奶奶 | glasses / 眼镜 | grandpa / 爷爷 | hat / 帽子 |
| 8 | push / 推开 | lamb / 小羊 | window / 窗户 | bear / 小熊 | door / 大门 |
| 9 | open / 打开 | little bear /小熊 | box / 盒子 | duck / 小鸭 | box / 箱子 |
| 10 | bust  / 摔坏 | fox / 狐狸 | toy / 玩具 | puppy / 小狗 | vase / 花瓶 |
| 11 | pull out / 拔掉 | calf / 小牛 | nail / 钉子 | tiger / 老虎 | teeth / 牙齿 |
| 12 | take-off / 脱掉 | brother / 弟弟 | pants / 裤子 | monkey / 小猴 | clothing / 衣服 |
| 13 | break  / 打碎 | tiger / 老虎 | mirror / 镜子 | pony / 小马 | tank / 水缸 |
| 14 | steal / 偷走 | fox / 狐狸 | tv / 电视 | monkey / 小猴 | cell phone / 手机 |
| 15 | bring / 端来 | piglet / 小猪 | cake / 蛋糕 | grandma / 奶奶 | fruit / 水果 |
| 16 | lift / 搬起 | calf / 小牛 | stone / 石头 | bear / 小熊 | box / 箱子 |
| 17 | tie / 系上 | dad / 爸爸 | tie / 领带 | brother / 哥哥 | red scarf / 红领巾 |
| 18 | blow out / 吹灭 | piglet / 小猪 | match / 火柴 | uncle / 叔叔 | candle / 蜡烛 |
| 19 | step / 踩坏 | bear / 小熊 | flowers / 花草 | monkey / 小猴 | balloon / 气球 |
| 20 | pick up / 抱起 | puppy / 小狗 | watermelon / 西瓜 | monkey / 小猴 | tree / 大树 |
| 21 | Write /写完 | the old /老人 | assignment / 书法 | sister / 姐姐 | homework / 作业 |
| 22 | wash /洗净 | rabbit / 兔子 | clothing / 衣服 | grandma / 奶奶 | plate / 盘子 |
| 23 | blow away /吹走 | bear / 小熊 | flower / 花朵 | piglet / 小猪 | branch / 树枝 |
| 24 | lift /举起 | calf / 小牛 | stool / 凳子 | monkey / 小猴 | bucket / 水桶 |
| 25 | tear off / 撕掉 | puppy / 小狗 | book / 书本 | calf / 小牛 | fan / 扇子 |
| 26 | kick over / 踢翻 | fox / 狐狸 | block / 积木 | wolf / 大灰狼 | basin / 水盆 |
| 27 | cut off / 剪断 | sister / 姐姐 | long hair / 长发 | calf / 小牛 | cord / 绳子 |
| 28 | cover /盖上 | tiger / 老虎 | cup cover / 杯盖 | monkey / 小猴 | box / 盒子 |
| 29 | turn off /关掉 | puppy / 小狗 | tv / 电视 | dad / 爸爸 | mobile phone / 手机 |
| 30 | pick up /捡起 | monkey / 小猴 | airplane / 飞机 | brother / 哥哥 | book / 书本 |
| 31 | pick up /拿起 | chick / 小鸡 | pencil / 铅笔 | kitten / 小猫 | water cup / 杯子 |
| 32 | fix it / 修好 | dad / 爸爸 | stopcock / 水龙头 | grandpa / 爷爷 | car / 车子 |
| 33 | drink it up /喝掉 | piglet / 小猪 | milk / 牛奶 | pony / 小马 | drinks / 饮料 |
| 34 | kick away / 踢飞 | tiger / 老虎 | shoe / 鞋子 | elephant / 小象 | ball / 皮球 |
| 35 | throw away / 扔掉 | puppy / 小狗 | paper / 纸团 | monkey / 猴子 | peel / 香蕉皮 |
| 36 | close / 关上 | mom / 妈妈 | window / 窗户 | grandma / 奶奶 | door / 房门 |