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Running through the Who, Where, and When: A Cross-cultural Analysis of Situational Changes in Comics
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ABSTRACT
Understanding visual narratives requires readers to track dimensions of time, spatial location, and characters across a sequence. Previous work has found situational changes across adjacent panels differ cross-culturally, but few works have examined such situational dimensions across extended sequences. We therefore investigated situational "runs" – uninterrupted sequences of the situational dimensions (time, space, characters) – in a corpus of 300+ annotated comics from the United States, Europe, and Asia. We compared runs' proportion and average lengths and found that across books, semantic information changed frequently and run length correlated with proportion. Yet, cross-cultural patterns arose, with American and European comics using more continuous runs than Asian comics. American and European comics also used more and longer temporal and character continuity, while Asian comics used more spatial continuity. These findings raise questions about comprehenders' processing strategies of visual narratives across cultures and how general frameworks of visual narrative comprehension account for variations in situational (dis)continuity.

To understand visual narrative sequences, as in comics or picture books, comprehenders build a mental model of the situation portrayed in the sequence (Cohn, 2019, 2020b; Dijk & Kintsch, 1983; Huff et al., 2020; Loschky et al., 2020). This mental model is constructed out of the ongoing changes to the occurrences in a story, which requires being updated with incoming information as the narrative progresses. While previous studies have examined how comprehenders process this incoming information in visual sequences (Cohn & Paczynski, 2013; Huff et al., 2020; Magliano et al., 2017, 2016), few works have analyzed how visual narratives themselves facilitate this incremental flow of information. In other words, how does meaningful information shift across sequencing in actual visual narratives? If we are to understand how people understand visual sequences, it is important that we also know the properties of the visual sequences that are being comprehended. Here we compare this flow of information across a corpus consisting of roughly 300 annotated comics from the United States of America (USA), Europe, and Asia.

Theories of visual narrative comprehension detail how mental models, or situation models, are constructed for sequential images. As schematized in Figure 1a, at each panel in a visual narrative sequence, readers extract information from the visual surface of an image, which is then connected to representations in semantic memory (Cohn, 2020b; Loschky et al., 2020). This information is fed into a situation model, which incorporates the relevant story elements such as locations, characters, objects, etc. (Dijk & Kintsch, 1983; Gernsbacher, 1997a; Zwaan & Radvansky, 1998). With each subsequent panel, that situation model is updated to accommodate the incoming information (Cohn, 2020b;
Gernsbacher, 1997b; Loschky et al., 2020). More discontinuous information requires greater updating processes (Huff et al., 2014; Hutson et al., 2018; Manfredi et al., 2017), and significant changes may sponsor a shift to a new model to reflect the (new) scene (Gernsbacher, 1997b; Loschky et al., 2020).

While mental model construction applies to all types of media comprehension, visual narrative sequences also have their own affordances for sequential mapping. At the most basic level, to form a coherent situation model, readers need to understand that the characters in the second panel in Figure 1a are the same as the characters in the next panel(s), despite the apparent visual dissimilarities. This coreference across panels has been called the continuity constraint (Cohn, 2020a). Similarly, readers need to be able to map different moments or parts of an action across panels into one larger event. Cues signaling changes in states form the activity constraint (Cohn, 2020a). While these concepts might appear simple to comprehend, recognition of these constraints by children typically develops around or after the age of four and adults not familiar with visual narratives may still struggle with them (Cohn, 2020a). Exposure and practice with visual narratives thus modulates the ability to construct a coherent situation model.

Situation models incorporate the meaningful story elements, such as locations, characters, objects, motivations, events, etc. (Gernsbacher, 1997a; Zacks et al., 2007; Zwaan & Radvansky, 1998). The closing and reopening of (new) models rely on sufficient change across any or various of such situational aspects (Zacks et al., 2009), and each one may contribute in a slightly different manner. Research on film editing showed that discontinuities in action signals segmentation more than discontinuities in space and time (Magliano & Zacks, 2011).
Shifts in time alone were also sufficient to convey a new situation, while shifts in locations were not, unless combined with time changes (Magliano et al., 2001). Character and object changes also appeared as strong indicators of event segmentation in film, and seemed even more successful than changes across goals in written narratives (Zacks et al., 2009).

This research suggests then that situational dimensions vary in the ways they cue segmentation. Intuitively, we may connect this with a presupposition that situational factors evoke different expectations in a narrative. In most storytelling media, time is naturally presumed to progress continuously (Zwaan, 2004), which could naturally emphasize discontinuities in temporal progression as more divergent. Within a certain time frame, a story may more easily be expected to switch between spaces, as events can unfold across multiple locations in a consecutive timeframe (Magliano et al., 2001). Within and across those locations then, a narrative could switch even more easily between its characters and objects, as multiple people and things inhabit such locations. These observations may suggest a hierarchical organization for situational changes in visual narrative sequences.

