Navigating comics II: Constraints on the reading order of comic page layouts

Neil Cohn and Hannah Campbell
Institute for Neural Computation, University of California, San Diego

Corresponding author:
Neil Cohn

neilcohn@visuallanguagelab.com

www.visuallanguagelab.com

Abstract

Although readers typically believe comic page layouts should be read following the left-to-right and down "Z-path" inherited from written language, several spatial arrangements can push readers to deviate from this order. These manipulations include separating panels from each other, overlapping one panel onto another, and using a long vertical panel to the right of a vertical column to "block" a horizontal row. We asked participants to order empty panels in comic page layouts that manipulated these factors. All manipulations caused participants to deviate from the conventional Z-path, and this departure was modulated by incremental changes to spatial arrangements: the more layouts deviated from a grid, the less likely participants were to use the Z-path. Overall, these results reinforce that various constraints push comic readers to engage with panels in predictable ways, even when deviating from the traditional Z-path of written language.

Keywords: visual language; page layout; reading order; writing systems; spatial representation

With the recent rise in respectability of comics and graphic novels as forms of literature and educational material (Nalu & Bliss, 2011; Short, Randolph-Seng, & McKenny, 2013), readers are increasingly posed with understanding how to progress through the panels of comic pages. The order that we read written language is fairly straightforward—we move across a line of text until that sequence ends, and then we progress to the next line. In English, this order progresses left-to-right and down in horizontal rows, while other languages, such as written Japanese, can be read right-to-left in vertical columns. By comparison, the reading order for comics is more complex, since panels can be arranged in numerous ways across the "canvas" of a page. Indeed, previous research has shown that various conventions and Gestalt constraints push readers to deviate from the reading order inherited by text (Cohn, 2013a). Here, we examine several of these conventions more carefully to further understand the constraints on readers' navigation of comic pages, which can in turn inform the creation of comics (Abel & Madden, 2008; McCloud, 2006) and efforts for automatic conversion of comic pages into digital formats (e.g., Bares, 2008; Tanaka, Shoji, Toyama, & Miyamichi, 2007).

While authors have creatively played with comic page layouts for over 100 years, only recently has scientific attention turned to understanding how readers navigate these pages. Previous research on comic pages often stressed their relationship to meaning, such as how pages serve aesthetic functions in a story (Caldwell, 2012; Groensteen, 1999; Peeters, 1998 [1991]) or how layout may contribute to aspects of meaning (Barber, 2002). However, while content and page layout interface together in comprehension, the order of reading comic panels is not dependent on their meaning (Cohn, 2013a, 2013b, 2014). A single four-panel comic strip might be arranged horizontally, vertically, or in a 2 x 2 grid. So long as the panels are still read in the same successive order, the meaning of the sequence should not change. Rather, what changes is the physical layout of the sequence, its *external compositional structure* (ECS).

Research has only recently begun examining the principles governing the *navigation* of ECS. Typically, comic pages have been thought to use the left-to-right and down order used to read text—the "Z-path" (e.g., Abel & Madden, 2008; Bongco, 2000; Duncan, 2000; McCloud, 2000), and this order is indeed the default reading order for otherwise ambiguous grid layouts, as in Figure 1a (Cohn, 2013a). However, various manipulations to the arrangement of panels can push readers to navigate panels in alternate routes. In a prior study, we presented participants with comic page layouts where the panels were empty of content and asked them to number the order that they would read those panels (Cohn, 2013a). The largest deviation from the Z-path was found in arrangements using *blockage*, where a long vertical panel "blocks" the Z-path and pushes readers to move vertically instead of horizontally (Figure 1b). In these situations, participants only used the Z-path 31% of the time, compared to nearly 95% for panels arranged in a stereotypical grid. This effect was modulated by participants' experience with comics: Participants who never read comics were more inclined to use the Z-path than those with any comic reading experience.

