Validation results

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```
# get total # of clips from each recording
complete2 <- complete %>%
  group_by(id) %>%
  distinct(file_name, .keep_all = T) %>%
  mutate(num_clips = NROW(Media)*2)

clips <- complete2 %>%
  select(id, num_clips) %>%
  distinct(id, .keep_all = T)

data <- merge(clips, random, by='id')
data2 <- rbind(data, complete2)
```

```
data3 <- data2 %>%
  group_by(method, id) %>%
  mutate(num_clips_drawn = (NROW(file_name))) %>%
  mutate(percen_ofallclips_drawn=(NROW(file_name)/num_clips)*100) # sanity check - complete method shou
```

```
data_annon <- data3 %>%
 gather("addressee", "language", Adult2OtherChild, Adult2Others, Adult2TargetChild, Adult2unsure, Other
  filter(language=='Mixed' | language=='Spanish' | language=='English/Quechua' | language =='Unsure') %
  group_by(id, method) %>%
  distinct_at(., vars(file_name, language), .keep_all = T) %>% # don't record multiple speakers speakin
  mutate(total_annotations = NROW(file_name)) # N of annotations made; distinct from N of speech clips

# separately, calculate the num and % of annotated clips
data_annon_cts <- data_annon %>%
  group_by(id, method) %>%
  distinct(file_name, .keep_all = T) %>%
  mutate(speech_clips = NROW(file_name)) %>% # N of unique clips annotated - NOT the # of annotations
  mutate(percen_ofallclips_annon=(NROW(file_name)/num_clips)*100) %>% # % of total clips annotated
  select(speech_clips, percen_ofallclips_annon, id, method, file_name, num_clips_drawn, percen_ofallcli


for_speech_clips <- data_annon_cts %>%
  select(id, method, speech_clips) %>%
  distinct_at(., vars(id, method), .keep_all = T)

# calculate the num and % of all clips available for annotation
data_annon$Childsleep <- as.factor(data_annon$Childsleep)
data_avbl <- data3 %>%
  group_by(id, method) %>%
```

```
  distinct(file_name, .keep_all = T) %>% # two, for random and complete
  mutate(voc = if_else(percents_voc > 0, "1", "0")) %>% # turn percents_voc binary
  filter(sleeping=='1' | PID == '1' | researcher_present == '1' | voc == '0') %>%
  count() %>%
  rename(not_avl_clips = n) %>%
  merge(., data_annon, by=c('id', 'method')) %>%
  mutate(avbl_clips = num_clips - not_avl_clips) %>% # clips that were *available* for annotation
  merge(., for_speech_clips, by=c('id', 'method')) %>% # N of unique clips annotated - NOT the # of ann
  mutate(percen_avl_annon = (speech_clips / avbl_clips)*100) %>% # the % of available clips that were a
  distinct_at(., vars(id, method), .keep_all = T) %>%
  group_by(method) %>%
  mutate(avbl_clips = paste(speech_clips, "(",round(percen_avl_annon,2),"%)")) %>%
  ungroup()%>%
  select(avbl_clips, id, method) %>%
  pivot_wider(names_from=method, values_from=c("avbl_clips"))
```

```
percen_tbl <- data_annon_cts %>%
  select(-file_name) %>%
  distinct_at(., vars(id,method), .keep_all = T) %>%
  mutate(clips_drawn = paste(num_clips_drawn,"(",round(percen_ofallclips_drawn,2),"%)")) %>%
  mutate(clips_annon = paste(speech_clips,"(",round(percen_ofallclips_annon,2),"%)")) %>%
  select(-num_clips_drawn, -percen_ofallclips_annon, -speech_clips, -percen_ofallclips_drawn) %>%
  relocate(c(id, method, clips_drawn, clips_annon)) %>%
  pivot_wider(names_from=method, values_from=c("clips_drawn", "clips_annon")) %>%
  merge(., data_avbl, by=c('id'))

percen_tbl$id <- plyr::mapvalues(percen_tbl$id,
                                 from=c('267-12mo', '261-8mo', '199', '198-9mo', '179', '1081', '1077',
            to=c('Spanish-English (267)', 'Spanish-English (261)','Spanish-English (199)',
  'Spanish-English (198)', 'Spanish-English (179)', 'Quechua-Spanish (1081)', 'Quechua-Spanish (1077)',

# actually decided to split this table and move part to the appendix
clip_annon_tbl <- percen_tbl %>%
  select(id, clips_annon_random, clips_annon_complete) %>%
  arrange(desc(id))

knitr::kable(clip_annon_tbl, caption = 'Number of clips annotated by child and annotation method.',
             booktabs=T,
             row.names = FALSE,
             col.names = c("Corpus (ID)", "Random", "Complete")) %>% # "
  kable_styling() %>%
  add_header_above(c(" " = 1, "# of clips annotated (% of total clips)" = 2)) %>%
  kableExtra::kable_styling(latex_options = "hold_position")
```

\begin{table}[!h]
\caption{(#tab:% drawn and annotated table)Number of clips annotated by child and annotation method.}

	# of clips annotated (% of total clips)	
Corpus (ID)	Random	Complete
Spanish-English (267)	101 (5.26 %)	274 (14.27 %)
Spanish-English (261)	92 (4.79 %)	294 (15.31 %)
Spanish-English (199)	118 (6.15 %)	467 (24.32 %)
Spanish-English (198)	81 (4.22 %)	302 (15.73 %)
Spanish-English (179)	120 (6.25 %)	633 (32.97 %)
Quechua-Spanish (1081)	92 (7.5 %)	285 (23.25 %)
Quechua-Spanish (1077)	83 (7.23 %)	355 (30.92 %)
Quechua-Spanish (1075)	81 (8.69 %)	199 (21.35 %)
Quechua-Spanish (1060)	111 (10.51 %)	405 (38.35 %)
Quechua-Spanish (1032)	97 (5.05 %)	372 (19.38 %)

\end{table}

```
clip_drawn_avbl_tbl <- percen_tbl %>%
  select(-clips_annon_random, -clips_annon_complete) %>%
  relocate(id, clips_drawn_random, clips_drawn_complete, random, complete) %>%
  arrange(desc(id))

knitr::kable(clip_drawn_avbl_tbl, caption = 'Number of clips drawn and number of clips annotated, by ch
             booktabs=T,
             row.names = FALSE,
             col.names = c("Corpus (ID)", "Random", "Complete", "Random", "Complete")) %>% # "
  kable_styling() %>%
  add_header_above(c(" " = 1, "# of clips drawn (% of total clips)" = 2, "# of clips annotated (% of ava
  kableExtra::kable_styling(latex_options = "hold_position")
```

\begin{table}[!h]
\caption{(#tab:% drawn and annotated table)Number of clips drawn and number of clips annotated, by child and annotation method.}

	# of clips drawn (% of total clips)		# of clips annotated (% of available clips)	
Corpus (ID)	Random	Complete	Random	Complete
Spanish-English (267)	345 (17.97 %)	960 (50 %)	101 (5.81 %)	274 (20.49 %)
Spanish-English (261)	290 (15.1 %)	960 (50 %)	92 (5.06 %)	294 (19.32 %)
Spanish-English (199)	192 (10 %)	960 (50 %)	118 (6.37 %)	467 (30.95 %)
Spanish-English (198)	284 (14.79 %)	960 (50 %)	81 (4.52 %)	302 (20.54 %)
Spanish-English (179)	192 (10 %)	960 (50 %)	120 (6.36 %)	633 (37.08 %)
Quechua-Spanish (1081)	249 (20.31 %)	613 (50 %)	92 (8.16 %)	285 (30.25 %)
Quechua-Spanish (1077)	137 (11.93 %)	574 (50 %)	83 (7.33 %)	355 (32.84 %)
Quechua-Spanish (1075)	267 (28.65 %)	466 (50 %)	81 (9.69 %)	199 (26.39 %)
Quechua-Spanish (1060)	154 (14.58 %)	528 (50 %)	111 (10.66 %)	405 (40.91 %)
Quechua-Spanish (1032)	263 (13.7 %)	960 (50 %)	97 (5.38 %)	372 (25.92 %)

\end{table}

0.0.1 Language categories across random and full methods

```
lang_annon <- data_annon %>%
  filter(language=='Mixed' | language=='Spanish' | language=='English/Quechua') %>% # only clips where
```