Consider the sequence illustrated in Figure 1b. The changes in event states across panels imply a continuous progression of time, while the location shifts from the first panel to the second (i.e., from somewhere on the street to an apartment building), thus being discontinuous. Likewise, from the first panel to the second, and from the second to the third, the sequence alters the characters we see. The first panel shows one character, while the second shows none and the third introduces two other characters, thus constituting two discontinuous transitions.

While studies of comprehension processes have underscored how readers perceive these cues, fewer studies have analyzed how actual visual narrative sequences themselves are structured. Indeed, cross-cultural variation in sequential image structures has been shown to create demands on processing strategies across readers exposed to those different cultural conventions (Cohn & Kutas, 2017). These corpus analyses have characterized the amount and types of discontinuity across panels that readers need to process. In the earliest of these approaches, McCloud (1993) found that sequencing in American and European comics showed more action-related transitions than ones related to characters or scenes. Both diverged from Japanese manga, which showed fewer action-related transitions and more transitions between characters. Unlike American or European comics, manga also used panels showing various aspects of the surrounding environment of a scene.

More substantive corpus analyses have shown similar results by comparing books within the more extensive Visual Language Research Corpus (VLRC) which includes annotations of over 300 comics from the United States, Europe, and Asia (Cohn, 2020a; Cohn et al., In prep). This corpus includes analysis of three primary situational dimensions: changes between characters, spatial locations, and states of time. Consistent with other discourse studies (Magliano et al., 2001; Magliano & Zacks, 2011; Rinck & Weber, 2003; Zacks et al., 2009) these situational changes were considered nonexclusive, as multiple dimensions could shift simultaneously. Spatial location and character changes were also considered nonbinary since these could also be incremental. Consider Figure 1b, where a partial spatial change occurs (moving from the outside of the apartment building to the inside, rather than to a different house/location), and partial character change maintains one character while not repeating another. In this analysis, Asian comics had comparatively fewer time changes along with more changes between characters than was found in European or American comics. Further studies both using the VLRC and outside it have shown that, for American comics, frequency of these situational changes have developed over time (Bateman et al., 2021; Cohn, 2020a; Cohn et al., 2017), possibly due to the influence of manga (e.g., Cicci, 2015). These studies thus suggest that comics from varying places may have distinct flows of information across panels, and either single or multiple aspects may change across panels.
Though this previous work analyzed situational changes across adjacent panels, it did not address situational continuity across extended sequences. Tseng et al. (Tseng & Bateman, 2018; Tseng et al., 2021, 2018) have explored “cohesive chains” across various media like comics and film, modeling how readers may perceive cues that relate to a contiguous representation. Repetitions of (parts of) the same character constitute a chain of identity, and such chains are also formed for objects, places, or events. Additional computational work using “run theory” has translated comics into binary elements, specifically the degree to which the distribution of appearances of the lead character strayed from “perfect” randomness (Laraudogoitia, 2008, 2009). Based on this, we here adapt the term of a run to refer to an uninterrupted string of the same representation, meaning that two or more consecutive panels repeat the same spatial location and/or character(s). For example, Figure 1b has a “time run” of six panels long, while the “space run” involves four panels and characters have a run of two consecutive panels.

To further analyze the flow of information across the structure of visual narrative sequencing, we analyzed situational runs in annotations of 342 comics from the VLRC (Cohn et al., In prep). Given previous corpus work supporting cross-cultural differences regarding situational changes (Cohn, 2020a; McCloud, 1993), we expect similar patterns for runs of continuity. For this, we consider the three main situational factors of time, space, and characters, as consistently effective cues for event segmentation (Magliano et al., 2001; Zacks et al., 2009), which are consistent with other work on visual narrative semantics (Cohn, 2020a; McCloud, 1993). As Asian comics differ from American and European ones in how they change between states of time and/or characters (Cohn, 2020a; McCloud, 1993), similar changes are predicted in extended runs of these situational dimensions. Since Asian comics have more instances of time not progressing in a continuous manner (Cohn, 2020a; McCloud, 1993), we expected that these comics would have fewer time runs compared to American and European comics. For spatial locations, these prior corpus studies discussed comparable proportions of scene-related changes across cultures, and thus we predict similar depictions of a continuous spatial location as well. Lastly, Asian comics were shown to employ more character changes, suggesting that runs of characters would be shorter compared to American and European comics.