In contrast to the findings of blockage situations, merely *staggering* adjacent panels seems to have much less influence on the reading order. Staggering occurs when differing panel sizes prevent the "gutter"—the space between panels—from extending contiguously between adjacent panels (Figure 1c). In essence, blockage situations exaggerate a staggering of panels, where the "blocking" panel is so long that it covers a significant space of an adjacent panel (prototypically, the length of a whole stack of panels). Yet, staggering in our prior study maintained a Z-path order of 89%—barely impacting the order compared with the large

influence of full blockage. This finding left open the question of how long a stagger needs to be to become blockage.

a. Grid   b. Blockage   c. Staggering   d. Separation   e. Overlap
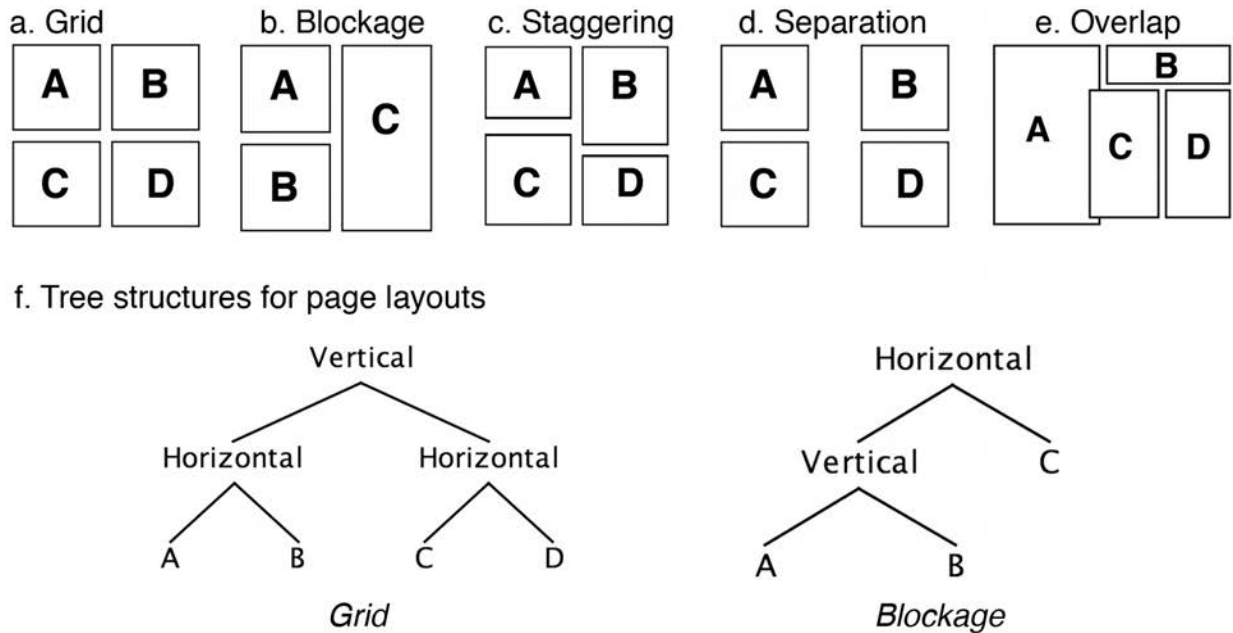
f. Tree structures for page layouts

Figure 1. Various properties of layouts in comic pages (a-e). Panels are lettered in the ways that readers most often navigate these panels. The tree structures in (f) represent the underlying cognitive organization of grid and blockage layouts.

Additional deviations in the Z-path can be motivated by various Gestalt constraints, such as proximity (e.g., Wertheimer, 1923). **Separation** of panels by increasing the size of the gutter between panels can push readers to navigate downward to the closest panel rather than jumping the gap to follow the Z-path (Figure 1d). Our prior study showed that separation situations used the Z-path 71% of the time—a clear impact, though participants still maintained the Z-path more than using an alternate path. Again though, it remains unknown how wide the separation between panels needs to be in order to push readers away from the Z-path. In the reverse proximity relationship, some panels may **overlap** other panels (Figure 1e), which in our previous study maintained the Z-path only 50% of the time. However, closer examination of these stimuli suggested that this deviation may have been influenced by confounding factors beyond the overlap, such as concurrent blockage.

Thus, several outstanding questions remain about how these factors influence the navigation of comic page layouts. Nevertheless, these early results suggested that readers use some general principles in guiding the order they move through an ECS. These constraints of **Assemblage** stipulate that readers *seek to build cohesive units of structure based on distance and coherence of composite shapes in as smooth a reading path as possible*. This principle is guided by preferences for 1) groupings of panels over non-groupings, 2) smooth paths over broken ones, 3) avoiding skipping over panels, and 4) avoiding leaving "gaps" of unread panels. These constraints therefore allow the creation of hierarchic structure for ECS, whereby horizontal rows and vertical stacks embed within each other in an overall page layout (Cohn, 2013a; Tanaka et al., 2007), as depicted in Figure 1f. Essentially, by following the principles of Assemblage,

readers are thought to construct—and seek to construct—these hierarchic groupings in the process of reading a comic page.

