Inclusive, open, and reproducible developmental science

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Version: February 1, 2023. This manuscript has not been peer reviewed.

Abstract

Over the past decade, there has been a growing appreciation of issues around metascience—how research is conducted—in psychological science. In addition to enhancing rigor and reproducibility through open and transparent research practices, greater inclusivity through diverse samples can enhance research relevance and applicability for historically marginalized and understudied populations. The present study reports on a comprehensive analysis of 2,615 posters presented at the 2021 biennial meeting of the Society for Research in Child Development. Results revealed that research that was presented is heavily skewed towards quantitative studies featuring American researchers and Western hemisphere samples. Sharing of data/materials, preregistrations, and replications are extremely uncommon. Data provide a much-needed baseline by which developmental science can benchmark progress towards greater inclusivity and openness.

Keywords: open science, metascience, inclusivity, reproducibility, developmental science, child development

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Open and reproducible science

It has been more than a decade since the replication crisis emerged in psychology, as spectacular findings from high-profile studies failed to replicate, raising questions about the reliability of the findings. Questionable research practices, such as *p*-hacking and "hypothesizing after results are known" (HARKing), and a general lack of transparency in the research process, have frequently been cited as primary drivers contributing to decreased rigor in psychological science research. In recognition of these issues, there has been a growing call to conduct research that is open and transparent (e.g., through sharing of data and materials), and to enhance rigor and reproducibility in psychological science (e.g., through preregistered analyses and registered reports). These efforts have spanned across both quantitative (Applebaum et al., 2018) and qualitative and mixed methods research (Levitt et al., 2018).

Not just open, but also inclusive

The term "open science" has often been understood as the ways in which research practices are transparent, and research materials and data are shared. That is, what is "open" in the term "open science" are aspects of the research enterprise, as well as researcher behavior that focuses on sharing and dissemination without barriers. However, in addition to "open science," there is a growing acknowledgement of the ways in which research can be open in other ways. Psychological science has been criticized for focusing heavily on largely homogenous White and Western-hemisphere samples, neglecting the global and cultural processes that profoundly shape development (Heinrich et al., 2010; Rad et al., 2018; Syed & Kathawalla, 2020). Historically, most psychological research has failed to consider over 90% of the world's populations (Arnett, 2009)

including diverse racial, ethnic, and cultural groups. Indeed, historically speaking, psychology has been particularly "closed" in acknowledging the diversity of findings from other cultures.

Therefore, it is important to not simply use "open science practices" as the only measure by which to assess research. For example, Sabik and colleagues question the value of a narrow focus on reproducibility without also attending to questions around who is represented, intersecting identities, and the broader sociohistorical context in which research unfolds (Sabik et al., 2021). Indeed, Conry-Murray and Silverstein highlight the multifaceted role of diversity in shaping the values of psychological science and how research in psychology can and should be conducted (Conry-Murray & Silverstein, 2022). Matsick and colleagues propose that viewing open science through a feminist psychology lens can help expand our understanding of issues around generalizability, representation, reflexivity, collaboration, and dissemination (Matsick et al., 2021). This is perhaps in part a response to an observation that open science has carried some exclusive connotations that serves to marginalize and exclude certain voices, with women in psychology often marginalized in so-called open scholarly dialogue (Murphy et al., 2020; Whitaker & Guest, 2020). This has led some in the field to not work toward open and inclusive scholarship. Therefore, it is important to consider how we define and operationalize the word "open" in open science. In the present study, we adopt a broad definition of open science that also encompasses *inclusivity* in research.

Openness and inclusivity in developmental science

Although much of the spotlight has been focused on social and personality psychology, issues around openness and inclusivity in developmental science has received far less attention. Yet, as early as 2014, as the awareness of the replication crisis in social psychology was arguably at its peak, Duncan and colleagues described the importance of replication and robustness checks,

common in other social and behavioral sciences, and how these practices could enhance the quality of research in developmental psychology (Duncan et al., 2014). Davis-Kean and Ellis (2019) identified key issues facing developmental researchers that may impede the creation of replicable developmental science, including small sample sizes, protocol flexibility, and analysis flexibility. In a recent "manifesto for new directions in developmental science," diversity and reproducible research were again identified as key topics and issues for the field (Barbot et al., 2020). Specifically, there is a growing awareness of the need to be more inclusive of global and cultural perspectives for a fuller developmental science, as well as implementing more rigorous, replicable research methods that allow for greater confidence in study findings (Barbot et al., 2020).

Despite the greater awareness and acknowledgement of these issues in developmental science, much of these calls have been based on research in other psychology disciplines, or through anecdotal data or small sample investigations. However, in one notable exception, Nielsen and colleagues conducted a descriptive study of published articles in *Child Development*, *Developmental Psychology*, and *Developmental Science* during the 2010s. They found that there was a "persistent sampling bias" in developmental psychology, with more than 90 percent of articles published in these journals featuring participants from the United States, English-speaking countries, and Europe (Nielsen et al., 2017). Yet, these findings only reflect a small portion of research in developmental science (i.e., peer-reviewed articles in prestigious journals). Moreover, we do not have information regarding the prevalence of open and reproducible science practices in developmental science more broadly. Without such data, it is impossible to gauge (1) the prevalence of open and inclusive research practices and (2) whether the field is moving in the right direction with respect to these priorities, which could inform project workflow and graduate training practices.

The pandemic as an opportunity

Due to the impacts of the global COVID-19 pandemic, many conferences were cancelled or shifted to virtual formats. The Society for Research in Child Development (SRCD) 2021 biennial meeting was among many academic organizations that moved to a fully virtual format in the spring of 2021. One of the notable advantages of the virtual format was that all research posters were made available for viewing and download on the conference portal for several months after the conclusion of the event. This provided a unique opportunity to systematically examine characteristics of research presented at one of the most influential and well-attended academic conferences of developmental scientists. By examining research posters at a large conference rather than peer-reviewed articles in just a few select journals, this would help expand our understanding of child development research and whether open science practices are being regularly used in this research. Because posters often reflect work that is happening right now, it also provides a more up-to-date snapshot regarding inclusive and open science practices, rather than the longer lag time when only looking at refereed articles.