```
  group_by(id, method) %>%
  distinct_at(., vars(file_name, language), .keep_all = T) %>% # don't record multiple speakers speakin
  mutate(total_lang_annotations = NROW(file_name)) # N of language annotations made; distinct from N of

que <- lang_annon %>%
  group_by(id, method) %>%
  filter(language=='English/Quechua') %>%
  group_by(method) %>%
  distinct(file_name, .keep_all = T) %>%
  group_by(id, method) %>% # irrespective of speaker/addressee; by-child only
  mutate(n_que=n()) %>%
  distinct_at(., vars(id, method), .keep_all = T) %>%
  mutate(percen_que = n_que / total_lang_annotations) # compute que/eng ratio

span <- lang_annon %>%
  group_by(id, method) %>%
  filter(language=='Spanish') %>%
  group_by(method) %>%
  distinct(file_name, .keep_all = T) %>%
  group_by(id, method) %>%
  mutate(n_span = n())  %>%
  distinct_at(., vars(id, method), .keep_all = T) %>%
  mutate(percen_span = n_span / total_lang_annotations) # compute span ratio

mixed <- lang_annon %>%
  group_by(id, method) %>%
  filter(language=='Mixed') %>%
  group_by(method) %>%
  distinct(file_name, .keep_all = T) %>%
  group_by(id, method) %>%
  mutate(n_mxd = n())  %>%
  distinct_at(., vars(id, method), .keep_all = T) %>%
  mutate(percen_mxd = n_mxd / total_lang_annotations) # compute mixed ratio
```

```
vars <- data_annon_cts %>%
  select(percen_ofallclips_drawn, id, method) %>%
  colnames(.)

final_data <- span %>%
  merge(., data_annon_cts, by=vars) %>%
  select(id, num_clips, age_YYMMDD, gender, location, method, percen_span, speech_clips, percen_ofallcli

final_data2 <-
  merge(final_data, que, by=c('id', 'method', 'percen_ofallclips_drawn', 'gender', 'location', 'num_clip
  select(id, gender, location, method, percen_span, percen_que, num_clips, percen_ofallclips_drawn, spe

plot_data <-
  merge(final_data2, mixed, by=c('id', 'method', 'percen_ofallclips_drawn', 'gender', 'location', 'num_
  select(id, gender, location, method, percen_span, percen_que, percen_mxd, num_clips, percen_ofallclips

# sanity check: calculate percen mixed + spanish + english/quechua
plot_data$total <- plot_data$percen_mxd + plot_data$percen_span + plot_data$percen_que
```

```r
# compute correlations
us_cor <- plot_data %>%
  distinct_at(., vars(method, id), .keep_all = T) %>%
  select(method, id, percen_span, location) %>%
  spread("method", "percen_span") %>%
  filter(location=='US') %>%
  summarize(., paste("r=",round(cor.test(complete, random)$estimate,2),",","p=",round(cor.test(complete

bo_cor <- plot_data %>%
  distinct_at(., vars(method, id), .keep_all = T) %>%
  select(method, id, percen_que, location) %>%
  spread("method", "percen_que") %>%
  filter(location=='Bolivia') %>%
  summarize(., paste("r=",round(cor.test(complete, random)$estimate,2),",","p=",round(cor.test(complete

# compute avg. %s of target lang categories
us_lang_tbl <- plot_data %>%
  filter(location=='US') %>%
  group_by(method) %>%
  summarize(avg=round(mean(percen_span),2),
            sd=round(sd(percen_span),2)) %>%
  mutate(stats=paste(avg,"(",sd,")")) %>%
  select(-avg, -sd) %>%
  spread(key='method', value = "stats")

bo_lang_tbl <- plot_data %>%
  filter(location=='Bolivia') %>%
  group_by(method) %>%
  summarize(avg=round(mean(percen_que),2),
            sd=round(sd(percen_que),2)) %>%
  mutate(stats=paste(avg,"(",sd,")")) %>%
  select(-avg, -sd) %>%
  spread(key='method', value = "stats")

# calculate relative errors
us_rel_error <- plot_data %>%
  filter(location=='US') %>%
  group_by(method, id) %>%
  summarize(avg=mean(percen_span)) %>%
  spread(key='method', value='avg') %>%
   mutate(relative_error = ((abs((random - complete)) / complete)*100),
          avg_rel_error = round(mean(relative_error),2),
          sd_rel_error = round(sd(relative_error),2)) %>%
  mutate(rel_error_stats=paste(avg_rel_error,"(",sd_rel_error,")")) %>%
  distinct(rel_error_stats)

bo_rel_error <- plot_data %>%
  filter(location=='Bolivia') %>%
  group_by(method, id) %>%
  summarize(avg=mean(percen_que)) %>%
  spread(key='method', value='avg') %>%
  mutate(relative_error = ((abs((random - complete)) / complete)*100),
          avg_rel_error = round(mean(relative_error),2),
```

```
        sd_rel_error = round(sd(relative_error),2)) %>%
  mutate(rel_error_stats=paste(avg_rel_error,"(",sd_rel_error,")")) %>%
  distinct(rel_error_stats)

# add correlations to table - will make pretty below
us_lang_tbl <- cbind(us_lang_tbl, us_cor) %>%
  cbind(., us_rel_error) %>%
  mutate(Corpus = "Spanish-English (Spanish)") %>%
  relocate(c(Corpus, random, complete))

bo_lang_tbl <- cbind(bo_lang_tbl, bo_cor) %>%
  cbind(., bo_rel_error) %>%
  mutate(Corpus = "Quechua-Spanish (Quechua)") %>%
  relocate(c(Corpus, random, complete))

lang_tbl <- rbind(us_lang_tbl, bo_lang_tbl)
```

```
knitr::kable(lang_tbl, caption = 'Minority language estimates by corpus and annotation method.',
             booktabs=T,
             row.names = FALSE,
             col.names = c("Corpus (language)", "Random", "All-day", "Correlation between estimates", "
  kable_styling() %>%
  add_header_above(c(" " = 1, "Annotation Method" = 2, " " = 2)) %>%
  kableExtra::kable_styling(latex_options = "hold_position")
```

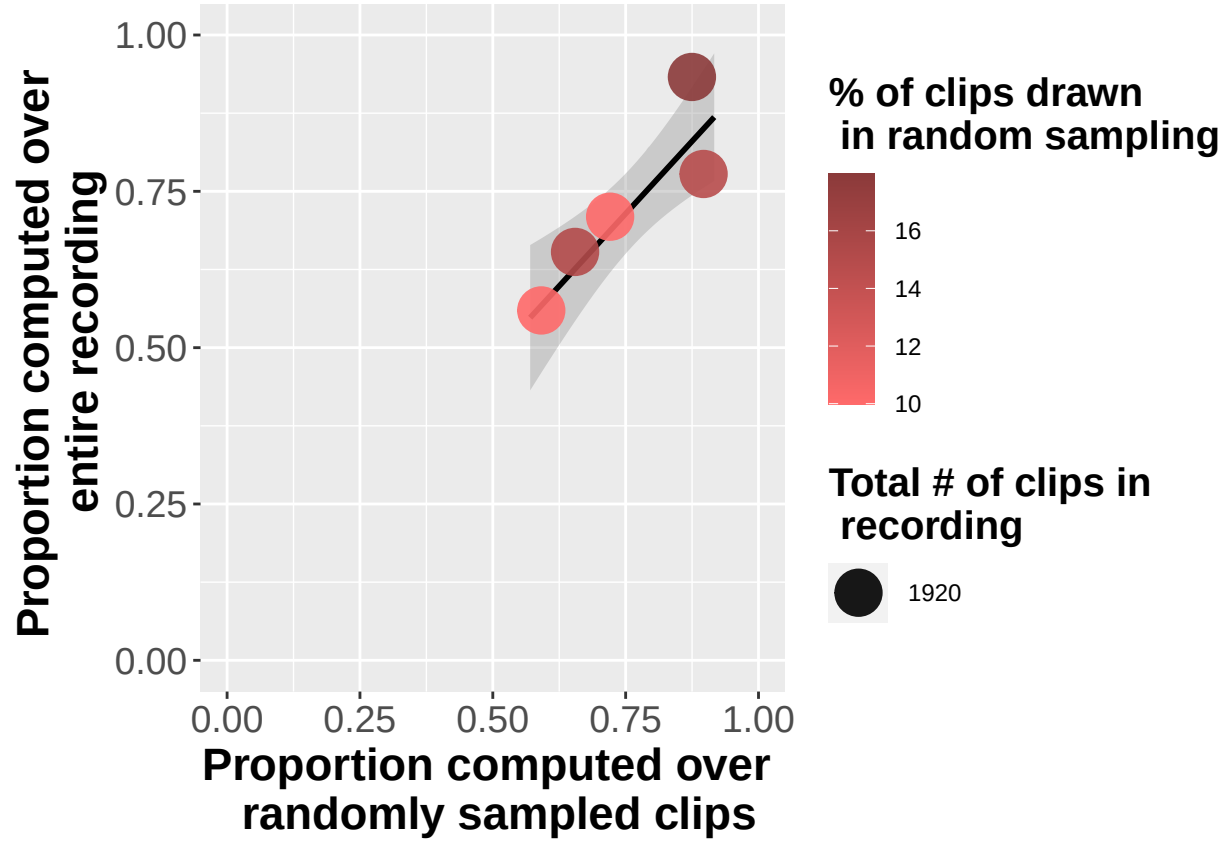
Table 1: (#tab:generate lang tables)Minority language estimates by corpus and annotation method.

	Annotation Method			
Corpus (language)	Random	All-day	Correlation between estimates	Average relative error (SD)
Spanish-English (Spanish)	0.75 (0.13)	0.69 (0.12)	r= 0.96 , p= 0.01	5.36 (4.82)
Quechua-Spanish (Quechua)	0.48 (0.11)	0.5 (0.12)	r= 0.9 , p= 0.04	11.02 (4.28)