Here, we further explore several of these open questions about the spatial factors influencing the order in which readers navigate comic pages, using the same methods as our previous study (Cohn, 2013a). Our overarching question asked: At what point do readers switch from using a Z-path to deviating from it? We again asked participants to number how they would order empty panels in page layouts, here we carefully manipulated several arrangements using blockage/staggering, separation, and overlap arrangements. Overall, we hypothesized that incremental changes in these constraints would motivate deviation from the Z-path, yet those deviations would maintain the general principles of Assemblage.

Methods

Stimuli

We constructed three different 11-page packets containing page layouts with empty panels. Each page consisted of two different arrangements of empty, ambiguous panels, resulting in 22 separate page layouts per packet. Each arrangement used one of six templates containing either one long horizontal panel, two long horizontal panels, or a 2 x 2 grid at the top or bottom of the page (Figure 2a). The remaining open space in each of these templates (depicted in grey in Figure 2a) was then filled with one of the five manipulations to blockage (Figure 2b), one of the four manipulations to separation (Figure 2c), or one of the four manipulations to overlap (Figure 2d). Across all packets, each experimental condition was paired with each page template, resulting in a total of 65 different individual page layouts, which were randomly divided into three different lists.
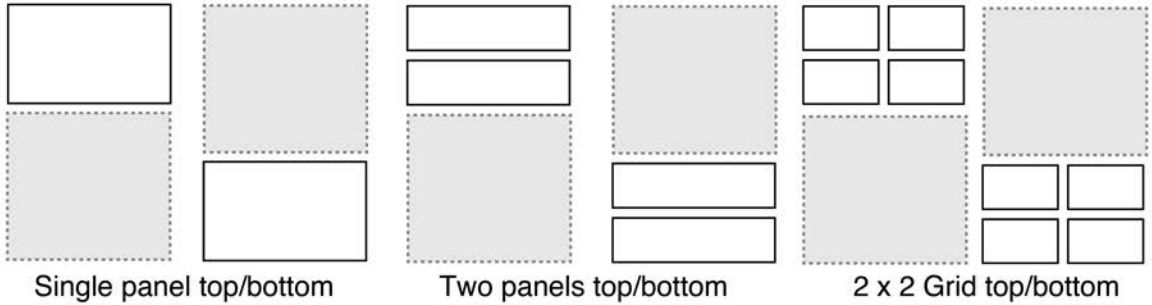
In the blockage/staggering condition, we used three leftward panels and two rightward panels. In the neutral condition (Figure 2b3), the gutter between the rightward panels aligned exactly in the middle of the central leftward panel, making it fully ambiguous between blockage and staggering. A full contrast then pulled this gutter to be fully contiguous with either the top row of panels (Figure 2b1: a grid on top, blockage on bottom) or the bottom row of panels (Figure 2b5: blockage on top, grid on bottom). Intermediate "half" manipulations then placed the gutter halfway between the neutral and top gutters (Figure 2b2) or between the neutral and bottom gutters (Figure 2c4).

In the separation condition, we used a 2 x 2 arrangement of panels and widened the distance between panels by increasing the size of the gutter on either the left or right sides of panels where one panel maintained the same size as in the control grid. The "half" sized panels reduced the separated panel to roughly two-thirds of its previous size (Figure 2c2&3), while the "full" size panel was altered to nearly one-third of its previous size (Figure 2c1&4). This yielded gutters that were progressively larger than the gutter in the control grid, which was used as a contrast.
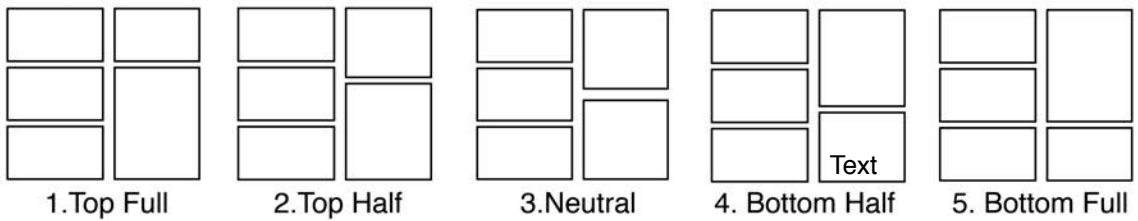
Finally, the overlap conditions used a 2 x 2 arrangement of panels where one panel overlapped a panel either above or below it, and on either the left or right side (Figure 2d). Again, instances of the grid were used as a control against reading orders of these overlapping panels.