In summary, the virtual conference provided a unique opportunity to take a snapshot of the field of child development research with respect to inclusive, open, and reproducible science practices. This snapshot can provide a baseline by which the field of developmental science can benchmark progress on making the field—as well as our research—as inclusive and open as possible. As such, the present study sought to understand "the metascience behind developmental science" by examining the characteristics of ongoing research in developmental psychology. Specifically, the study revealed the extent to which research presented at a large developmental psychology conference reflect inclusive (who is studied), open (what is shared), and reproducible (how it's studied) science best practices.

Study aims and hypotheses

We believe it is important to operationalize open science more broadly to also include greater diversity of sample participants, greater diversity of methodological approaches and techniques, greater representation of global perspectives, and greater opportunities for researchers from different career levels. We believe this broader perspective of openness is integral, especially given the increasing interdisciplinarity of developmental science, as well as the greater opportunities for collaboration facilitated by digital technologies. Accordingly, the purpose of the present study is to provide comprehensive and updated data regarding the current state of developmental psychology research, which could lead to more specific insights and targeted strategies for addressing these important issues.

We asked the following broad questions: (1) How diverse and inclusive is developmental science research, and (2) To what extent are principles of open and reproducible science reflected in developmental science research? To answer our questions, we conducted a rich descriptive analysis (frequencies and cross-tabulations) of all posters presented at the 2021 SRCD biennial meeting. We coded posters on predetermined key dimensions on inclusivity (e.g., geographic diversity of presenters, demographics of study sample), openness (e.g., are data and materials shared), and reproducibility (e.g., are analyses preregistered). In addition, posters were coded for dimensions such as developmental science subfield, type of research design (e.g., quantitative vs. qualitative), and data collection method (primary vs. secondary data). By acknowledging the diversity of perspective and approaches in developmental science, these codes will further illuminate how these practices might vary by key subgroups.

In addition to these two broad questions, we also sought to confirm several specific hypotheses. First, based on anecdotal evidence from SRCD panel chairs, we suspect that inclusive,

open, and reproducible science practices might have differed significantly as a function of research area. Second, there is anecdotal evidence to suggest that students and early career scholars are more likely to embrace and implement open science practices compared to mid- and late-career scholars, perhaps due to the recency of the reproducibility crisis over the past decade. Third, there is anecdotal evidence indicating that open science practices might be more common outside of the United States, particularly in Europe (see https://reproducibilitea.org/ for a geographic distribution of open science journal clubs). Our data allow us to examine the veracity of each of these hypotheses.

Method

Data set

The 2021 SRCD biennial meeting was held virtually in April of 2021 using an online conference system. All posters were made available to conference attendees through July of 2021. The system allowed for posters to be saved in a print-friendly mode. Therefore, we downloaded all posters for offline coding. The University of Kentucky IRB determined that the present study did not require IRB review "because it does not appear [the researchers] will be doing research about living individuals, but about the nature and characteristics of relevant research studies (and the institutions through which the studies were conducted) as presented in a poster format at the 2021 Society for Research in Child Development (SRCD)." Therefore, the data set used is properly characterized not as a data set about human subjects, but rather as meta-data—publicly-available data gleaned from research posters. Posters were chosen (rather than symposia and invited talks) because it reflects the most common presentation format, represents the broadest possible group of scientists (e.g., students are more likely to be represented in poster presentations), and are readily codable.

Coding categories

Table 1 presents a snapshot of the coding categories. We describe each of the codes in detail below.

Panel. At the time of submission, authors were asked to select a review panel for their poster from a prespecified list of panels provided by SRCD. We retrieved these data from the conference portal for each poster. A full list of panels can be found in Table 2.

Lead author institution. We identified the institutional affiliation of the lead author. This information was provided on the title page of the poster. In some cases, the lead author had more than one institutional affiliation. In these cases, the first affiliation was selected.

Lead author position. We identified the position of the lead author at their institution. We prespecified five categories: student, post-doc, tenure track faculty, tenured, faculty, and other. In some cases, the lead author position was ascertained from the "Author Information" section that was present in some posters. However, in cases where this information was not immediately apparent from the poster, an internet search was conducted to determine the lead author's position at the time of the SRCD meeting.

Institution location. We coded the institution of the lead author into one of nine prespecified categories: United States, Canada, Europe, Australia/New Zealand, South America, Central America, Middle East, Africa, and Asia. An internet search was conducted to confirm the geographic location of the institution.

Research design. We coded the type of research design that characterized the poster in one of five categories: quantitative, qualitative, mixed methods, meta-analysis/systematic review, and other. Posters in the Other category included federal agency posters, informational posters, posters featuring teaching tips, and literature reviews (distinct from systematic reviews).

Data type. We coded whether data collection was primary or secondary. We defined secondary data as data that the authors on the poster did not collect themselves.

Location of sample. We coded the geographic location of the participant sample based on information in the Methods section and other parts of the poster. If this information was not present, we made the assumption that *location of sample* was identical to the *institution location*. Some posters featured studies with participants from multiple distinct geographic locations; this was coded as a separate category. Other posters indicated that participants were drawn from an online subject pool such as MTurk and Prolific; these posters were coded as Online Platform if country-specific information was not included. We also coded for whether or not the location of the sample was explicitly stated on the poster.

Shared materials. We coded whether the poster contained shared data/materials or provided an external link or QR code where shared data/materials could be accessed. Posters that included complete survey instruments were coded as having shared materials. However, screenshots of experimental tasks or example questions were not coded as having shared materials. For meta-analyses/systematic reviews, the inclusion a PRISMA flowchart and list of all references were coded as having shared materials. Links to Google Drive and OSF that indicated that study materials were stored there (including preprints) were also coded as having shared materials.

Registered. A preregistration is a document that can take multiple forms, but often it includes a study rationale and a list of prespecified research questions and hypotheses. Preregistrations often include the researchers' plans for how to recruit participants and analyze data. Registered reports represent a more formal version of a preregistration that involves a submission to a journal prior to the start of data collection or data analysis. We coded for whether the poster indicated that part or all of their analysis was preregistered or registered. We coded the

poster as being registered even if the poster did not actually contain a link to the preregistration. A link to a preregistration counted as being registered.

Replication. We coded for whether the poster indicated that part of all of their analysis was meant to replicate findings from a specific study. Verbiage that indicated that the study was a replication without citing the study to be replicated was not coded as a replication.

Type of replication. For posters that were determined to be a replication study (in whole or in part), we coded for whether the replication was a conceptual or direct replication. Posters that contained information indicating that their study had identical procedures and participant age range were coded as a direct replication. Otherwise, the poster was coded as being a conceptual replication.