```
# for later
per_ann <- plot_data %>%
  filter(method=='random') %>%
  select(id, percen_ofallclips_drawn)

us_plot <- plot_data %>%
  filter(location=='US') %>%
  distinct_at(., vars(method, id), .keep_all = T)%>%
  select(-percen_que, -percen_ofallclips_drawn, -percen_mxd, -speech_clips, -total) %>%
  spread("method", "percen_span") %>%
  merge(., per_ann, by='id') %>%
  distinct(id, .keep_all = T) %>%
ggplot(., aes(random, complete)) +
  geom_smooth(method = "lm", color="black") +
  geom_jitter(aes(size=num_clips,color=round(percen_ofallclips_drawn,2)),alpha=.9,position = position_j
  scale_size_continuous(range = c(5, 9)) +
  scale_colour_gradient(low='indianred1', high = 'indianred4') +
  ylab("Proportion computed over \n entire recording") +
```

```
  xlab("Proportion computed over \n randomly sampled clips") +
  ylim(0,1) +
  xlim(0,1)+
  #facet_wrap(~location, scales = "free") +
  labs(col='% of clips drawn \n in random sampling') +
       #title = 'Proportion of Spanish clips \n in U.S. corpus') +
 theme(title = element_text(size=18, face="bold"),
   axis.text=element_text(size=14),
      axis.title=element_text(size=17,face="bold"),
      legend.title = element_text(size=15)) +
      guides(size=guide_legend(title="Total # of clips in \n recording"))
us_plot
```

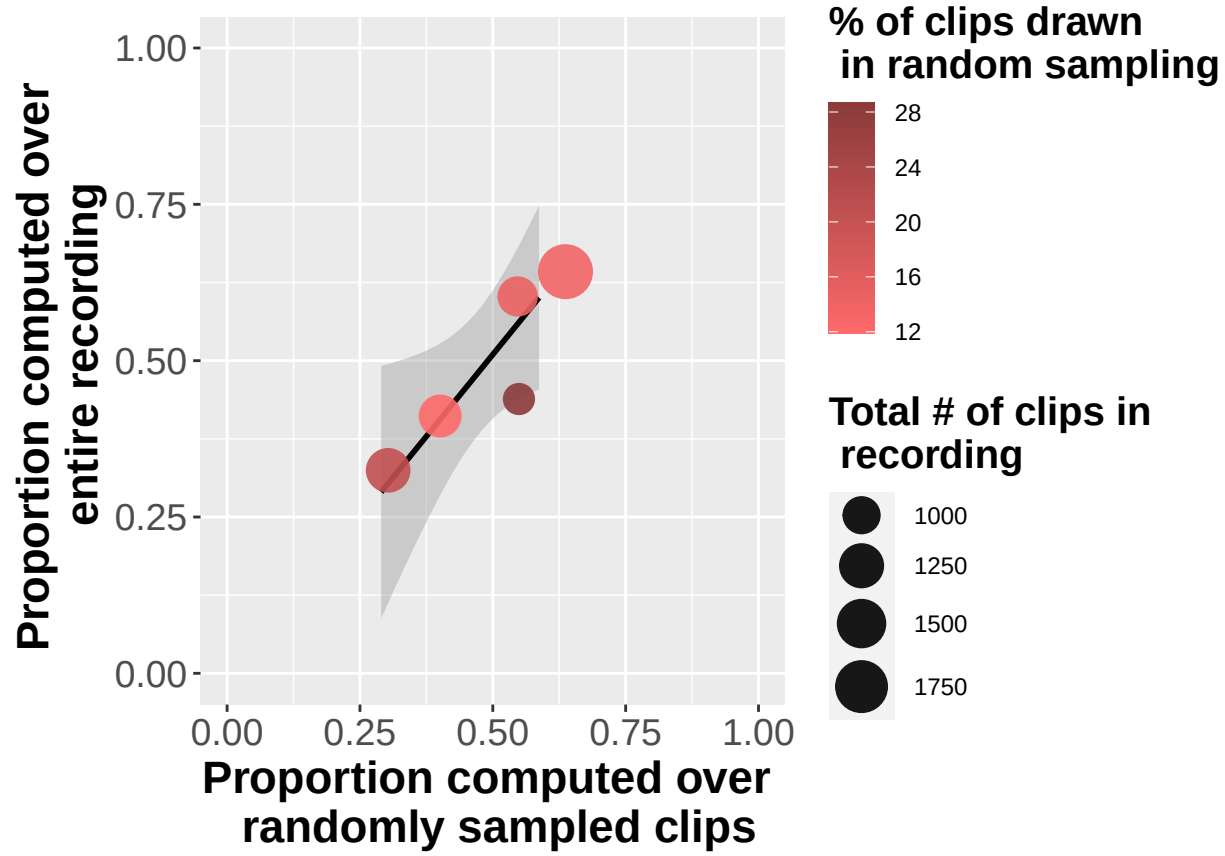



```
jpeg("/Users/megcychosz/Google Drive/biling_CDS/results/figures/us_plot.jpeg", height = 500, width = 60
us_plot
dev.off()
```

```
## pdf
##   2
```

```
bo_plot <- plot_data %>%
  filter(location=='Bolivia') %>%
  distinct_at(., vars(method, id), .keep_all = T) %>%
  select(-percen_span, -percen_ofallclips_drawn, -percen_mxd, -speech_clips, -total) %>%
  spread("method", "percen_que") %>%
  merge(., per_ann, by='id') %>%
```

```
  distinct(id, .keep_all = T) %>%
ggplot(., aes(random, complete)) +
  geom_smooth(method = "lm", color="black") +
  geom_jitter(aes(size=num_clips,color=round(percen_ofallclips_drawn,2)),alpha=.9,position = position_j
  scale_size_continuous(range = c(5, 9)) +
  scale_colour_gradient(low='indianred1', high = 'indianred4') +
  ylab("Proportion computed over \n entire recording") +
  xlab("Proportion computed over \n randomly sampled clips") +
  ylim(0,1) +
  xlim(0,1)+
  #facet_wrap(~location, scales = "free") +
  labs(col='% of clips drawn \n in random sampling') +
       #title = 'Proportion of Quechua clips \n in Bolivian corpus') +
 theme(title = element_text(size=18, face="bold"),
   axis.text=element_text(size=14),
      axis.title=element_text(size=17,face="bold"),
      legend.title = element_text(size=15))+
       #legend.position = c(.8, .5)) +
      guides(size=guide_legend(title="Total # of clips in \n recording"))
bo_plot
```




```
jpeg("/Users/megcychosz/Google Drive/biling_CDS/results/figures/bolivia_plot.jpeg", height = 500, width
bo_plot
dev.off()
```