Final packets assigned the stimuli pages in random orders (3 lists). This ensured that participants saw various manipulations of the different factors of layout, yet those contexts changed due to their placement within the varying page templates.
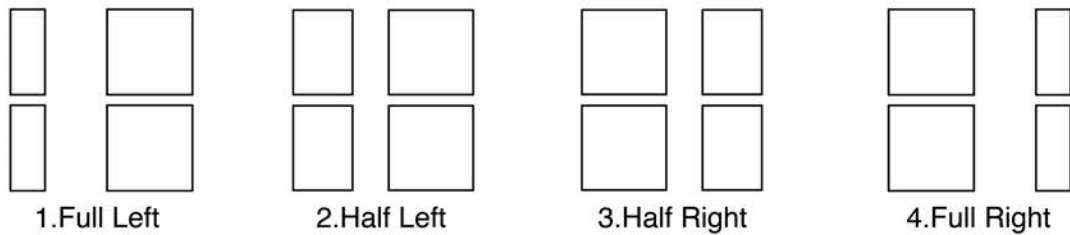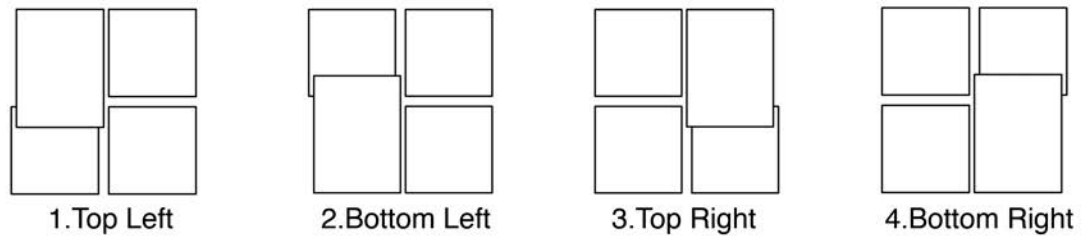
Figure 2. Page layouts involved in our experimental stimuli. Row (a) depicts template page layouts where the dotted grey area was filled with elements depicted in rows (b), (c), and (d). Row (b) depicts manipulations in the blockage condition, ranging from a full continuous gutter either with the top or bottom panels and medial gutters for the rightward panels. Row (c) depicts manipulations of the size of the vertical gutter between panels. Row (d) depicts manipulations where either the left or right panels on the top or bottom overlap their vertically adjacent panel.

Participants

We recruited 72 comic readers (38 males, 34 females, mean age: 21.03) from the UC San Diego community. All participants gave their informed written consent according to the guidelines of the UCSD Human Research Protections Program and filled out the "Visual Language Fluency Index" (VLFI) questionnaire used to assess their comic reading expertise (Cohn, Paczynski, Jackendoff, Holcomb, & Kuperberg, 2012). This questionnaire asked participants to rate the frequency with which they read various types of visual narratives (comic books, comic strips, graphic novels, Japanese comics, etc.) and drew comics, both currently and while growing up. A formula combined these ratings to calculate a "VLFI score" that correlates significantly with both behavioral and neurocognitive measures (see Cohn et al., 2012 for more details). An idealized average along this metric would be a score of 12, with low being below 7 and high above 20. Participants' fluency was a high average, with a mean score of 15.7 (SD = 9.1). Results from three participants were excluded due to not understanding the task.

Procedure

Participants were given packets that contained the various experimental page layouts. Starting with "1," they were asked to number the panels in the order that they would read them if seen in an actual comic book. Participants were told that each page should stand on its own (restarting numbers on each page), and that there were no "two page spreads" that spanned adjacent pages.