Procedure

After posters were downloaded to a secure server, the PI and trained members of the research team coded the posters on the characteristics presented in Table 1. Some of this information was readily available from the poster. For example, some posters had a dedicated "Author Information" section that provided information about the lead author institution and position. However, most posters did not. For these posters, an internet search was conducted to identify the lead author's institution and position at the time of the conference in April of 2021.

Due to the size of the data set to be constructed, coding occurred in two stages, which started during the summer of 2021 and continued through the summer of 2022. In the first stage, the PI and research assistants focused on coding four categories: panel, lead author position, lead author institution, and institution location. Prior to coding, the PI and research assistants practiced coding on a smaller number of posters to establish intercoder reliability; this was established with a 95.14% agreement rate. As coding progressed continued, a decision was made to allocate certain

coding tasks to specific members of the research team due to experience and time constraints. Specifically, the PI took a leading role in coding information related to the lead author position, while the other research team members focused their attention on coding information on review panel, lead author institution, geographical location. Any disagreements or other questions were resolved by the PI and documented in the data set.

In the second stage of coding, the research team coded the posters on the remaining categories. Just as before, the PI and research assistants practiced coding on a smaller number of posters to establish intercoder reliability; this was established with a 91.67% agreement rate. Based on the relative strengths and preferences of the coding team, the team opted to code the posters using a "divide-and-conquer" strategy, wherein each coder would be responsible for a set of coding categories. Coder A coded research design and data type, Coder B coded location of sample and location of sample stated, Coder C coded shared materials, and Coder D coded registration, replication, and type of replication. As before, any disagreements or other questions were resolved by the PI and documented in the data set. However, for some posters, given the nature of the content presented, it was impossible to accurately apply a code for certain categories (e.g., missing/incomplete information, incorrect URLs). In these uncommon instances, these were left blank and coded as "Uncategorized." Our results were unaffected by the inclusion of this "Uncategorized" code.

Coding rules

The coding process was governed by several guiding principles and simplifying assumptions. (1) We only considered information about the lead author of the poster. This was done under the assumption that the lead author was the individual who was primarily responsible for the content in the poster. (2) In some cases, the lead author on the poster was different from

the lead author listed on the online conference portal. We decided to go with the lead author listed on the poster itself for coding purposes. (3) Lead author position was coded based on information available on the poster or via an internet search. Because coding took place after the conclusion of the conference, in some cases the lead author had changed their position and affiliation. We decided to code lead author position based on their affiliation at the time of the conference. (4) If the poster was clearly based on the lead author's role as a student, but at the time of the conference the individual had moved into a different position, we coded position as Student rather than the individual's current position. Our rationale was that the work reflected the lead author's effort while they were a student. This was further confirmed if the institution on the poster was the individual's institution while they were a student. (5) Some downloaded posters included not just the poster content, but also the abstract that was originally submitted to SRCD for peer review. We only coded the poster content, not the submitted abstract. (6) Some posters contained videos, either directly embedded in the virtual poster or a link to an external video hosting platform. To simplify the coding process, only information on the poster was coded; that is, we did not attempt to view these videos to determine codes.

Analysis plan

We asked two broad questions: (1) How diverse and inclusive is developmental science research? (2) To what extent are principles of open and reproducible science reflected in developmental science research? Our results are organized within each of these two broad questions. Due to the descriptive nature of the study, we generated frequencies and cross-tabulations to answer our research questions. We generated frequencies for all coding categories; these tables are presented below. We did not generate cross-tabulations for all combinations of variables, but instead focused our attention on the specific hypotheses we presented earlier. For

cross-tabulations, we conducted chi-square tests to confirm that any observed differences between groups were meaningful and not due to chance. Results of cross tabulations are briefly summarized below; cross-tabulation tables are presented in the Supplementary Material. Detailed information, including a deidentified data set, codebook of variables, and the code used to run the analyses, can be found at https://osf.io/93qm2/?view_only=80e7161fcf52425d955a475472be09cd.

Results

Inclusivity: Research topics, methods, and designs

We probed for how inclusive developmental science research is in terms of research topics, methods, and designs used. Table 2 shows the breakdown of posters by SRCD review panel. Just two panels—Parenting & Parent-Child Relationships and Education/Schooling—comprised nearly 20% of all posters. Table 3 shows the research methods used. Quantitative research methods comprised nearly 9 out of 10 posters. Just over five percent of posters featured qualitative methods or mixed methods. Table 4 shows the type of data used in posters. Primary data collection—where authors collect their own data—was by far the most common approach. Secondary data, such as the use of publicly available data sets, were only featured in 15.5% of posters.

We were interested in exploring systematic differences in research methods and designs used as a function of research topic. We grouped the 31 individual SRCD review panels into nine broader categories to more readily ascertain potential differences across research area (Table S1). We found significant differences in research design across research areas, $\chi^2(32) = 169.17$, $p < .001$ (Table S2), with posters in the *Education and Social Policy* and *Diversity, Equity, and Identity* groups with the highest proportion of qualitative methods used (7.4% and 8.5%, respectively). There were significant differences in data type across research areas, $\chi^2(8) = 85.17$, $p < .001$ (Table S3), with posters in the *Cognition* group with the greatest proportion of primary data sources

(94.2%) and posters in the *Other* group (comprising *Health, Growth, Injury* and *Methods, History, Theory* panels) with the greatest proportion of secondary data sources (30.4%). We also found significant differences in reporting of sample location across research areas, $\chi^2(8) = 67.81$, $p < .001$ (Table S4), with posters in the *Cognition* group least likely to report the location of their study samples (16.0%). We did not find any significant differences in shared materials across research areas, $\chi^2(8) = 10.05$, $p = .26$ (Table S5). Finally, when turning to reproducibility, we found significant differences in preregistration practices across research areas, $\chi^2(8) = 22.72$, $p = .004$ (Table S6), with posters in the Family Context, Education and Social Policy, and Diversity, Equity, and Identity groups with the lowest proportion of preregistration practices (0.91%, 0.82%, and 0.95%, respectively). However, we found no significant differences in replication studies across research areas, $\chi^2(8) = 13.59$, $p = .09$ (Table S7).