Method

Materials

We analyzed data from the Visual Language Research Corpus (VLRC, see http://www.visuallanguagelab.com/vlrc) by selecting comics with annotations of situational changes that occurred across panels (Cohn et al., In prep). Data collection for the whole VLRC progressed across a five-year period across several subprojects that fed into this larger corpus (for details, see Cohn et al., In prep). Books were collected through convenience sampling, which included public domain resources and donations from various comic companies. For the current study’s corpus, the inclusion of the necessary data was the main principle of selection. The result of this selection consisted of 342 books (out of originally 362 books) from nine countries with a total of 55,094 panels across 7,236 pages (see Table 1), which amounted to a sufficiently diverse corpus that suited our cross-cultural research objectives. Annotations in the VLRC were done by 12 coders who had all completed at least one prior course in visual language theory (Cohn, 2013a). All coders underwent training and practice sessions where they had to reach a threshold of 80% agreement before being allowed to annotate for the main corpus. Coders annotated books that suited their given subprojects.
Our analysis focused on comic books within the corpus (excluding strips) that were annotated with properties of situational changes. This included comics from Europe (Sweden, The Netherlands, Belgium, Germany, France), Asia (China, Korea, Japan), and several subgenres of comics from the United States. While we do not subdivide countries into their subgenres here, we make an exception for original English language (OEL) manga, which are comics created by English speakers, but with the intent to have manga-like structures (i.e., aiming to use the Japanese visual language originating in manga). Prior work has suggested that OEL manga share features of both Japanese and American comics (Cohn, 2020a), so they were included here to compare against those two countries. As these comics come from one country (the USA) but ostensibly aim to use the structure characteristic of another country (Japan), it may be informative about how properties of visual narratives might interact across cultures.

### Areas of analysis

We did calculations based on two properties of the semantic changes within visual narratives, namely frequencies of situational runs (how often did runs occur in a book) and total run lengths (the total amount of panels that were part of a run). Other relevant categories already included in the existing dataset were the country where the comic was published, the number of panels per book, and the categories of situational changes.

We analyzed three dimensions of situational change: time, spatial location, and characters. When no time passed between panels or the situation was ambiguous this was coded with a 0, while “time changes” (1) were judged as a progression between narrative moments. Most often, this applied when the time in one panel followed that of the previous panel, resulting in seemingly consecutive moments, but this also included nonchronological transitions (e.g., flashbacks, flashforwards, etc.). The guiding principle here was whether there was determinable change between the temporal states (1) or not (0). Because changes in “time” are typically considered as normative between panels in visual narratives, we considered time changes as a feature of continuity, while changes in spatial location and characters were discontinuities. Hence, “spatial location change” was analyzed by assessing whether panels depicted the same location as the previous panel (0 = no change), showed a partial change that still maintained some contiguity between spaces (0.5, e.g., switching rooms within a building), or showed a different location (1 = full change, e.g., depicting a room inside one building and then another building). There was only change if the graphic information in the panels showed change explicitly, meaning that temporarily omitted backgrounds were considered as continuing the previous depicted location. When a next panel would then show a background, change (or lack thereof) would be annotated. Likewise, “character change” referred to whether the

### Table 1. Overview of the comics selected from the visual language research corpus.

<table>
<thead>
<tr>
<th>Country</th>
<th>Region</th>
<th>Years</th>
<th>Number of comics</th>
<th>Total pages</th>
<th>Total panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>Europe</td>
<td>1994–2011</td>
<td>23</td>
<td>384</td>
<td>1,532</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>Europe</td>
<td>1946–2016</td>
<td>41</td>
<td>809</td>
<td>6,788</td>
</tr>
<tr>
<td>Belgium</td>
<td>Europe</td>
<td>1954–2016</td>
<td>40</td>
<td>633</td>
<td>6,560</td>
</tr>
<tr>
<td>Germany</td>
<td>Europe</td>
<td>1990–2010</td>
<td>19</td>
<td>450</td>
<td>1,680</td>
</tr>
<tr>
<td>China</td>
<td>Asia</td>
<td>2002–2015</td>
<td>13</td>
<td>349</td>
<td>2,212</td>
</tr>
<tr>
<td>Korea</td>
<td>Asia</td>
<td>2003–2010</td>
<td>15</td>
<td>326</td>
<td>2,227</td>
</tr>
<tr>
<td>Japan</td>
<td>Asia</td>
<td>1981–2014</td>
<td>70</td>
<td>1,453</td>
<td>14,045</td>
</tr>
<tr>
<td>USA (OEL manga)</td>
<td>United States</td>
<td>2003–2014</td>
<td>17</td>
<td>406</td>
<td>3,436</td>
</tr>
<tr>
<td>USA</td>
<td>United States</td>
<td>1997–2014</td>
<td>79</td>
<td>1,827</td>
<td>10,956</td>
</tr>
</tbody>
</table>
panel showed exactly the same character(s) as its previous panel (0 = no change), whether the panel showed some continuous character(s) while other characters changed (e.g., being either added or omitted; 0.5 = partial change), and last, whether all characters changed relative to the previous panel (1 = full change). Here too, annotations were based on explicit graphic depictions, focusing purely on character presence, regardless of how much of the character was shown. As such, transitions from depicted characters to off-panel figures (such as those implied by speech balloons) were seen as omitting characters, thus constituting partial or full change.