Data Analysis

We considered a "Z-path order" as any successive numbering from a starting panel of a layout segment (the upper left panel) to the horizontally adjacent (rightward) panel. All successive numbering to vertically placed panels—or any other panels—were considered as not following the Z-path. We calculated the mean rate that each participant followed the Z-path for each manipulation of page layout (Grid, Blockage/Staggering, Separation, Overlap).

Some participants viewed panels in a "reversed" order consistent with Japanese manga—right-to-left as opposed to left-to-right. In the case of Blockage situations, these stimuli were discarded because the horizontal inverse of blockage no longer creates a "blocking" panel. However, for Separation and Overlap, the inverted layouts simply resulted in a flipped Left/Right arrangement, and thus we recorded these instances as the opposite from their originally coded type (i.e., a Top Left overlap then became a Top Right overlap).

In addition, within the separation scenarios, some participants cleverly placed numbers within the gutter space between panels. We assumed that this was indicative of treating the blank space as if it were a borderless panel. We therefore coded all numbers that successively moved horizontally in a row as following the Z-path, while those that still moved vertically as deviating from the Z-path.

For each manipulation (Blockage/Staggering, Separation, Overlap) we compared the rate of Z-path usage in the experimental manipulation with the rate of the Z-path in the control grid using an Independent Samples t-test. This assessed whether such arrangements alone varied from the reading order in a canonical Z-path scenario. Additional analyses compared the varying arrangements of each type of manipulation. For the blockage/staggering layouts, the mean rates at which participants' used the Z-path for each condition were analyzed using an ANOVA across all five layouts. For separation, we used a 2 (Laterality: Left/Right) x 2 (Width: Full/Half) ANOVA, while for overlap we used a 2 (Laterality: Left/Right) x 2 (Height: Top/Bottom) ANOVA. Significant main effects and interactions were followed by pairwise t-tests.

Finally, in order to investigate any influence of "visual language fluency," mean rates of Z-path orders for all participants were correlated with participants' VLFI score using a Pearson's correlation set to an alpha level of .05.

Results

Control grid

As expected, participants primarily used the Z-path to navigate through 2 x 2 grids which were built into the page templates (M = .91, SD = .18). This mean was then used as a control to test against all other experimental manipulations.

Blockage/Staggering

All blockage/staggering layouts used the Z-path significantly less than it was used in the control grid (all ts > 5.2, all ps < .001). However, the rate of using the Z-path differed significantly between the five different blockage/staggering manipulations, $F(4,264)=33.32$, p<.001. This effect arose because, as depicted in Figure 3a, the further down that the righthand gutter was placed, the more participants deviated from the Z-path (all ts > 1.8, all ps < .064).

Separation

All manipulations to the width of the gutter between panels yielded rates of viewing the Z-path that were significantly different from the control grid (all ts > 4.3, all ps < .001). Between these manipulations, we found a trending main effect of Laterality (Left vs. Right), $F(1,23)=3.14$, p=.09, and a main effect of Width (Full vs. Half), $F(1,23)=7,8$, p<.05. However, there was no interaction between Width and Laterality, $F(1,23)=.824$, p=.365. As depicted in Figure 3b, these results arose because Full separations used the Z-path less than the Half separations (all ts > 1.7, all ps < .097), but distinctions between Left and Right gutters did not differ between Full and Half separations (all ts < .658, all ps > .513). In other words, the wider the gutter, the less the Z-path was used, regardless of which side the gutter was placed.