Inclusivity: Researchers and participants

We were also interested in characteristics of the researchers conducting child development research, as well as who is being studied. Table 5 shows the distribution of the positions held by lead authors. Almost 60% of all posters had an undergraduate or graduate student lead author. Table 6 shows that more than 92% of posters featured a lead author are affiliated with Western hemisphere and English-speaking institutions (United States, Canada, Europe, and Australia/New Zealand). Only 7% of posters featured a lead author from Asia, Africa, Central America, South America, and the Middle East, combined. The location of study participants tracked closely with the geographic distribution of lead authors, as shown in Table 7.

Openness: Transparency and sharing

We coded for two observable measures of openness. One measure is whether the poster explicitly stated the location of the participant sample. Understanding the geographical location of

the study would allow readers to better interpret and situate the findings in its proper context. Unfortunately, previous research has shown that 11 percent of papers published in *Psychological Science* in 2014 did not provide information that would allow the reader to infer the location of participant samples (Rad et al., 2018). As shown in Table 8, our results indicate that 32 percent of posters explicitly stated the location of the participant sample. Differences in sample transparency by author position were not significant, $\chi^2(4) = 7.51$, $p = .11$ (Table S8). However, first authors from United States institutions were significantly less likely to explicitly state the location of their participant sample compared to first authors outside of Europe (29.0% vs. 43.2%), $\chi^2(1) = 43.89$, $p < .001$ (Table S9).

A second measure of openness involves whether posters included shared data or materials or provided information (via a link or QR code) that would allow readers to obtain study data or materials. As shown in Table 9, less than five percent of posters included such information. As before, differences in sharing practices by author position were not significant, $\chi^2(4) = 2.07$, $p = .72$ (Table S10). First authors from European institutions were significantly more likely to share data or materials compared to first authors from outside of Europe (8.5% vs. 4.8%), $\chi^2(1) = 5.73$, $p = .02$ (Table S11).

Reproducibility: Registrations and replications

Finally, we coded for two observable measures of reproducibility. One measure is whether the poster indicated that the study's analysis—in whole or in part—was preregistered or registered prior to presentation. We adopted a very liberal criterion in which we coded posters as being registered as long as the poster indicated that they did so, even if the poster did not contain a link to the preregistration document. Yet, as shown in Table 10, only two percent of all posters indicated that all or part of their study was preregistered or registered. We found that there were

significant differences in preregistration practices as a function of author position, $\chi^2(4) = 12.80$, $p = .01$, with 5.0% of post-doctoral scholars having reported a preregistration or registered report (compared to less than 2.4% for all other author positions; Table S12). We continued to find stronger support for open science practices in Europe, with first authors from European institutions significantly more likely to have preregistered or registered their study compared to first authors outside of Europe (7.5% vs. 1.6%), $\chi^2(1) = 33.78$, $p < .001$ (Table S13).

A second measure concerned whether the poster was intended to replicate one or more findings from a previous study. We also adopted a liberal criterion in which we coded posters as being a replication study if the poster included language that indicated that a replication was an aim of the study. Even using this criterion, only 1.3% of posters were classified as a replication study; most of these replications were classified as a conceptual replication, meaning that the study was not intended as a "pure" replication study but rather to replicate a broad finding using a different measure or different developmental sample. Tables 11 and 12 present findings for the replication categories. Differences in the frequency of replication studies were not observed as a function of author position, $\chi^2(4) = 2.44$, $p = .66$ (Table S14), or first-author location, $\chi^2(1) = 0.001$, $p = .98$ (Table S15).

Discussion

Given the dearth of information regarding inclusive, open, and reproducible science practices in developmental science, the purpose of the present study was to generate rich descriptive information regarding the prevalence of these practices by coding 2,615 posters presented at the 2021 SRCD biennial meeting. Results revealed that child development research is heavily skewed towards particular types of research—namely, quantitative studies that feature largely American researchers and Western-hemisphere study samples. Open and inclusive science

is still extremely uncommon in developmental research, even after more than a decade since the replication crisis first emerged in psychology.

Developmental science is a quantitative-focused science

Our results showed that nearly 90 percent of all posters featured quantitative methods. Developmental science has traditionally been known as a quantitative-focused social science, but our results are among the first to show how dominant these methods really are for poster presentations. Hiding underneath this 90% figure, however, is a more complex story. Why is child development research so heavily skewed towards quantitative methods? Is it because our research questions are best addressed using quantitative methods, or might it reflect the current realities of graduate training? If graduate training is still geared heavily towards quantitative methods, this would not only lead emerging scholars to use such methods in their research, but also to ask research questions in such a way that leads to the use of quantitative methods. That is, our familiarity with quantitative methods might limit the types of questions we ask as a field. It is also possible that the reviewers who review submissions for SRCD are not likely to be trained or familiar with qualitative methods, which may result in lower scores for projects that do feature qualitative or mixed methods due to a lack of knowledge of how to assess such research, or perhaps even a bias against such methods. In fact, qualitative researchers are likely to pursue scholarly venues other than SRCD that are more likely to embrace and understand qualitative research practices.

We found that 15.5% of posters used secondary data, with significant variation across research areas. There is a growing embrace for secondary data analyses, although the use of such data is not at all new in developmental psychology (Brooks-Gunn et al., 1991). It is hard to know how to interpret this 15.5% figure, as there is no other figure to benchmark this against. The value

in secondary data is the ability to leverage an already existing data set to answer research questions that are more likely to be appropriately powered, which can limit the proliferation of findings from smaller samples that might not replicate (Davis-Kean et al., 2015).

Developmental science is a Western hemisphere-centric science

Our analysis underscored what psychologists have known for years but had not yet been explored in developmental science in particular: child development research reflects the experiences of individuals from Western and English-speaking countries. A staggering 92% of lead authors on SRCD posters were based in the United States, Canada, Europe, Australia, and New Zealand. When examining participant samples, the story was not much better—more than 88% of posters featured participants from those four geographic regions. Remarkably, this figure is almost identical to that generated by Nielsen and colleagues in their 2017 study examining publications in developmental psychology journals. In that study, 91.67% of articles in 2008 and 92.37% of articles in 2015 featured participants from the United States, English-speaking countries, and Europe (Nielsen et al., 2017). (Whether a decrease from 92.37 to 88% is a meaningful one probably depends on whether you see the glass as half full or half empty.) However, we also note more recent work by Moriguchi who analyzed papers published in one journal—*Infant and Child Development*. His findings indicate that there has been a small increase in the proportion of first authors and study participants from non-Western populations since 2010 (Moriguchi, 2022).