```
## pdf
##   2
```

0.0.2 Chid-directed speech across random and full methods

```
reg_annon <- data_annon %>%
  filter(addressee=='Adult2TargetChild' | addressee=='Otherchild2TargetChild' | addressee=='Adult2Others
  group_by(id, method) %>%
  distinct_at(., vars(file_name, addressee), .keep_all = T) %>% # don't record multiple speakers speaki
  mutate(total_reg_annotations = NROW(file_name))# N of register annotations made; distinct from N of s

cds <- reg_annon %>%
  group_by(id, method) %>%
  filter(addressee=='Adult2TargetChild' | addressee=='Otherchild2TargetChild') %>%
  group_by(method) %>%
  distinct(file_name, .keep_all = T) %>%
  group_by(id, method) %>%
  mutate(n_cds = n()) %>% # # of CDS clips
  distinct_at(., vars(id, method), .keep_all = T) %>%
  mutate(percen_cds = n_cds / total_reg_annotations) %>%
  select(id, num_clips, age_YYMMDD, gender, location, method, percen_cds, n_cds, percen_ofallclips_drawn

ads <- reg_annon %>%
  filter(addressee=='Adult2Others' | addressee=='Otherchild2adults') %>%
  group_by(method) %>%
  distinct(file_name, .keep_all = T) %>%
  group_by(id, method) %>%
  mutate(n_ads = n()) %>% # # of ADS clips
  distinct_at(., vars(id, method), .keep_all = T) %>%
  mutate(percen_ads = n_ads / total_reg_annotations) %>%
  select(id, num_clips, age_YYMMDD, gender, location, method, percen_ads, n_ads, percen_ofallclips_drawn

o_child <- reg_annon %>%
  filter(addressee=='Adult2OtherChild' | addressee=='Otherchild2OtherChild') %>%
  group_by(method) %>%
  distinct(file_name, .keep_all = T) %>%
  group_by(id, method) %>%
  mutate(n_ods = n()) %>% # # of ODS clips
  distinct_at(., vars(id, method), .keep_all = T) %>%
  mutate(percen_ods = n_ods / total_reg_annotations) %>%
  select(id, num_clips, age_YYMMDD, gender, location, method, percen_ods, n_ods, percen_ofallclips_drawn

o2 <- merge(cds, ads, all=T)
o3 <- merge(o2, o_child, all = T)
o3[is.na(o3)] <- 0 # one child doesn't have any ODS

# sanity check
o3$total <- o3$percen_ods + o3$percen_ads + o3$percen_cds
```

```
# for later
percen_cds_df <- o3 %>%
  distinct_at(., vars(id, method), .keep_all = T) %>%
  filter(method=='random') %>%
  select(id, percen_ofallclips_drawn) # get the % of clips annotated for each id and method

cds_plot_data <- o3 %>%
```

```
  select(id, gender, location, num_clips, method, percen_cds) %>%
  spread("method", "percen_cds") %>%
  merge(., percen_cds_df, by='id')

# compute correlations
cds_cors <- cds_plot_data %>%
  group_by(location) %>%
  summarize(., paste("r=",round(cor.test(complete, random)$estimate,2),",","p=",round(cor.test(complete

reg_tbl <- o3 %>%
  group_by(method, location) %>%
  summarize(avg=round(mean(percen_cds),2),
            sd=round(sd(percen_cds),2)) %>%
  mutate(stats=paste(avg,"(",sd,")")) %>%
  select(-avg, -sd) %>%
  spread(key='method', value = "stats")

# calculate relative errors
cds_rel_error <- o3 %>%
  group_by(method, location, id) %>%
  summarize(avg=mean(percen_cds)) %>%
  spread(key='method', value='avg') %>%
  group_by(id) %>%
  mutate(relative_error = ((abs(random - complete) / complete)*100)) %>%
  ungroup() %>%
  group_by(location) %>%
  mutate(avg_rel_error = round(mean(relative_error),2),
         sd_rel_error = round(sd(relative_error),2),
         rel_error_stats=paste(avg_rel_error,"(",sd_rel_error,")")) %>%
  distinct(rel_error_stats)

# WILL DECIDE IF WE SHOULD ADD INDIVIDUAL OR GROUPED PRBs

# add correlations to table - will make pretty below
final_reg_tbl <- merge(reg_tbl, cds_cors, by='location')
final_reg_tbl$location <-
  plyr::mapvalues(final_reg_tbl$location,
                  from = c("Bolivia", "US"),
                  to =c("Quechua-Spanish", "Spanish-English"))

knitr::kable(final_reg_tbl, caption = 'Average child-directed speech estimates by corpus and annotation
             booktabs=T,
             row.names = FALSE,
             col.names = c("Corpus", "Random", "All-day", "Correlation between estimates")) %>% # "
  #column_spec(2, width = "4cm") %>% # force column headers onto two rows
  #column_spec(3, width = "3cm") %>%
  #column_spec(4, width = "5cm") %>%
  kable_styling() %>%
  add_header_above(c(" " = 1, "Annotation Method" = 2, " " = 1)) %>%
  kableExtra::kable_styling(latex_options = "hold_position")
```

Table 2: (#tab:cds proportion stats)Average child-directed speech estimates by corpus and annotation method.

	Annotation Method		
Corpus	Random	All-day	Correlation between estimates
Quechua-Spanish	0.11 (0.05)	0.13 (0.03)	r= 0.63 , p= 0.26
Spanish-English	0.54 (0.19)	0.53 (0.2)	r= 0.97 , p= 0.01

```
ads_plot_data <- o3 %>%
  #filter(location=='Bolivia') %>%
  select(id, gender, location, num_clips, method, percen_ads) %>%
  spread("method", "percen_ads") %>%
  merge(., percen_cds_df, by='id')

# compute correlations
ads_cors <- ads_plot_data %>%
  group_by(location) %>%
  summarize(., paste("r=",round(cor.test(complete, random)$estimate,2),",","p=",round(cor.test(complete

reg_tbl <- o3 %>%
  group_by(method, location) %>%
  summarize(avg=round(mean(percen_ads),2),
            sd=round(sd(percen_ads),2)) %>%
  mutate(stats=paste(avg,"(",sd,")")) %>%
  select(-avg, -sd) %>%
  spread(key='method', value = "stats")

# calculate relative errors
ads_rel_error <- o3 %>%
  group_by(method, location, id) %>%
  summarize(avg=mean(percen_ads)) %>%
  spread(key='method', value='avg') %>%
  group_by(id) %>%
  mutate(relative_error = ((abs(random - complete) / complete)*100)) %>%
  ungroup() %>%
  group_by(location) %>%
  mutate(avg_rel_error = round(mean(relative_error),2),
         sd_rel_error = round(sd(relative_error),2),
         rel_error_stats=paste(avg_rel_error,"(",sd_rel_error,")")) %>%
  distinct(rel_error_stats)

# add correlations to table - will make pretty below
final_reg_tbl <- merge(reg_tbl, ads_cors, by='location')
final_reg_tbl2 <- merge(final_reg_tbl, ads_rel_error, by='location')
final_reg_tbl$location <-
  plyr::mapvalues(final_reg_tbl$location,
                  from = c("Bolivia", "US"),
                  to =c("Quechua-Spanish", "Spanish-English"))