Overlap

All conditions with overlapping panels used the Z-path significantly less than was used in the control grid (all ts 4.5, all ps < .001). Between these manipulations, we found significant main effects of Laterality, $F(1,66)=22.06$, p<.001, and Height, $F(1,66)=4.96$, p<.05, but no interaction between Height and Laterality, $F(166)=.275$, p=.602. As depicted in Figure 3c, participants used the Z-path to order the overlapping panels on the left side of the grid far less than those on the right side of the grid (all ts > 2.2, all ps < .05). In addition, layouts with overlapping panels on the bottom were ordered using the Z-path less often than those with overlapping panels on the top on the left side, $t(66)=1.8$, p=.063, but not on the right side, $t(66)=1.16=$, p=.251.
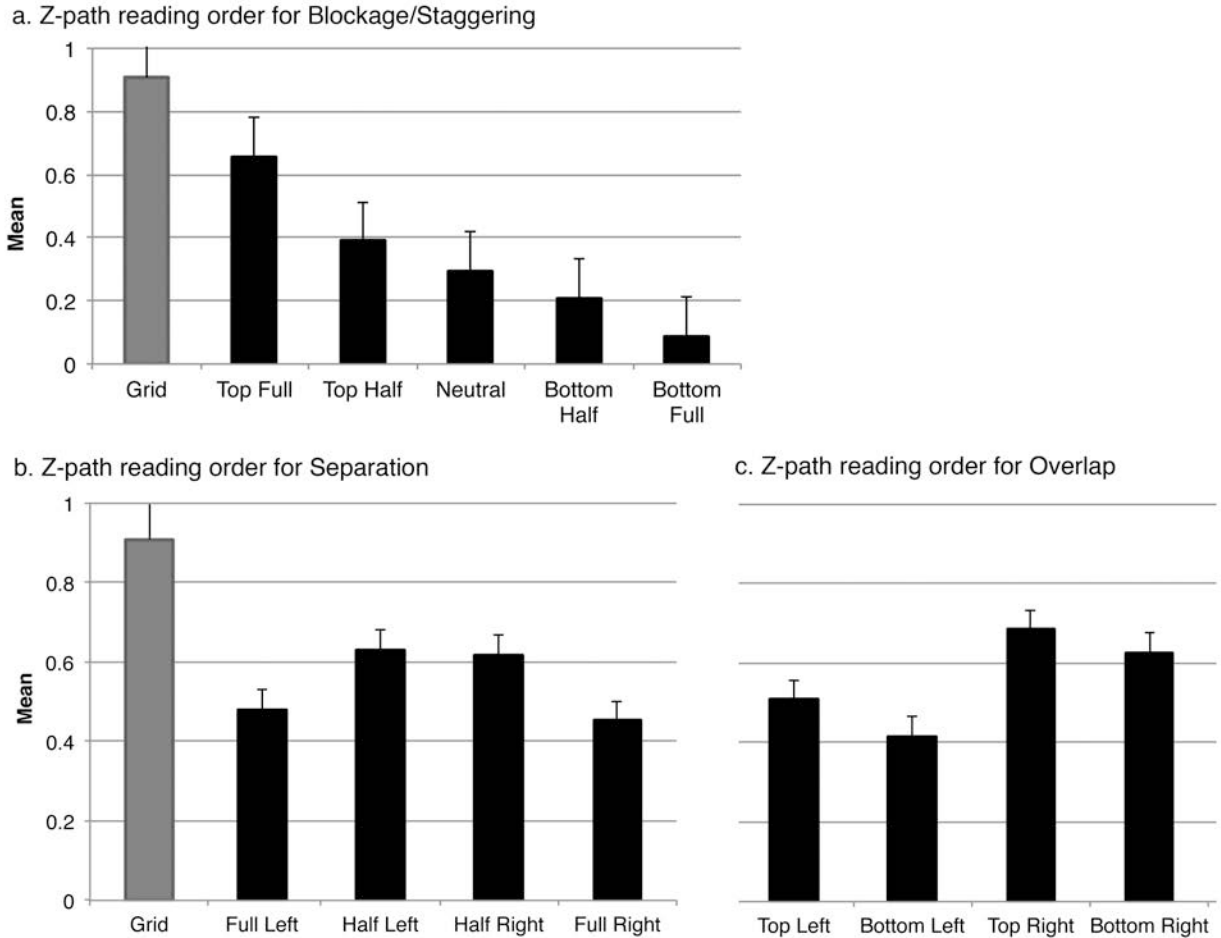
Figure 3. Experimental results for the navigation of various manipulations to comic page layouts. All data show the mean rates of Z-path orders. Error bars represent standard error.

Visual language fluency

No significant correlations were found between VLFI scores and mean rates of using the Z-path in any of the experimental manipulations. However, correlation coefficients (r-values) appeared to successively increase in the blockage/staggering layouts (Top Full: -.19, Top Half: -.09, Neutral: -.07, Bottom Half: -.07, Bottom Full: -.01). Though the r-values were not significant (all ps > .122), we take this pattern as possibly suggesting that experience in reading comics was less influential as the gutter became higher (i.e., became more like staggering than blockage).