Despite the challenges associated with a virtual conference format, including reduced opportunities for meaningful engagement, some argued that a virtual conference would serve to expand opportunities that would otherwise not have been available. This could have led conference participants—at least for 2021—to be more geographically diverse. Supporting the latter

perspective, travel and registration costs dramatically reduced for participants and attendees. This no doubt reduced barriers and increased access for many researchers, particularly students, to participate. We argue that these reduced barriers may have allowed for greater participation from researchers globally. However, because we lacked information on the number of submissions and acceptances over time, we cannot definitively conclude this.

Developmental science is not yet open

We found that less than one-third of posters explicitly stated the location of their participant samples. We might expect American researchers to be less likely to provide this information for several reasons, including a pervasive U.S.-centric bias as well as the fact that almost all SRCD biennial meetings have taken place in the United States. Our results confirmed this hypothesis. From our perspective, the practice of not providing such information is troubling. In many cases, all that is required is to add just a few words (e.g., "from the United States") in the Method section, which would help to contextualize the findings and to aid the reader in not overgeneralizing the findings to other cultures and contexts. However, this information is not being included on posters.

In terms of sharing data and materials, the outlook was even bleaker, with only about five percent of posters sharing data or materials or including a link or QR code where the reader could access those materials. We found stronger uptake of these practices amongst researchers based in Europe, but overall numbers remained low. Of course, there are various reasons why data or materials cannot be shared, including the proprietary nature of certain assessment materials, or restrictions on data sharing from institutional review boards. It is difficult to determine how meaningful this five percent figure is without another figure to benchmark against. Yet, especially given the poster format where space is often at a premium, it is not unreasonable to expect authors to provide a link to supplementary material where the interested reader can obtain additional

information. We know that the practice of requesting data from the authors "upon request" is not particularly effective (Wicherts et al, 2006), so the proliferation of online repositories such as OSF and GitHub should facilitate sharing of data and materials. However, in developmental science, these practices have not yet taken root, at least when examining the content of research posters.

Developmental science is not yet reproducible

Finally, we found that the practice of preregistrations, registered reports, and replication studies are extremely uncommon in child development research. Again, without information to benchmark these figures against, it is impossible to determine whether even these low numbers should be a cause for encouragement if these practices were actually less common in previous years. But the mere frequency of replication is not the only criterion that matters. Recent research has revealed significant variability in the *likelihood* of replicability as a function of psychology subfield and research design, with developmental psychology ranking at the bottom and experimental studies being less likely to replicate than non-experimental studies across subfields (Youyou et al., 2023), indicating that the challenge of replicability is not just one of prevalence, but also of study design and quality.

We know that common criticisms against preregistrations include an increase in work-related stress as well as increasing the overall duration of the project (Sarafoglou et al., 2022). From a graduate student perspective, preregistrations and registered reports are perceived as being a moderate to high difficulty activity (Kathawalla et al., 2021), perhaps indicating the barriers associated with implementing such practices even if individuals find these to be valuable and to enhance the quality of science. Interestingly, we found that post-docs were the most likely of any career level to engage in preregistration practices. This might be due to some of the opportunities and incentives that are common during the post-doctoral years—for example, the benefits of

preparing and posting preregistrations can be a strong tangible indicator of research progress that can be particularly useful during the academic job market. We also note that these figures are almost certainly underestimates of actual reproducible practices, as some authors may have determined it to be unnecessary to include this information on their posters. We discuss individual differences in poster construction below.

Limitations

In constructing the data set, we had to make some simplifying assumptions. However, some of these assumptions might not be valid in all circumstances. For example, we made the decision to only focus on the lead author of the poster when assigning codes, such as geographic location of the researcher. However, differences in authorship norms, as well as logistical considerations, could have skewed our results. For example, the first author on the poster could reflect a variety of roles, such as the person who made the greatest intellectual contribution, or the person tasked with presenting the paper, or even the most senior author. We assumed that the lead author was the individual who made the greatest intellectual contribution, but this might not have been true for all posters.

There are likely individual differences in how researchers and labs construct posters, with some individuals providing as many details as possible, while others take a more minimalist approach. The virtual format of the posters likely complicated this further. Poster presenters were provided the opportunity to host a live Zoom session during the conference where attendees could interact with an actual presenter; however, not all presenters took advantage of this opportunity. Moreover, some posters included video links of the presenters narrating various aspects of their poster; this was not a requirement, but the virtual format made this feature possible. We did not code for the content provided in these video links.

We only looked at posters, not talks. We chose to look at posters because it represented the broadest possible set of research presentations that could also be more readily coded. However, the distribution of these practices could well differ between posters and talks. Anecdotal evidence points to a general belief that student presentations are more often represented in poster sessions compared to symposia and talks, so there could be meaningful differences in terms of who is more likely to select certain presentation formats over others. However, it would also be important to examine whether *published* research in developmental journals, such as *Child Development*, might show similar or different rates of inclusive, open, and reproducible practices compared to conference presentations such as posters and talks. As previously described, the work by Moriguchi (2022) examining the characteristics of researchers and study samples featured in *Infant and Child Development* is an important step. In a separate descriptive study of a related field, Makel and colleagues analyzed self-reported survey data from 1,488 participants who had published at least one article between 2008 and 2018 in education research journals (Makel et al., 2021). Building on this work, coding published papers and collecting survey data from published authors in developmental journals could supplement the findings we present in this paper.

Different dimensions of openness and reproducibility are relevant depending on the type of research being conducted. For example, in qualitative research, the concept of reflexivity is important. Reflexivity, sometimes referred to as positionality, refers to "the degree of influence that the researcher exerts, either intentionally or unintentionally, on the findings" (Jootun et al., 2009, p. 42). This is especially important in qualitative research, when individual researchers must interpret the meaning of participant responses in interviews, focus groups, or other formats. Because researchers necessarily view data through the lenses of their own identity and lived experiences, articulating the values and perspectives that the researchers bring to the data analysis

and interpretive process can help the reader better situate the findings in context. Therefore, many qualitative studies will often include a statement of reflexivity or positionality that articulates the researchers' values and perspectives that shaped the data coding, analysis, and interpretation. Such statements could be viewed as an example of open science that is common in qualitative research. (Of course, we should note that the authors of the current study were trained as quantitative psychologists, which certainly shaped this project in various ways.) The present study did not examine whether statements of reflexibility were present in posters that featured qualitative analyses. Future research could examine other features of inclusive, open, and reproducible science beyond those that we commonly associate with quantitative developmental science research.