To analyze situational runs, we looked for panels annotated with a “0” for spatial locations and characters, and a “1” for time. Spatial location and character runs were defined as where semantic information was maintained across a sequence of panels. A single “0” annotation would thus be a two-panel sequence maintaining similar situational dimensions. Two consecutive “0” annotations would then involve a three-panel sequence, etc. For time, a run was defined as a normative progression of time; therefore, we considered annotations of a “1” instead of a “0.” Runs were analyzed for each type of the situational changes.

As situational dimensions have also been shown to change simultaneously, we also considered certain interactions. First, a completely continuous run was defined as a sequence of panels with time changes but neither spatial location nor character changes. Second, a discontinuous run was in case both spatial locations and characters change while time does not. With these types, together with the individual categories of time, spatial location, and characters, we analyzed five types of runs.

**Data analysis**

We computed the average frequencies of our two areas of analysis (frequency of runs and total amount of run panels) that could be compared across books of different lengths. We created two new variables that were used to analyze the data: average run length per book and proportion of run panels per book. Average run length was calculated by dividing the total run length per book by the frequency of runs in that book. Run panel proportion was calculated by dividing the total run length in a book by the total number of panels per book. Together, these measures aimed to capture how long continuity persisted in an uninterrupted string (average run length) and how many panels of the book in total were part of such sequences (run panel proportion). This way, we accounted for books that included just one or a few long continuous sequences as well as books that included many short continuous sequences.

Our data analysis first considered the five types of runs in general, collapsing across countries. Afterward, cross-cultural variation was considered. We therefore conducted linear mixed models to investigate whether the average run lengths and run panel proportions differed across cultures. The cross-cultural analysis compared comics from Europe and Asia, collapsing across individual countries given results of prior research (Cohn, 2020a), and comics from the United States, collapsing across genres (with one exception; see below). The different run types were the dependent variables for each analysis, with region set as the fixed effect and books as random effect. Figures were created in R version 4.0.3 (R Core Team, 2020), using RStudio (RStudio Team, 2022), the tidyverse package version 1.3.1 (Wickham et al., 2019) and the ggsignif package version 0.6.3 (Ahlmann-Eltze & Patil, 2021).

We chose targeted contrasts as informed by previous research (Cohn, 2020a; McCloud, 1993). Our first comparison was between comics from the United States and Asia, along with a separate classification of OEL manga, which may be informative in relation to comics from Asia (specifically Japan) and the United States. We also contrasted comics from the United States and Asia against Europe. This was to investigate whether these continental groupings differ in their situational runs, given that prior work has shown clustering across these broader groupings in analyses of semantic changes (Cohn, 2020a).
Results

Overall analysis

We first asked whether the average length of runs and the run panel proportions per book differed across instances of (dis)continuity and situational aspects (Figure 2). Completely continuous runs spanned an average length of 2.62 panels, with maximally 20 run panels in a sequence. Roughly one third of the total panels in a book were part of a continuous run (36.54%). Completely discontinuous runs were shorter, as the average length of a discontinuity run was 2.08 panels, and the maximum amount of sequential run panels was 15. Here, only 13.87% of panels in a book was part of a discontinuous run.

Further analyses examined each type of situational run. Time runs had an average length of 11.63 panels, with 73 panels maximum in a run (which was the maximum number of panels in a run considered in our analysis). Across books, a large proportion of panels were part of a time run (84.65%). Spatial location runs were similar, with also a maximum of 73 panels and a similar run panel proportion (85.25%). However, they were a bit shorter, with an average length of 7.09 panels. Character runs were the shortest and constituted the least number of panels, with an average run length of 2.90 panels, a maximum number of 22 panels, and almost half of the total panels in a book as part of a run (46.07%).
We also asked whether run panel proportion had a relationship to average run length (Figure 3). A positive correlation, \( r(1024) = .33, p < .001 \), suggested that a greater amount of run panels in a book aligned with longer sequences of runs. In other words, when a book used many panels in runs, they were often within longer runs.