Discussion

This experiment examined the order in which participants prefer to progress through various spatial arrangements found in the external compositional structure of comic pages. Overall, we found that all manipulations of page layout that departed from the canonical grid—blockage/staggering, separation between panels, and overlapping panels—caused participants to order panels using strategies that went against the Z-path of left-to-right and down. In general, the more dramatic the variation from a canonical layout, the more likely participants were to

deviate from the Z-path—such as when the gutter progressively became lower in blockage/staggering layouts or when the width of the gutter increased in separation layouts. Below, we further explore these findings and their implications with regard to our hypothesis that participants will follow principles of Assemblage to navigate page layouts.

Blockage/Staggering

In our previous study, we found that blockage greatly caused participants to deviate from the Z-path, while the staggering of panels created marginal deviation from the Z-path. We thus asked: How far down does a rightward gutter need to be placed in order for participants to move downward vertically instead of following the horizontal order of the Z-path? Here, we found that the height of the rightward gutter relative to an upper or lower contiguous gutter significantly influenced the rate at which the Z-path was used. Participants were most likely to use the Z-path when the top gutter was contiguous between adjacent panels. This usage then incrementally decreased as the gutter moved downward (i.e., staggering), such that the Z-path was used less than 10% of the time when it was fully contiguous with the bottom border (i.e., full blockage).

These results suggested that participants are most sensitive to how contiguous a lefthand panel's bottom gutter is with the gutter of its adjacent rightward panel. This finding is consistent with the Assemblage constraint seeking to build cohesive groupings of panels and to maintain smooth paths of reading. If the lefthand panel's gutter is retained in a contiguous line with that of its rightward adjacent panel, then the Z-path is likely maintained. However, as panels become increasingly staggered, and the contiguity between gutters becomes harder to construe, the rightward panel is no longer viewed as maintaining a grouping of panels that form a horizontal row. Rather, the vertical panel "blocks" that horizontal tier, leading instead to a more cohesive segmentation in a vertical direction (as in the blockage tree structure in Figure 1f). Thus, these results support the idea that comic readers seek to build groupings of panels using cues from the contiguity of the gutter between panels.

Separation

Manipulating the width of the gutter between panels also showed an increasing influence of deviation from the Z-path. We asked whether increasing the distance between gutters on either the left or right side of a panel would push participants to depart from the Z-path. This was the case: While all gutters wider than the canonical grid (with "normal" gutter width) used the Z-path significantly less, this departure grew more pronounced as the width of the gutter grew wider. However, the laterality of the gutter did not matter. In other words, only the width of the gutter mattered, not its relative placement.

These findings again support the view that readers follow the Assemblage constraint of attempting to build cohesive units of grouped areas. As the gap between panels increases, participants appear to form groupings of vertical stacks, not horizontal rows. Readers are thus more inclined to follow the Gestalt groupings of proximity than the Z-path, which would require them to jump over a gap (the gap of the gutter)—another constraint of Assemblage.

Overlap

Finally, we found that overlapping panels also led to deviations from the Z-path. Overlap is the reverse proximity relationship from separation, since it brings panels closer together rather than moving them further apart. In previous research, the results related to overlapping panels were difficult to interpret, and thus this study sought to provide more reliable data on how

overlapping panels might influence panel-to-panel navigation. Overlapping panels did cause readers to depart from using the Z-path, especially when the overlap was on the left side of the 2 x 2 grid than the right side. A less pronounced influence was shown for overlapping panels situated on the bottom of a grid compared to those on the top.

We believe that the deviation caused by the overlap on the left side was greater because readers first interact with the leftward panels rather than those on the right, given the overall left-to-right progression of reading (whether using the Z-path explicitly or not) and the preference for an upper left "entry point" into a layout (Cohn, 2013a). By deviating from the Z-path in these layouts, the leftward panels can form a cohesive vertical grouping that can progress as a whole to the rightward stack, consistent with the Assemblage constraints. In contrast, following the Z-path would thus disregard the proximity created by panels touching each other. This effect of proximity seems to also be slightly motivated by overlap from the lower panels. Since lower panels are read after top panels in general, a bottom overlap may provide an anticipatory cue for readers that it belongs next, more than might be indicated by a top overlapping panel which may just be taken as bleeding onto the space of surrounding panels. This again may show an influence of a contiguous border. An overlap of a panel on top still retains a visible bottom border, which is then merely staggered with the adjacent gutter. However, overlap created by a bottom panel allows the top panel to have no bottom border to create contiguity with an adjacent gutter. Thus, there is greater necessity to group panels when a bottom panel overlaps a top one than when a top one overlaps one beneath it.