Implications and recommendations

The effort involved in the coding process was a herculean task, with several rounds of coding which took approximately 12 months to complete. In constructing this data set, we lamented that this information could easily have been obtained as part of the conference submission process, potentially obviating the need to individually code posters (although we acknowledge that there could be changes from the time of submission to the actual presentation). The point here is that these data could have been collected using a more streamlined process, but this is currently not happening. Without collecting such data in a systematic way over time, it is impossible to determine whether we are making process towards making developmental science more inclusive and open.

Yet even before we consider collecting data, the question remains about which data we want to track in the first place. In the present study, we identified and defined a small number of poster metadata that we could easily retrieve and code for. However, there are many other dimensions that we did not examine in the present study. For example, as the field continues to

move towards a “team science” approach, examining the number of authors on posters or the number of different institutions and sites involved in a poster could be important to examine. We could also examine more fine-grained aspects of the research itself, including age groups of participants (how developmental is developmental science) and research design (experimental vs. correlational). We hope that these findings spark a renewed focus on what our priorities are in terms of inclusivity, openness, and reproducibility in developmental science. Only then can we identify which data to collect and track over time.

Before concluding, we note that there has been an explosion of interest in adopting and applying inclusive, open, and reproducible science practices in developmental science in recent years. Numerous commentaries and resources from developmental psychologists regarding best practices in open and inclusive science are available. The excellent article by Kalandadze and Hart provides an annotated reading list organized around ten topics in open developmental science (Kalandadze & Hart, 2022). Gilmore (2022) has proposed several solutions to help developmental psychologists share data and materials, including the storage and sharing of video data. Turoman and colleagues provide a case study of how open and reproducible science practices are implemented in a project workflow, describing common challenges as well as the pros and cons of their approach (Turoman et al., 2022). Opportunities and challenges in implementing open science practices in longitudinal developmental research is also highlighted in a commentary by Kirtley (2022). Consistent with our own approach in conducting descriptive research, Kosie and Lew-Williams outlines various considerations for incorporating open science practices in descriptive developmental research (Kosie & Lew-Williams, 2022). We note the proposal by Whitmore and Mills regarding how researchers can expand inclusivity and openness through co-

created research in collaboration with members of the researched population (Whitmore & Mills, 2021).

Conclusion

Before concluding, we want to acknowledge the important commentary and arguments set forth by Ledgerwood and her colleagues in the piece titled, "The Pandemic as a Portal: Reimagining Psychological Science as Truly Open and Inclusive." Our findings, as well as their paper, shine the spotlight on the metascience behind psychological science by prompting us all to consider why and how we conduct research (Ledgerwood et al., 2022). What are our individual and collective priorities values around research, and why is there often a disconnect between what we preach and what we practice? What incentives shape our research process, and are these the right incentives to move the field forward? What questions are we asking, and how are we exploring these questions? How is the research process shaped by unseen biases and structures that are difficult to change, but must evolve? Our data indicate that open and inclusive science practices are still extremely uncommon in developmental research, even after more than a decade since the replication crisis first emerged in psychology. Although these findings are sobering, these data provide a much-needed baseline by which the field of developmental science can benchmark progress on making the field—as well as our research—as inclusive and open as possible.

Acknowledgements

The data necessary to reproduce the analyses presented here are publicly accessible. The analytic code necessary to reproduce the analyses presented in this paper is publicly accessible. The materials necessary to attempt to replicate the findings presented here are publicly accessible. Data, analytic code, and materials can be found here: https://osf.io/93qm2/?view_only=80e7161fcf52425d955a475472be09cd. The analyses presented here were not preregistered. The authors would like to thank attendees at the Developmental, Social, and Health Brown Bag at the University of Kentucky, and the Research and Professional Developmental Seminar Series at the University of Louisville, for feedback on an earlier version of this work.

Figures and Tables

Table 1
Coding categories

Category	Description	Source
Lead author	Name of lead author	On poster
Panel	Name of review panel to which the poster was assigned	Online portal
Lead author institution	Name of lead author institution	On poster
Lead author position	Options: Student, post-doc, tenure track faculty, tenured faculty, other	On poster
Institution location	Options: United States, Canada, Europe, Australia/NZ, South America, Central America, Middle East, Africa, Asia	Internet search
Research design	Options: Quantitative, qualitative, mixed methods, meta-analysis, other	On poster
Data type	Options: Primary, secondary	On poster
Location of sample	Geographic location of the participant sample	On poster
Shared materials?	Does the poster say that materials are shared?	On poster
Registered?	Does the poster say that analyses were registered or preregistered?	On poster
Replication?	Does the poster say that the analysis was a replication?	On poster
Type of replication	Options: Direct, conceptual	Inferred from poster

Table 2

SRCD assigned panel

Panel name	N	Percent
Attention, Learning, Memory	106	4.05
Biological Processes: Neuroscience and Genetics	49	1.87
Biological Processes: Psychophysiology	51	1.95
Black Caucus	19	0.73
Cognitive Processes	156	5.97
Developmental Disabilities	80	3.06
Developmental Psychopathology	171	6.54
Diversity, Equity & Social Justice	43	1.64
Education, Schooling	226	8.64
Family Context & Processes	151	5.77
Federal Agency Sessions	9	0.34
Health, Growth, Injury	62	2.37
Language, Communication	171	6.54
Methods, History, Theory	30	1.15
Moral Development	69	2.64
Parenting & Parent-Child Relationships	289	11.05
Perceptual, Sensory, Motor	40	1.53
Prevention and Interventions	65	2.49
Race, Ethnicity, Culture, Context	126	4.82
School Readiness/Childcare	55	2.1
Sex, Gender	41	1.57
Social Cognition	110	4.21
Social Policy	19	0.73
Social Relationships	102	3.9
Social, Emotional, Personality	128	4.89
Solicited Content: COVID-19 Related	119	4.55
Solicited Content: Global South	3	0.11
Solicited Content: Indigenous Children and Families	5	0.19
Solicited Content: Refugee Children	13	0.5
Teaching Institute	21	0.8

Technology, Media & Child Development	84	3.21
Uncategorized	2	0.08
Total	2,615	100

Table 3
Research design

	N	Percent
Quantitative	2,349	89.83
Qualitative	87	3.33
Mixed Methods	51	1.95
Meta-analysis/Systematic Review	54	2.07
Other	65	2.49
Uncategorized	9	0.34
Total	2,615	100