**Cross-cultural analysis**

Next, we asked whether these runs differed across cultures. Our primary analysis here focused on contrasts between Asia, Europe, and the United States, along with additional examination of OEL manga vs books from Asia or the United States.

**Average run panel lengths**

For the completely continuous runs, discontinuous runs, and each of our situational categories, we fit a linear mixed model predicting average run panel with a fixed effect of region and a random effect of books. The model was significant for the interaction type of complete continuity, \( F(3, 336.99) = 5.39, p = .001 \), and complete discontinuity, \( F(3, 2.62) = 17.58, p = .029 \). It was also significant for the three situational runs: time, \( F(3, 337.98) = 11.18, p < .001 \), spatial location, \( F(3, 336.99) = 15.57, p < .001 \), and character, \( F(3, 337.00) = 8.76, p < .001 \). Table 2 lists the significant post hoc contrasts for our data, and Figures 4 and 5 illustrate the average run lengths per region for the completely (dis)continuous runs and each of the situational categories, respectively.

![Figure 3. Correlation between run panel proportion and average run length.](image)

**Table 2.** Significant post hoc contrasts for the interaction types of complete continuity and complete discontinuity and the three situational categories of time, spatial location, and characters regarding average run lengths.

<table>
<thead>
<tr>
<th>Interaction type/ Situational category</th>
<th>Contrast</th>
<th>Estimate</th>
<th>SE</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuity</td>
<td>Asia vs USA</td>
<td>−0.309</td>
<td>0.089</td>
<td>−3.457</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>Asia vs Europe</td>
<td>−0.273</td>
<td>0.077</td>
<td>−3.542</td>
<td>.002</td>
</tr>
<tr>
<td>Discontinuity</td>
<td>Asia vs Europe</td>
<td>0.572</td>
<td>0.098</td>
<td>5.852</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>USA vs Europe</td>
<td>0.624</td>
<td>0.104</td>
<td>5.981</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time</td>
<td>Asia vs Europe</td>
<td>−11.572</td>
<td>2.17</td>
<td>−5.333</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>USA vs Europe</td>
<td>−8.939</td>
<td>2.322</td>
<td>−3.850</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Spatial location</td>
<td>Asia vs USA</td>
<td>3.212</td>
<td>0.535</td>
<td>6.000</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Asia vs OEL manga</td>
<td>3.087</td>
<td>0.930</td>
<td>3.319</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Asia vs Europe</td>
<td>2.626</td>
<td>0.462</td>
<td>5.689</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Character</td>
<td>Asia vs USA</td>
<td>−0.327</td>
<td>0.093</td>
<td>−3.497</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>Asia vs Europe</td>
<td>−0.398</td>
<td>0.081</td>
<td>−4.937</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>
As shown in Figure 4 (statistics in Table 2), American and European comics had the longest run lengths of complete continuity, in relation to Asian comics. In turn, Asian and American comics had the longest stretches of complete discontinuity, compared to European comics.
Broken down by each situational category (Figure 5), European comics had the longest time runs out of the three main regions. However, for spatial location, Asian comics had the longest runs, reflecting that they used longer runs compared not only to Europe and America, but also OEL manga. Lastly, the longest character run lengths appeared in American and European comics, meaning character runs in Asian comics were the shortest.

Run panel proportion

For the completely continuous runs, discontinuous runs, and each of our situational categories, we fit a linear mixed model predicting run panel proportion with a fixed effect of region and a random effect of books. The model was again significant for all run types. For the interaction types, this concerned complete continuity, $F(3, 336.99) = 26.483, p < .001$, and complete discontinuity, $F(3, 336.48) = 31.07, p < .001$. For each situational category, the model was significant for time runs, $F(3, 337.00) = 3.46, p = .017$, spatial location runs, $F(3, 336.99) = 3.167, p = .025$, and character runs, $F(3, 337.00) = 23.844, p < .001$. Table 3 below lists the significant post hoc contrasts for our data, and Figures 6 and 7 illustrate the run panel proportions per region for the completely (dis)continuous runs and each of the situational categories, respectively.

**Table 3.** Significant post hoc contrasts for the interaction types of complete continuity and complete discontinuity and the three situational categories of time, spatial location, and characters regarding run panel proportions; marginally significant results italicized.