knitr::kable(final_reg_tbl2, caption = 'Average adult-directed speech estimates by corpus and annotatio
             booktabs=T,
```

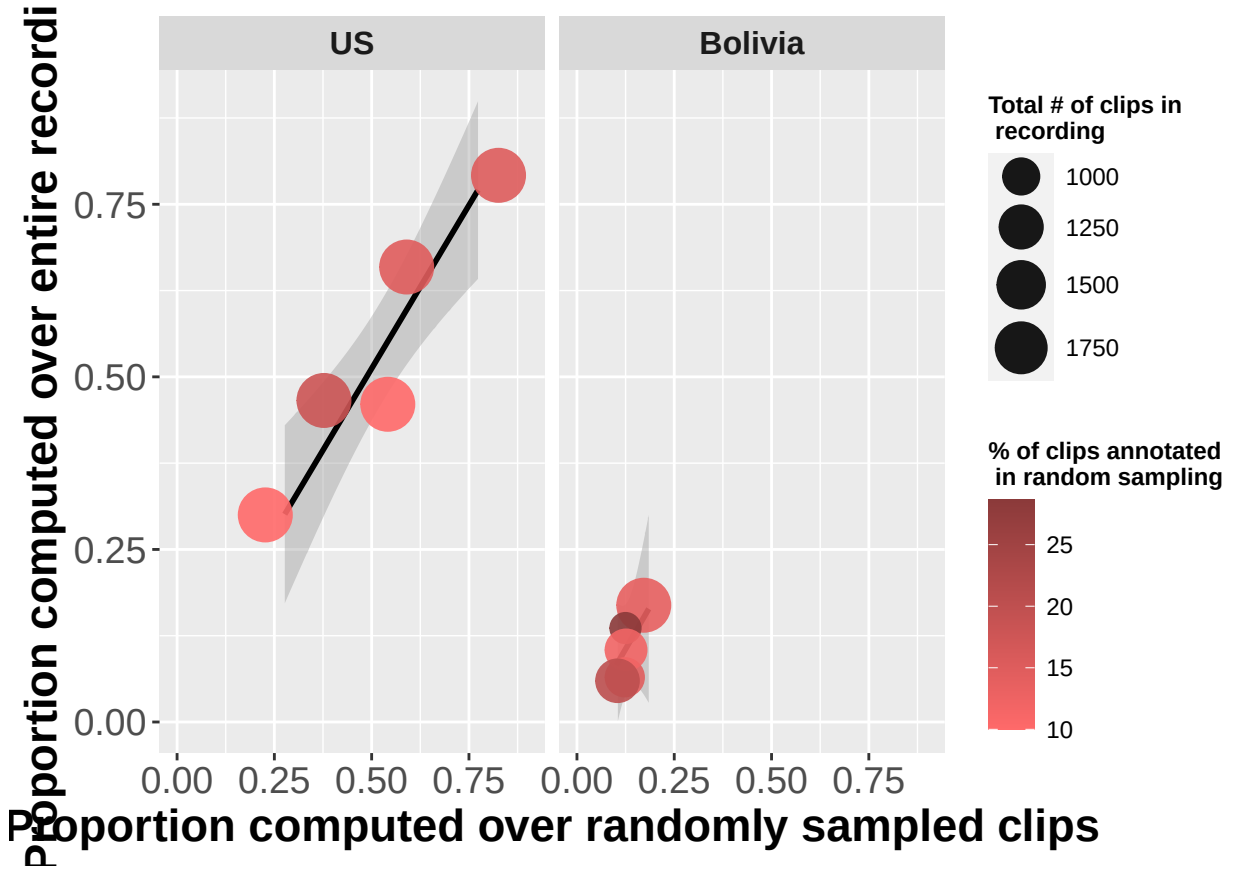
```
            row.names = FALSE,
            col.names = c("Corpus", "Random", "All-day", "Correlation between estimates", "Average rela
  kable_styling() %>%
  add_header_above(c(" " = 1, "Annotation Method" = 2, " " = 2)) %>%
  kableExtra::kable_styling(latex_options = "hold_position")
```

Table 3: (#tab:ads proportion stats)Average adult-directed speech estimates by corpus and annotation method.

	Annotation Method			
Corpus	Random	All-day	Correlation between estimates	Average relative error (SD)
Bolivia	0.45 (0.13)	0.4 (0.09)	r= 0.84 , p= 0.07	11.56 (12.11)
US	0.27 (0.17)	0.27 (0.2)	r= 0.96 , p= 0.01	16.75 (12.45)

```
# reorder location variable
cds_plot_data$location <- factor(cds_plot_data$location, levels = c("US", "Bolivia"))

cds_plot <- ggplot(cds_plot_data, aes(random, complete)) +
  geom_smooth(method = "lm", color="black") +
  geom_jitter(aes(size=num_clips,color=round(percen_ofallclips_drawn,2)),alpha=.9,position = position_ji
  scale_size_continuous(range = c(5, 9)) +
  scale_colour_gradient(low='indianred1', high = 'indianred4') +
  ylab("Proportion computed over entire recording") +
  xlab("Proportion computed over randomly sampled clips") +
  ylim(0,0.9) +
  xlim(0,0.9)+
  facet_wrap(~location, scales = "fixed") +
  labs(col='% of clips annotated \n in random sampling') +
       #title = 'Proportion of child-directed speech clips \n in U.S. and Bolivian corpora') +
 theme(title = element_text(size=18, face="bold"),
   axis.text=element_text(size=14),
      axis.title=element_text(size=17,face="bold"),
      legend.title = element_text(size=9),
      #legend.position = c(.85, .55),
      strip.text.x = element_text(size=12, face="bold")) +
      guides(size=guide_legend(title="Total # of clips in \n recording"))
cds_plot
```




```
jpeg("/Users/megcychosz/Google Drive/biling_CDS/results/figures/cds_plot.jpeg", height = 500, width = 5
cds_plot
dev.off()
```

```
## pdf
##   2
```

0.0.3 Part III: language across random and questionnaire methods

```
# enter questionnaire estimates
ques <- data.frame("id"=c("179", "198-9mo", "199", "261-8mo", "267-12mo"),
                   "ques_est"=c(".71", ".57", ".94", ".69", ".87"))

ques_tbl <- plot_data %>%
  filter(location=='US') %>%
  merge(., ques, by='id') %>%
  distinct_at(., vars(method, id), .keep_all = T) %>%
  select(-percen_ofallclips_drawn, -percen_mxd, -percen_que, -speech_clips, -total, -gender, -location,
  mutate(percen_span = round(percen_span,2)) %>%
  spread("method", "percen_span") %>%
  relocate(id, random, complete, ques_est)

# compute correlations
ques_random_cors <- ques_tbl %>%
  mutate(ques_est = as.numeric(ques_est)) %>%
```

```
  summarize(., paste("r=",round(cor.test(ques_est, random)$estimate,2),",","p=",round(cor.test(ques_est
ques_complete_cors <- ques_tbl %>%
  mutate(ques_est = as.numeric(ques_est)) %>%
  summarize(., paste("r=",round(cor.test(ques_est, complete)$estimate,2),",","p=",round(cor.test(ques_es

# create table
knitr::kable(ques_tbl, caption = 'Spanish language estimates in U.S. corpus, by child and estimation me
             booktabs=T,
             row.names = FALSE,
             col.names = c("Child ID", "Random", "All-day", "Parental Questionnaire")) %>%
  kable_styling() %>%
  add_header_above(c(" " = 1, "From daylong recording" = 2, " " = 1)) %>%
  kableExtra::kable_styling(latex_options = "hold_position")
```

Table 4: (#tab:make table for questionnaire method)Spanish language estimates in U.S. corpus, by child and estimation method.

	From daylong recording		
Child ID	Random	All-day	Parental Questionnaire
179	0.57	0.57	.71
198-9mo	0.87	0.78	.57
199	0.76	0.70	.94
261-8mo	0.69	0.65	.69
267-12mo	0.92	0.92	.87

```
# we also want to know what the results are for the combination of CDS*Spanish, not just Spanish
reg_annon <- data_annon %>%
  filter(addressee=='Adult2TargetChild' | addressee=='Otherchild2TargetChild') %>% # only CDS clips
  group_by(id, method) %>%
  distinct_at(., vars(file_name, addressee), .keep_all = T) %>% # don't record multiple speakers speaki
  mutate(total_cds_annotations = NROW(file_name))#

span_cds_tbl <- reg_annon %>%
  group_by(id, method) %>%
  filter(addressee=='Adult2TargetChild' | addressee=='Otherchild2TargetChild' & location=='US') %>% # o
  merge(., ques, by='id') %>%
  filter(language=='Spanish') %>% # only Spanish clips
  group_by(method) %>%
  distinct(file_name, .keep_all = T) %>%
  group_by(id, method) %>%
  mutate(n_span_cds = n()) %>% # # of CDS clips where Spanish was spoken
  distinct_at(., vars(id, method), .keep_all = T) %>%
  mutate(percen_span_cds = round(n_span_cds / total_cds_annotations,2)) %>%
  select(method, percen_span_cds, id, ques_est) %>%
  spread("method", "percen_span_cds") %>%
  relocate(id, random, complete, ques_est)