Table 4
Data type

	N	Percent
Primary	2,178	83.29
Secondary	405	15.49
Uncategorized	32	1.22
Total	2,615	100

Table 5
Lead author position

	N	Percent
Student	1,559	59.62
Post-doc	219	8.37
Tenure-track faculty	208	7.95
Tenured faculty	193	7.38
Other	339	12.96
Uncategorized	97	3.71
Total	2,615	100

Table 6

Institution location

	N	Percent
United States	1,979	75.68
Canada	209	7.99
Europe	228	8.72
Australia/New Zealand	9	0.34
South America	36	1.38
Central America	6	0.23
Middle East	38	1.45
Africa	1	0.04
Asia	103	3.94
Uncategorized	6	0.23
Total	2,615	100

Table 7

Location of study sample

	N	Percent
United States	1,884	72.05
Canada	196	7.5
Europe	217	8.3
Australia/New Zealand	12	0.46
South America	42	1.61
Central America	11	0.42
Middle East	39	1.49
Africa	7	0.27
Asia	124	4.74
Multiple countries	51	1.95
Online platform	4	0.15
Not applicable	8	0.31
Uncategorized	20	0.76
Total	2,615	100

Table 8

Was sample location stated?

	N	Percent
No	1,745	66.73
Yes	838	32.05
Uncategorized	32	1.22
Total	2,615	100

Table 9

Shared materials?

	N	Percent
No	2,376	90.86
Yes	127	4.86
Uncategorized	112	4.28
Total	2,615	100

Table 10

Was study preregistered?

	N	Percent
No	2,540	97.13
Yes	56	2.14
Uncategorized	19	0.73
Total	2,615	100

Table 11
Replication study?

	N	Percent
No	2,562	97.97
Yes	34	1.3
Uncategorized	19	0.73
Total	2,615	100

Table 12
Type of replication

	N	Percent
Direct	11	0.42
Conceptual	19	0.73
Not applicable	2,564	98.05
Uncategorized	21	0.8
Total	2,615	100

Supplementary Materials

Table S1

SRCD panels grouped by research area

	N	Percent
Biological processes	**100**	**3.8%**
Biological Processes: Neuroscience and Genetics	49	
Biological Processes: Psychophysiology	51	
Cognition	**583**	**22.3%**
Attention, Learning, Memory	106	
Cognitive Processes	156	
Language, Communication	171	
Perceptual, Sensory, Motor	40	
Social Cognition	110	
Social	**383**	**14.7%**
Moral Development	69	
Social Relationships	102	
Social, Emotional, Personality	128	
Technology, Media & Child Development	84	
Family context	**440**	**16.8%**
Family Context & Processes	151	
Parenting & Parent-Child Relationships	289	
Education and Social Policy	**365**	**14.0%**
Education, Schooling	226	
Prevention and Interventions	65	
School Readiness/Childcare	55	
Social Policy	19	
Diversity, Equity, and Identity	**210**	**8.0%**
Diversity, Equity & Social Justice	43	
Race, Ethnicity, Culture, Context	126	
Sex, Gender	41	
Clinical	**251**	**9.6%**
Developmental Disabilities	80	
Developmental Psychopathology	171	
Other	**92**	**3.5%**
Health, Growth, Injury	62	
Methods, History, Theory	30	
Solicited Content	**140**	**5.4%**
Solicited Content: COVID-19 Related	119	
Solicited Content: Global South	3	
Solicited Content: Indigenous Children and Families	5	
Solicited Content: Refugee Children	13	
Excluded	**49**	**1.9%**
Black Caucus	19	
Federal Agency Sessions	9	
Teaching Institute	21	
Total	**2613**	**100.0%**

Table S2

Cross tabulation: Research design as a function of research area

Panel	Research Design					Row total
	Quant	Qual	Mixed	Meta-analysis	Other	
Biological processes	94	0	0	3	3	100
	94.0%	0.0%	0.0%	3.0%	3.0%	100.0%
Cognition	563	4	2	7	5	581
	96.9%	0.7%	0.3%	1.2%	0.9%	100.0%
Social	360	11	3	5	3	382
	94.2%	2.9%	0.8%	1.3%	0.8%	100.0%
Family context	413	13	6	3	3	438
	94.3%	3.0%	1.4%	0.7%	0.7%	100.0%
Education and Social Policy	299	27	19	12	7	364
	82.1%	7.4%	5.2%	3.3%	1.9%	100.0%
Diversity, Equity, and Identity	178	18	6	6	3	211
	84.4%	8.5%	2.8%	2.8%	1.4%	100.0%
Clinical	233	3	1	10	2	249
	93.6%	1.2%	0.4%	4.0%	0.8%	100.0%
Other	77	2	3	6	4	92
	83.7%	2.2%	3.3%	6.5%	4.3%	100.0%
Solicited Content	115	7	10	1	6	139
	82.7%	5.0%	7.2%	0.7%	4.3%	100.0%
Column total	2332	85	50	53	36	2556
	91.2%	3.3%	2.0%	2.1%	1.4%	100.0%

Table S3

Cross tabulation: Data type as a function of research area

Panel	Data type		Row total
	Primary	Secondary	
Biological processes	81	19	100
	81.0%	19.0%	100.0%
Cognition	547	34	581
	94.1%	5.9%	100.0%
Social	330	51	381
	86.6%	13.4%	100.0%
Family context	372	65	437
	85.1%	14.9%	100.0%
Education and Social Policy	287	77	364
	78.8%	21.2%	100.0%
Diversity, Equity, and Identity	161	49	210
	76.7%	23.3%	100.0%
Clinical	195	54	249
	78.3%	21.7%	100.0%
Other	64	28	92
	69.6%	30.4%	100.0%
Solicited Content	118	20	138
	85.5%	14.5%	100.0%
Column total	2155	397	2552
	84.4%	15.6%	100.0%

Table S4

Cross tabulation: Sample location stated as a function of research area

Panel	Sample location stated?		Row total
	No	Yes	
Biological processes	84	16	100
	84.0%	16.0%	100.0%
Cognition	448	133	581
	77.1%	22.9%	100.0%
Social	262	120	382
	68.6%	31.4%	100.0%
Family context	286	152	438
	65.3%	34.7%	100.0%
Education and Social Policy	213	150	363
	58.7%	41.3%	100.0%
Diversity, Equity, and Identity	116	93	209
	55.5%	44.5%	100.0%
Clinical	165	84	249
	66.3%	33.7%	100.0%
Other	62	30	92
	67.4%	32.6%	100.0%
Solicited Content	84	55	139
	60.4%	39.6%	100.0%
Column total	1720	833	2553
	67.4%	32.6%	100.0%