<table>
<thead>
<tr>
<th>Interaction type/ Situational category</th>
<th>Contrast</th>
<th>Estimate</th>
<th>SE</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuity</td>
<td>Asia vs USA</td>
<td>−15.221</td>
<td>2.380</td>
<td>−6.396</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Asia vs OEL manga</td>
<td>−9.541</td>
<td>4.135</td>
<td>−2.307</td>
<td>.063</td>
</tr>
<tr>
<td></td>
<td>Asia vs Europe</td>
<td>−17.654</td>
<td>2.053</td>
<td>−8.601</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Discontinuity</td>
<td>Asia vs USA</td>
<td>−6.349</td>
<td>1.578</td>
<td>−4.024</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Asia vs Europe</td>
<td>7.244</td>
<td>1.360</td>
<td>5.325</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>USA vs Europe</td>
<td>13.593</td>
<td>1.455</td>
<td>9.341</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time</td>
<td>Asia vs USA</td>
<td>−7.718</td>
<td>3.083</td>
<td>−2.503</td>
<td>.049</td>
</tr>
<tr>
<td></td>
<td>USA vs Europe</td>
<td>7.474</td>
<td>2.845</td>
<td>2.627</td>
<td>.043</td>
</tr>
<tr>
<td>Spatial location</td>
<td>Asia vs USA</td>
<td>6.582</td>
<td>2.144</td>
<td>3.070</td>
<td>.011</td>
</tr>
<tr>
<td>Character</td>
<td>Asia vs USA</td>
<td>−13.077</td>
<td>2.390</td>
<td>−5.471</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Asia vs Europe</td>
<td>−17.021</td>
<td>2.061</td>
<td>−8.257</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

**Figure 6.** Run panel proportions for (a) completely continuous runs, and (b) completely discontinuous runs.
As depicted in Figure 6 (statistics in Table 3), the greatest proportions of completely continuous run panels were found in European and American comics, which did not differ from each other, but both differed from the amount used in Asian comics. OEL manga also included more continuous run panels than Asian comics. For complete discontinuity, the largest proportion was found in American comics, followed by Asian, and then European ones.

Regarding each situational category (Figure 7), comics from the United States had the greatest proportion of time run panels out of the three main regions. Thus, even though Europe had longer time run lengths on average, American comics included higher proportions of run panels overall. For spatial location, Asian books had more spatial location run panels per book than those from the United States. European comics appeared to fall somewhere in the middle, as they did not differ from Asian or American comics. The final category again reflected the dynamics of the average lengths, namely, both American and European comics had greater proportions of character run panels than Asian comics.

**Discussion**

This study investigated the flow of information across panels in comics from the United States, Europe, and Asia by analyzing runs of complete continuity, complete discontinuity, and the situational aspects of time, spatial location, and characters. We found complete continuity persisting more than complete discontinuity, and a distinct organization of time, spatial location, and character runs. We also found cross-cultural variation as different patterns emerged for the
regions. As predicted, our results were similar to previous findings of situational changes across panels differing cross-culturally (Cohn, 2020a; McCloud, 1993). Below, we first consider the implications of our results on visual narrative sequencing in general, and then turn to our cross-cultural analysis.

Across all books, semantic information across panels appeared to change frequently, as stretches of complete continuity were relatively short – only just above two panels long. Few sequences maintained the same depicted spatial location and characters simultaneously with consecutive events. Still, those occurrences were more constant than stretches of complete change, where time was halted, and locations and characters changed with each panel. This implies that continuous sequences are punctuated with discontinuity, but with continuity persisting overall. This would be consistent with what we might view from a perspective of event comprehension (Zacks et al., 2009), such as with discontinuous relations marking the coarse-grained boundaries between discourse units.

Moreover, analysis of individual situational dimensions suggested a graded relationship between character, spatial location, and time changes, in line with previous research showing the varying effectiveness of situational factors (Magliano et al., 2001; Magliano & Zacks, 2011; Zacks et al., 2009). Time runs were the longest and took up the largest portion per book, meaning that many panels in succession and many panels per book were involved in consecutive moments. Spatial location runs were not as long as runs of temporal continuity, but similarly involved many panels per book, reflecting longer stretches of spatial continuity. Finally, character runs were considerably shorter and took up the least number of panels per book.

Altogether, these relative frequencies of situational continuity reflect the speculated hierarchic structure that characters change or persist within spatial locations, and those spatial continuities are embedded within longer temporal continuities. However, we should take note here that temporal continuity was conceptualized in a different manner than character and spatial continuity. While continuity was analyzed for spatial locations and characters based on visual depictions of the content, temporal continuity required some inferable change, as time naturally progresses, and stagnation was therefore considered the more discontinuous occurrence. This complicates comparing the three dimensions as equal aspects of one hierarchical organization. Nevertheless, the notion of time as a higher level situational feature resonates with prior research that found temporal discontinuity a more dominant cue for event segmentation (Magliano et al., 2001), and which treated annotation of time (dis)continuities the same as its other situational factors.