# compute correlations
cor.test(as.numeric(span_cds_tbl$ques_est), span_cds_tbl$complete)
```

```
##
```

```
##  Pearson's product-moment correlation
##
## data:  as.numeric(span_cds_tbl$ques_est) and span_cds_tbl$complete
## t = 1.022, df = 3, p-value = 0.382
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.6781348  0.9600192
## sample estimates:
##       cor
## 0.5081637
```

```
cor.test(as.numeric(span_cds_tbl$ques_est), span_cds_tbl$random)
```

```
##
##  Pearson's product-moment correlation
##
## data:  as.numeric(span_cds_tbl$ques_est) and span_cds_tbl$random
## t = 0.12188, df = 3, p-value = 0.9107
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.8656838  0.8969149
## sample estimates:
##       cor
## 0.0701952
```

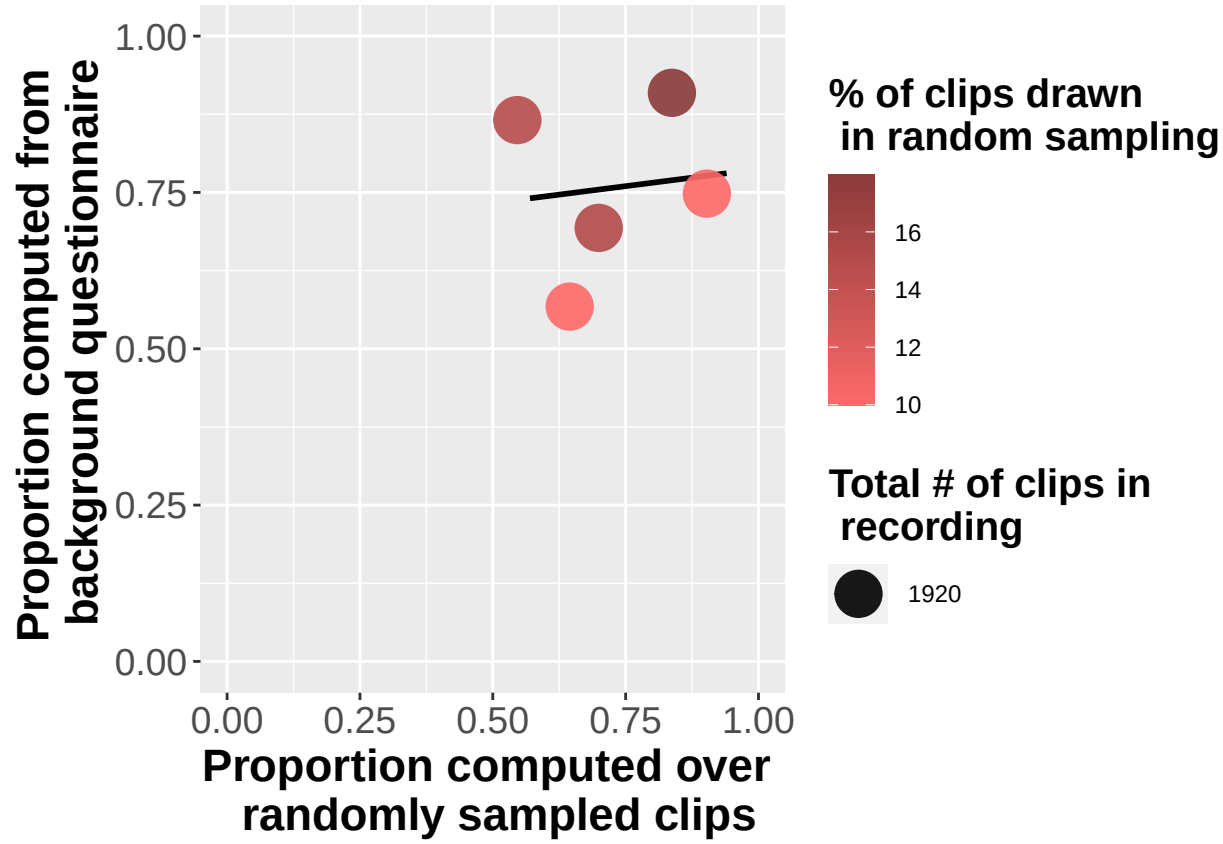
```
# create table
knitr::kable(span_cds_tbl, caption = 'Spanish language in child-directed speech \n estimates in U.S. co
             booktabs=T,
             row.names = FALSE,
             col.names = c("Child ID", "Random", "All-day", "Parental Questionnaire")) %>%
  kable_styling() %>%
  add_header_above(c(" " = 1, "From daylong recording" = 2, " " = 1)) %>%
  kableExtra::kable_styling(latex_options = "hold_position")
```

Table 5: (#tab:make table for questionnaire method)Spanish language in child-directed speech estimates in U.S. corpus, by child and estimation method.

	From daylong recording		
Child ID	Random	All-day	Parental Questionnaire
179	0.53	0.52	.71
198-9mo	0.78	0.64	.57
199	0.64	0.66	.94
261-8mo	0.55	0.48	.69
267-12mo	0.82	0.87	.87

```
# for later
per_ann <- plot_data %>%
  filter(method=='random' & location=='US') %>%
  select(id, percen_ofallclips_drawn)
```

```r
ques_plot <- plot_data %>%
  filter(location=='US') %>%
  merge(., ques, by='id') %>%
  distinct_at(., vars(method, id), .keep_all = T) %>%
  select(-percen_que, -percen_ofallclips_drawn, -percen_mxd, -speech_clips, -total) %>%
  spread("method", "percen_span") %>%
  select(-complete) %>%
  merge(., per_ann, by='id') %>%
  distinct(id, .keep_all = T) %>%
ggplot(., aes(as.numeric(ques_est), random)) +
  geom_smooth(method = "lm", color="black", se=FALSE) +
  geom_jitter(aes(size=num_clips,color=round(percen_ofallclips_drawn,2)),alpha=.9,position = position_j
  scale_size_continuous(range = c(5, 9)) +
  scale_colour_gradient(low='indianred1', high = 'indianred4') +
  ylab("Proportion computed from \n background questionnaire") +
  xlab("Proportion computed over \n randomly sampled clips") +
  ylim(0,1) +
  xlim(0,1)+
  labs(col='% of clips drawn \n in random sampling') +
       #title = 'Proportion of Spanish clips \n in U.S. corpus: random sampling and background question
 theme(title = element_text(size=18, face="bold"),
   axis.text=element_text(size=14),
      axis.title=element_text(size=17,face="bold"),
      legend.title = element_text(size=15)) +
      guides(size=guide_legend(title="Total # of clips in \n recording"))
ques_plot
```



```
jpeg("/Users/megcychosz/Google Drive/biling_CDS/results/figures/ques_plot.jpeg", height = 500, width = 
ques_plot
dev.off()
```