Table S5

Cross tabulation: Shared materials as a function of research area

Panel	Shared materials?		Row total
	No	Yes	
Biological processes	88	6	94
	93.6%	6.4%	100.0%
Cognition	507	29	536
	94.6%	5.4%	100.0%
Social	349	21	370
	94.3%	5.7%	100.0%
Family context	419	12	431
	97.2%	2.8%	100.0%
Education and Social Policy	340	19	359
	94.7%	5.3%	100.0%
Diversity, Equity, and Identity	193	14	207
	93.2%	6.8%	100.0%
Clinical	239	7	246
	97.2%	2.8%	100.0%
Other	80	6	86
	93.0%	7.0%	100.0%
Solicited Content	131	7	138
	94.9%	5.1%	100.0%
Column total	2346	121	2467
	95.1%	4.9%	100.0%

Table S6

Cross tabulation: Preregistration practices as a function of research area

Panel	Preregistration practices?		Row total
	No	Yes	
Biological processes	94	5	99
	94.9%	5.1%	100.0%
Cognition	557	24	581
	95.9%	4.1%	100.0%
Social	374	8	382
	97.9%	2.1%	100.0%
Family context	434	4	438
	99.1%	0.9%	100.0%
Education and Social Policy	361	3	364
	99.2%	0.8%	100.0%
Diversity, Equity, and Identity	209	2	211
	99.1%	0.9%	100.0%
Clinical	245	4	249
	98.4%	1.6%	100.0%
Other	90	2	92
	97.8%	2.2%	100.0%
Solicited Content	136	4	140
	97.1%	2.9%	100.0%
Column total	2500	56	2556
	97.8%	2.2%	100.0%

Table S7

Cross tabulation: Replication study as a function of research area

Panel	Replication study?		Row total
	No	Yes	
Biological processes	95	4	99
	96.0%	4.0%	100.0%
Cognition	572	9	581
	98.5%	1.5%	100.0%
Social	378	4	382
	99.0%	1.0%	100.0%
Family context	429	9	438
	97.9%	2.1%	100.0%
Education and Social Policy	361	3	364
	99.2%	0.8%	100.0%
Diversity, Equity, and Identity	208	3	211
	98.6%	1.4%	100.0%
Clinical	248	1	249
	99.6%	0.4%	100.0%
Other	92	0	92
	100.0%	0.0%	100.0%
Solicited Content	140	0	140
	100.0%	0.0%	100.0%
Column total	2523	33	2556
	98.7%	1.3%	100.0%

Table S8

Cross tabulation: Sample location stated as a function of lead author position

Lead author position	Was sample location stated?		Row total
	0: No	1: Yes	
1: Student	1070	483	1553
	68.9%	31.1%	100.0%
2: Post-doc	158	60	218
	72.5%	27.5%	100.0%
3: Tenure-track faculty	129	76	205
	62.9%	37.1%	100.0%
4: Tenured faculty	126	64	190
	66.3%	33.7%	100.0%
5: Other	207	116	323
	64.1%	35.9%	100.0%
Column total	1690	799	2489

Table S9

Cross tabulation: Sample location stated as a function of location of lead author's institution

Institution location	Was sample location stated?		Row total
	0: No	1: Yes	
0: Rest of World	358	272	630
	56.8%	43.2%	100.0%
1: USA	1388	566	1954
	71.0%	29.0%	100.0%
Column total	1746	838	2584

Table S10

Cross tabulation: Shared materials as a function of lead author position

Lead author position	Shared materials?		Row total
	0: No	1: Yes	
1: Student	1426	76	1502
	94.9%	5.1%	100.0%
2: Post-doc	196	7	203
	96.6%	3.4%	100.0%
3: Tenure-track faculty	191	10	201
	95.0%	5.0%	100.0%
4: Tenured faculty	180	10	190
	94.7%	5.3%	100.0%
5: Other	299	20	319
	93.7%	6.3%	100.0%
Column total	2292	123	2415

Table S11

Cross tabulation: Shared materials as a function of location of lead author's institution

Institution location	Shared materials?		Row total
	0: No	1: Yes	
0: Outside of Europe	2184	109	2293
	95.2%	4.8%	100.0%
1: Europe	193	18	211
	91.5%	8.5%	100.0%
Column total	2377	127	2504

Table S12

Cross tabulation: Preregistration practices as a function of lead author position

Lead author position	Preregistered?		Row total
	0: No	1: Yes	
1: Student	1521	34	1555
	97.8%	2.2%	100.0%
2: Post-doc	208	11	219
	95.0%	5.0%	100.0%
3: Tenure-track faculty	203	3	206
	98.5%	1.5%	100.0%
4: Tenured faculty	192	0	192
	100.0%	0.0%	100.0%
5: Other	322	8	330
	97.6%	2.4%	100.0%
Column total	2446	56	2502

Table S13

Cross tabulation: Preregistration practices as a function of location of lead author's institution

Institution location	Preregistered?		Row total
	0: No	1: Yes	
0: Outside of Europe	2332	39	2371
	98.4%	1.6%	100.0%
1: Europe	209	17	226
	92.5%	7.5%	100.0%
Column total	2541	56	2597

Table S14

Cross tabulation: Replication study as a function of lead author position

Lead author position	Replication study?		Row total
	0: No	1: Yes	
1: Student	1535	20	1555
	98.7%	1.3%	100.0%
2: Post-doc	215	4	219
	98.2%	1.8%	100.0%
3: Tenure-track faculty	205	1	206
	99.5%	0.5%	100.0%
4: Tenured faculty	188	4	192
	97.9%	2.1%	100.0%
5: Other	326	4	330
	98.8%	1.2%	100.0%
Column total	2469	33	2502

Table S15

Cross tabulation: Replication study as a function of location of lead author's institution

Institution location	Replication study?		Row total
	0: No	1: Yes	
0: Outside of Europe	2340	31	2371
	98.7%	1.3%	100.0%
1: Europe	223	3	226
	98.7%	1.3%	100.0%
Column total	2563	34	2597

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