These relative manifestations of situational aspects within the visual narratives’ sequencing could potentially inform expectations of comprehenders. In film studies, shifts in time alone conveyed situational change, while shifts in locations were often combined with time changes (Magliano et al., 2001). This implies that temporal changes are more impactful as a cue for event segmentation than spatial location changes. Similarly, in verbal narratives, time shifts increase processing load more so than spatial shifts (Rinck & Weber, 2003). For visual narratives, as informed by our results, frequent time discontinuities could be more challenging to process than frequent discontinuities in locations or characters. Future work could test these effects on processing by comparing whether no shifts, few shifts, and frequent shifts across a sequence in a visual narrative are more demanding depending on the situational dimension that changes.

Our analysis also found cross-cultural variation of complete (dis)continuity and individual situational categories. Overall, Asian comics were the most discontinuous, and appeared to change information the most across panels. Both American and European comics had longer sequences of complete continuity than Asian comics, while Asian comics displayed more constant change than European comics. In contrast, European comics changed information the least. Interestingly, American comics were more versatile, portraying similar continuity run lengths and proportions to European comics, but also similar discontinuity lengths and even larger discontinuity proportions than Asian comics. This suggests that comics from the United
States strike a balance between sustaining and changing the situational elements across panels. Alternatively, some American comics may reflect patterns more similar to European comics, while others reflect patterns closer to Asian comics, perhaps dividing across subgenres (Cohn, 2020a).

Further insight arose from analysis of each situational dimension. Our predictions for time runs were partially confirmed, as Asian comics differed in situational changes from both the United States and Europe, but in different ways. American comics involved more panels in time runs per book compared to Asian comics, but then both had similar sequence lengths. For European comics it was the reverse: they had longer average run lengths than Asian comics, but involved similar numbers of panels in runs overall. Concerning spatial location, we expected similar flows of information across cultures as in prior analyses of adjacent panels (Cohn, 2020a; McCloud, 1993). This prediction was again partially confirmed: Asian comics were similar in their number of panels involved in spatial runs to European comics but involved more spatial run panels per book than comics from the United States. In addition, Asian comics maintained longer spatial runs than both American and European comics. Last, the results for character runs did fully adhere to expectations; namely, Asian comics changed characters more often between panels than comics from the United States and Europe. Altogether, our findings indicate that Asian comics used more time and character changes, but fewer shifts in spatial location compared to comics from the United States and Europe.

An additional comparison with OEL manga lent further insight into the interactions between types of comics and the cultures in which they were created. We found two ways where OEL manga differed from Asian comics and coincided with those from the United States and Europe. First, like other comics from the United States, OEL manga had slightly more panels involved in complete continuity runs than Asian comics. Second, also like American and European comics, OEL manga had shorter spatial runs than Asian comics. In these regards, American creators of OEL manga appear more like other creators from the United States than those from Asia. Yet, as there were no significant contrasts related to either time or character runs, OEL manga remain somewhat similar to both Asian and American comics. This suggests either that these works have a hybrid nature, or that within our dataset some works are more similar to one type or another, as in prior clustering analysis of OEL manga (Cohn, 2020a).

These findings of situational continuity across cultures can connect to findings related to the attentional framing of panels, i.e., the amount of information depicted in a scene (Cohn, 2011, 2020a; Cohn et al., 2012). Prior work has shown that American (and European) comics use more panels depicting multiple active characters, while Asian comics use more panels depicting single characters, zooms of single characters, or panels of just the environment without characters. These framing differences align well with our findings of continuity. The longer length of continuity runs for European and American comics, specifically with longer character and time runs, well aligns with the idea that they are showing more information in their panels for a longer length of a sequence. In contrast, the greater discontinuity of characters in Asian comics is consistent with the idea of portraying panels with more single characters since panels would then shift between different characters. Thus, our findings reinforce the idea that differences arise in the structure of storytelling from different cultures’ visual narratives.

These cross-cultural variations within comics imply the potential for differences in the structures that readers of those books bring to bear on their comprehension. Readers of distinct cultures may adopt processing strategies optimized for the structure of the visual narratives that they read. This then also suggests that visual narrative sequences from cultures with unfamiliar patterns could pose challenges for comprehension. For example, if someone often reads American comics that maintain continuity across longer sequences, then the increase of discontinuity in Asian manga might become more demanding. Previous experimental work has suggested that comprehenders’ processing of sequences indeed are affected by the structure of the comics they read (Cohn & Kutas, 2017; Foulsham & Cohn, 2020).