```
## pdf
##   2
```

0.0.4 Part I: Running variance

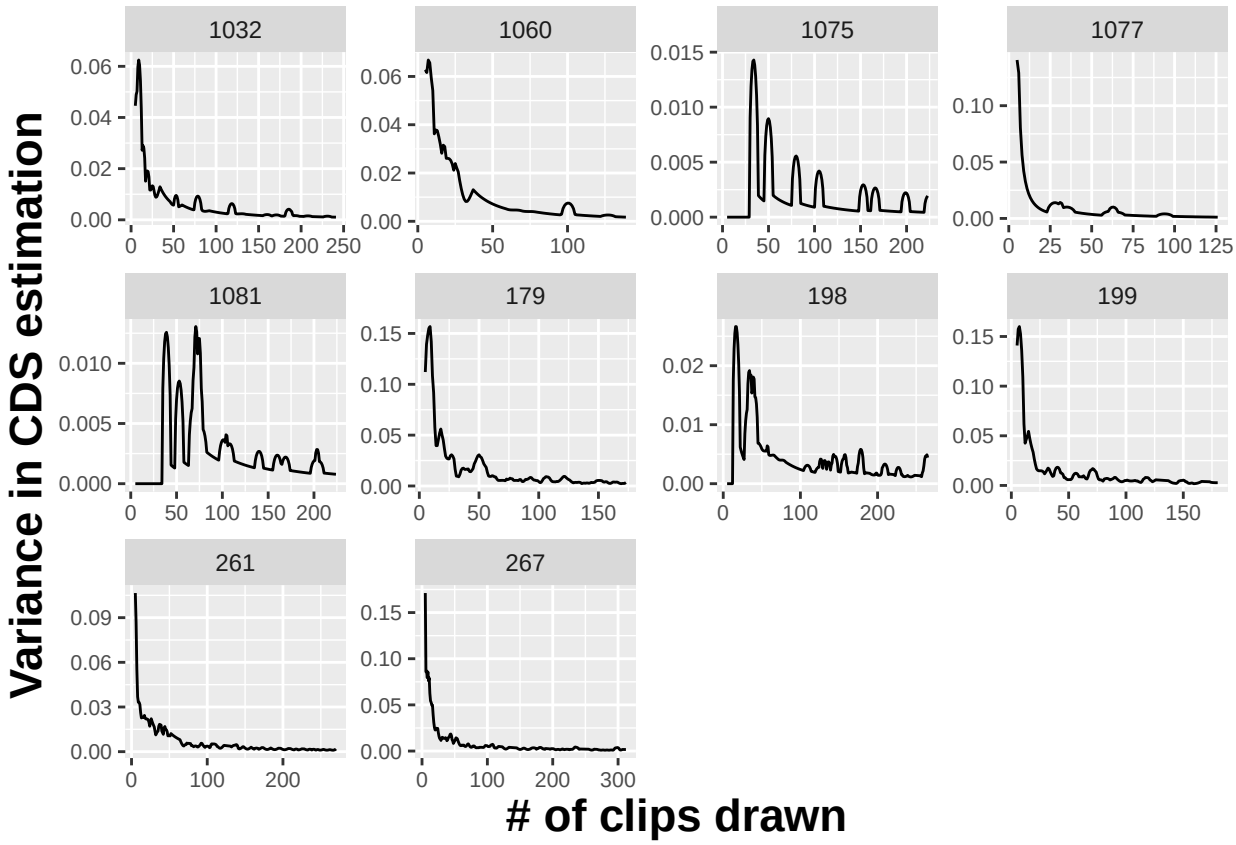
```
random$id <- plyr::mapvalues(random$id,
                from=c("198-9mo", "261-8mo", "267-12mo"),
                to=c("198", "261", "267"))

# only doing for CDS first - filter for other languages for language
cds_var <- random %>%
  group_by(id) %>%
  mutate(total=n()) %>% # note that this is the total clips drawn, not just listened to
  select(-Otherchild2OtherChild, -Otherchild2adults, -Otherchild2unsure, -Adult2OtherChild, -Adult2Othe
  gather("addressee", "language", Adult2TargetChild, Otherchild2TargetChild) %>%
  distinct_at(., vars(file_name, timestamp_HHMMSS), .keep_all = T) %>% # CDS only gets counted 1x/clip;
  select(-addressee)


cds_var$cds_cts <- plyr::mapvalues(cds_var$language,
                from=c("Categorize language to target child", "English/Quechua", "Mixed", "Spanish", "U
                to=c("0", "1", "1", "1", "1"))
cds_var$cds_cts <- as.numeric(cds_var$cds_cts)
cds_var$total <- as.numeric(cds_var$total)

cds_rolling <- cds_var %>%
  group_by(id) %>%
  mutate(cds_running_cts = as.numeric(cumsum(cds_cts)),
         annotation_num = as.numeric(1:n())) %>%
  mutate(roll_prop_cds = cds_running_cts / annotation_num,
         roll_mean_cds = rollmean(roll_prop_cds, k=10, fill = NA),
         roll_sd_cds = rollapply(roll_prop_cds, width=10, FUN=sd, fill=NA))
```

```
cds_var_plot <- cds_rolling %>%
filter(roll_sd_cds!='NA') %>% # remove rows where variance wasn't estimated
ggplot(., aes(annotation_num, roll_prop_cds)) +
  #geom_line(aes(y=rollapply(roll_prop_cds, 10, FUN=sd, fill=NA))) +
  geom_line(aes(y=roll_sd_cds)) +
  xlab("# of clips drawn") +
  ylab("Variance in CDS estimation") +
  facet_wrap(~id, scales = "free") +
  #title = 'Variance in child-directed estimation as a function of clips drawn') +
 theme(title = element_text(size=18, face="bold"),
   axis.text=element_text(size=8),
      axis.title=element_text(size=17,face="bold"),
      legend.title = element_text(size=15))
cds_var_plot
```




```
jpeg("/Users/megcychosz/Google Drive/biling_CDS/results/figures/cds_var_plot.jpeg", height = 450, width
cds_var_plot
dev.off()
```

```
## pdf
##   2
```

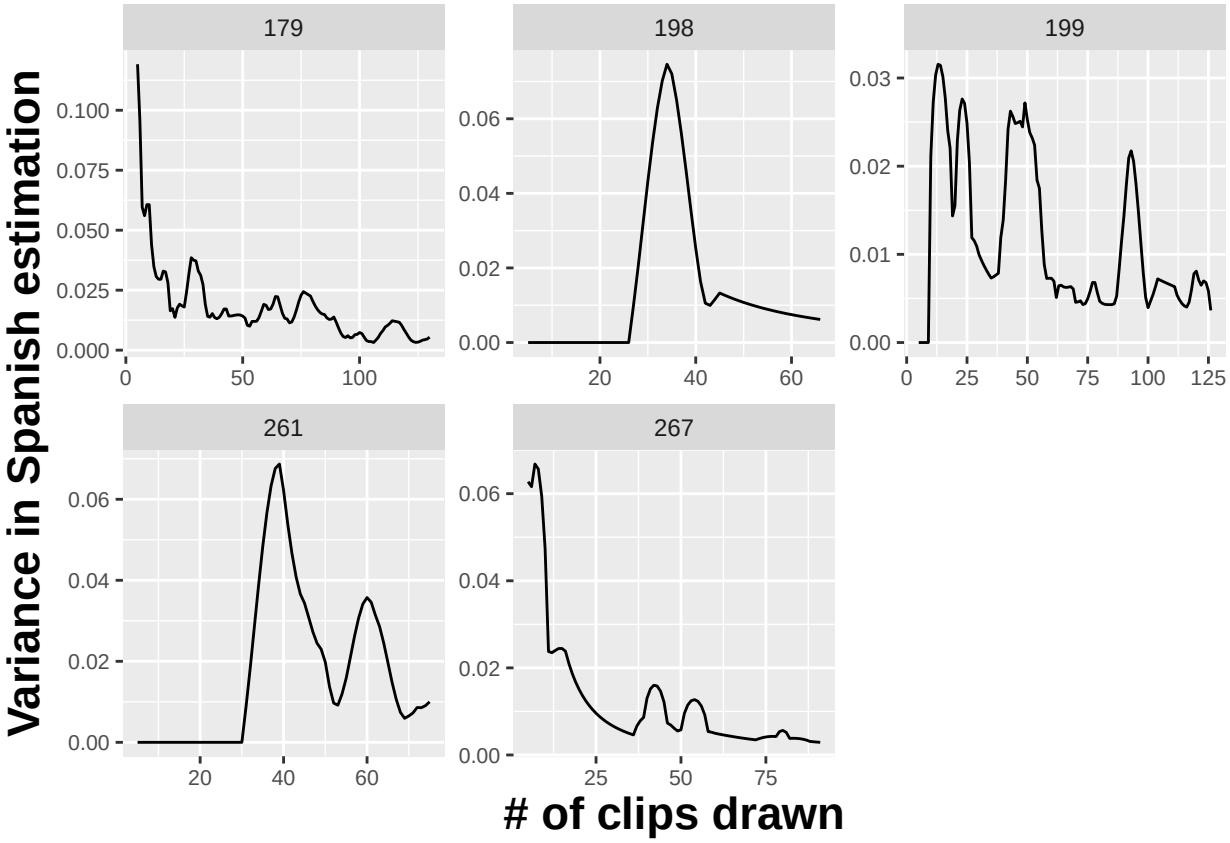
```
# now calculate rolling variances for US (Spanish)
span_var <- random %>%
  group_by(id) %>%
  mutate(total=n()) %>% # note that this is the total clips drawn, not just listened to
  gather("addressee", "language", Adult2TargetChild, Otherchild2TargetChild, Otherchild2OtherChild, Othe
         Otherchild2unsure, Adult2OtherChild, Adult2Others, Adult2unsure) %>%
  filter(language=='Spanish' | language=='English/Quechua' | language=='Mixed') %>%
  distinct_at(., vars(file_name, language), .keep_all = T) %>% # each language only gets counted 1x/cli
  select(-addressee)

span_var$span_cts <- plyr::mapvalues(span_var$language,
                from=c("English/Quechua", "Mixed", "Spanish"),
                to=c("0", "0", "1"))
span_var$span_cts <- as.numeric(span_var$span_cts)
span_var$total <- as.numeric(span_var$total)

span_rolling <- span_var %>%
  filter(location=='US') %>%
  group_by(id) %>%
```

```
  mutate(span_running_cts = as.numeric(cumsum(span_cts)),
         annotation_num = as.numeric(1:n())) %>%
  mutate(roll_prop_span = span_running_cts / annotation_num,
         roll_mean_span = rollmean(roll_prop_span, k=10, fill = NA),
         roll_sd_span = rollapply(roll_prop_span, width=10, FUN=sd, fill=NA))
```

```
span_var_plot <- span_rolling %>%
filter(roll_sd_span!='NA') %>% # remove rows where variance wasn't estimated
ggplot(., aes(annotation_num, roll_prop_span)) +
  geom_line(aes(y=roll_sd_span)) +
  xlab("# of clips drawn") +
  ylab("Variance in Spanish estimation") +
  facet_wrap(~id, scales = "free") +
  #title = 'Variance in Spanish language estimation as a function of clips drawn: US corpus') +
 theme(title = element_text(size=18, face="bold"),
   axis.text=element_text(size=8),
      axis.title=element_text(size=17,face="bold"),
      legend.title = element_text(size=15))
span_var_plot
```




```
jpeg("/Users/megcychosz/Google Drive/biling_CDS/results/figures/span_var_plot.jpeg", height = 450, width
span_var_plot
dev.off()
```

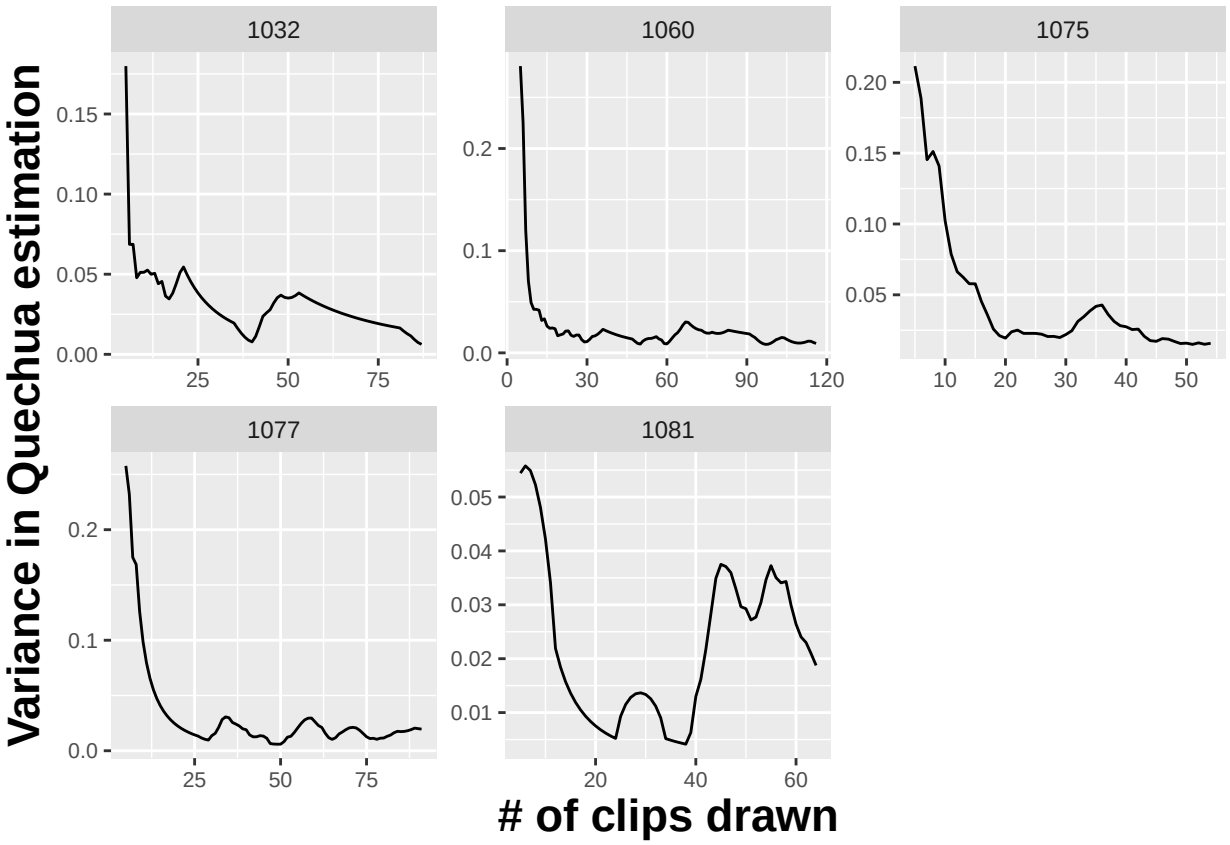
```
## pdf
##   2
```

```
que_var <- random %>%
  group_by(id) %>%
  mutate(total=n()) %>% # note that this is the total clips drawn, not just listened to
  gather("addressee", "language", Adult2TargetChild, Otherchild2TargetChild, Otherchild2OtherChild, Oth
         Otherchild2unsure, Adult2OtherChild, Adult2Others, Adult2unsure) %>%
  filter(language=='Spanish' | language=='English/Quechua' | language=='Mixed') %>%
  distinct_at(., vars(file_name, language), .keep_all = T) %>% # each language only gets counted 1x/cli
  select(-addressee)

que_var$que_cts <- plyr::mapvalues(que_var$language,
                from=c("English/Quechua", "Mixed", "Spanish"),
                to=c("1", "0", "0"))
que_var$que_cts <- as.numeric(que_var$que_cts)
que_var$total <- as.numeric(que_var$total)

que_rolling <- que_var %>%
  filter(location=='Bolivia') %>%
  group_by(id) %>%
  mutate(que_running_cts = as.numeric(cumsum(que_cts)),
         annotation_num = as.numeric(1:n())) %>%
  mutate(roll_prop_que = que_running_cts / annotation_num,
         roll_mean_que = rollmean(roll_prop_que, k=10, fill = NA),
         roll_sd_que = rollapply(roll_prop_que, width=10, FUN=sd, fill=NA))
```

```
que_var_plot <- que_rolling %>%
filter(roll_sd_que!='NA') %>% # remove rows where variance wasn't estimated
ggplot(., aes(annotation_num, roll_prop_que)) +
  geom_line(aes(y=roll_sd_que)) +
  xlab("# of clips drawn") +
  ylab("Variance in Quechua estimation") +
  facet_wrap(~id, scales = "free") +
  #title = 'Variance in Quechua language estimation as a function of clips drawn: Bolivia corpus') +
 theme(title = element_text(size=18, face="bold"),
   axis.text=element_text(size=8),
      axis.title=element_text(size=17,face="bold"),
      legend.title = element_text(size=15))
que_var_plot
```




```
jpeg("/Users/megcychosz/Google Drive/biling_CDS/results/figures/que_var_plot.jpeg", height = 450, width
que_var_plot
dev.off()
```

```
## pdf
##   2
```

```
# cds model
cds_model_data <- cds_rolling %>%
  group_by(id) %>%
  mutate(halfrow = as.numeric(n()/2)) %>% # for a sanity check
  filter(row_number() > n()*.90) # get the top 10% of rows from each group


cds_model <- cds_model_data %>%
  filter(roll_sd_cds!='NA') %>%
  lmer(roll_sd_cds~annotation_num + (1|id), data = .) %>%
  summary()

# spanish model
span_model_data <- span_rolling %>%
  group_by(id) %>%
  mutate(halfrow = as.numeric(n()/2)) %>% # for a sanity check
  filter(row_number() > n()*.90)

span_model <- span_model_data %>%
```

```
  filter(roll_sd_span!='NA') %>%
  lmer(roll_sd_span~annotation_num + (1|id), data = .) %>%
  summary()
```