It is thus worth considering how our corpus findings may inform general theories of (visual) narrative comprehension. Recent work has posited general frameworks for situation model construction for visual narratives (Cohn, 2020b; Loschky et al., 2020). While we would not predict qualitatively different processes
at work, our corpus analysis implies that how those general notions are implemented may change depending on the type of comic being engaged. As previous work indicated, greater discontinuity can motivate greater updating processes (Huff et al., 2014; Hutson et al., 2018; Manfredi et al., 2017), with large amounts of discontinuity prompting the shift to a new model (Gernsbacher, 1997b; Loschky et al., 2020). Under this view, more incongruous information requires more effort to integrate, meaning that the greater discontinuities in manga may be more demanding, particularly for readers familiar with the relatively continuous American and/or European narratives. However, it is also possible that frequent readers of manga could habituate to such discontinuities through the structures in their sequences, thereby making the demands of updating situation models in the face of such discontinuity easier to process. For such readers, it might be possible that long runs of continuity may then create additional demands. Indeed, character changes have been seen to evoke greater neural responses associated with updating processes in studies of event-related potentials (P600s) for participants with less experience with manga reading while growing up (Cohn & Kutas, 2017). Our corpus results therefore could be informative for further investigation of visual narrative comprehension across cultures, and for substantiating the degree to which general theories of processing apply broadly to characterize such potential variation.

For example, these cross-cultural patterns may interact with more global tendencies in the situational dimensions of sequencing. Overall, we found a consistent trend for maintaining a distinction between temporal, spatial, and then character continuity. Comprehenders thus may have a baseline preference for the relative costs of comprehending different types of situational change, with discontinuities in characters being the least demanding compared to changes in spatial location or time discontinuities. Therefore, there may be a tension in comprehension between how these global preferences might interact with the variation found cross-culturally for situational changes. Future psychological work could investigate how readership of different types of comics may entrain people to process sequences in particular ways.

These results both align with general models of event comprehension and raise further questions. According to discourse models, greater discontinuity across situational aspects would constitute greater cues for event segmentation (Magliano et al., 2001; Zacks et al., 2009). As such, our examples of complete discontinuity would likely constitute coarse segmentation boundaries (see Magliano & Zacks, 2011; Zacks et al., 2007), as would presumably other dense combinations of situational shifts (e.g., Figure 1, where intuitively, concurrent discontinuities across space and characters appear more effective than individual instances). However, our cross-cultural findings illustrate variance in situational runs, which suggests that authors (and readers) of these varying comics encode patterns related to these types of storytelling. As most models of discourse comprehension focus on the general processes of segmentation and updating as prompted by situation changes (Gernsbacher, 1997a; Zacks et al., 2007; Zwaan & Radovsky, 1998), there remains little explanation of how such situational patterns would be stored cognitively. If indeed structures of this nature are encoded, this poses questions for theories of discourse as to what patterns of information would be stored by readers/authors.

However, such discontinuity may not be the only driving force in comprehension. For example, visual narrative constructions inherently involve discontinuity such as flipping back and forth between characters (Cohn, 2013b), which do not motivate consistent segmentation (Cutting, 2019). In addition, narrative categories and their relationships have actually been shown to be more predictive of sequential segmentation than situational discontinuity (Cohn & Bender, 2017). Finally, in the context of visual narratives in comics, physical cues of the layout may also function as prosodic cues for the division of meaningful information. For example, in Figure 1b the first and second panels come from different pages, which may elicit a physical segmentation between images, aligning with the situational changes. These narrative and layout structures, which do use attested encodable patterns, thus may provide a scaffolding to help guide situational discontinuities. This is consistent with the idea that visual narratives involve a parallel architecture of structures which coalesce throughout the comprehension process (Cohn, 2020a).

In conclusion, our corpus work investigated situational continuity in comics both in general and cross-culturally by comparing books from the United States, Europe, and Asia. Across countries, comics maintained complete situational continuity only for short sequences, with runs of temporal continuity being longer than those of spatial continuity, which were in turn longer than runs of character continuity.
Our cross-cultural findings aligned with prior observations of meaningful changes across adjacent panels (Cohn, 2020a; McCloud, 1993), with greater temporal and character continuity maintained in comics from Europe and the United States compared to those from Asia, but not spatial continuity. These findings reinforce prior work showing cross-cultural differences between comics, particularly contrasts between Asian and European/American storytelling. Such work further raises questions about the processing strategies that readers use in processing such patterns, and the degree to which models of comprehension characterize the construction of situational (dis)continuity.

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