Concluding remarks

Overall, our results provide greater clarity to understanding how page layouts using blockage/staggering, separation, and overlap influence readers to deviate from the Z-path. Compared to our original study on ECS (Cohn, 2013a), this experiment used controlled manipulations of simple arrangements—often based on 2 x 2 grids. However, page layouts, especially in American comics, appear to be increasing in their aesthetic complexity, if not their arrangement of panels. Such complexity includes the use of borderless panels, panels of irregular shapes, and varying degrees of overlapping and inset panels (i.e., panels within panels), which have yet to be tested in a controlled experimental context. Thus, future experiments will likely need to examine such aesthetic complexity and situations where more panels are involved in the arrangements. For example, studies thus far have not examined instances of multiple embedding of horizontal and vertical segments.

In addition, we have hypothesized that participants use general constraints of Assemblage together with preference rules in order to navigate through page layouts (Cohn, 2013a). Each of the hypothesized constraints may influence a reader's navigation, yet such constraints could hypothetically be played off of each other. For example, would a reader be more influenced by blockage or overlap if presented with competing influences in the same arrangement? Such interactions could be explored to assess whether certain types of manipulations are more influential than others, or whether the broad constraints of Assemblage are able to predict such competing interests more generally.

Finally, studies on page layout thus far have asked participants to order panels that are devoid of content—probing their general preferences for how to move through a layout. With few exceptions (Chiba, Tanaka, Shoji, & Toyama, 2007; Omori, Ishii, & Kurata, 2004), research has not actually measured how participants move between panels in online comprehension, and no prior studies have explicitly manipulated the navigation of ECS combined with the narrative

structure of sequential images to test explicit hypotheses about their interaction (Cohn, 2013a, 2014). In other words, how does the content of panels influence the way that readers navigate through a page layout? In one of the few studies using eye-tracking on comic pages (Omori et al., 2004), participants were more inclined to look in the Z-path order in blockage situations than to follow the downward vertical stack, a trend that was ameliorated by changing the layout to follow the Z-path instead of using blockage. Such results differ from our finding that readers choose the vertical stack when given a conscious choice of how to order panels involved in blockage/staggering. Targeted manipulation of blockage/staggering with panels containing content could further clarify the disparity between these findings, whether using eye-tracking or some other type of online measurement.

Altogether, the results of this experiment further demonstrate that aspects of spatial arrangements in comics lead readers to deviate from the stereotypical reading order used in written text. These findings reinforce that such variance is also not random, but follows explicit principles of combination that seek to form cohesive structures as readers successive progress through a page layout.

References

Abel, J., & Madden, M. (2008). *Drawing Words and Writing Pictures*. New York, NY: First Second Books.

Barber, J. (2002). *The Phenomenon of Multiple Dialectics in Comics Layout.* (Masters Thesis), London College of Printing, London.

Bares, W. (2008). *Panel Beat: Layout and Timing of Comic Panels*. Paper presented at the Proceedings of the 9th international symposium on Smart Graphics, Rennes, France.

Bongco, M. (2000). *Reading Comics: Language, Culture, and the Concept of the Superhero in Comic Books*. New York, NY: Garland Publishing Inc.

Caldwell, J. (2012). Comic panel layout: A Peircean analysis. *Studies in Comics, 2*(2), 317-338. doi: 10.1386/stic.2.2.317_1

Chiba, S., Tanaka, T., Shoji, K., & Toyama, F. (2007). Eye Movement in Reading Comics *Proceedings of the 14th Annual International Display Workshops* (pp. 1255-1258).

Cohn, N. (2013a). Navigating comics: An empirical and theoretical approach to strategies of reading comic page layouts. *Frontiers in Psychology—Cognitive Science, 4*, 1-15. doi: 10.3389/fpsyg.2013.00186

Cohn, N. (2013b). *The visual language of comics: Introduction to the structure and cognition of sequential images*. London, UK: Bloomsbury.

Cohn, N. (2014). The architecture of visual narrative comprehension: The interaction of narrative structure and page layout in understanding comics. *Frontiers in Psychology, 5*, 1-9. doi: 10.3389/fpsyg.2014.00680

Cohn, N., Paczynski, M., Jackendoff, R., Holcomb, P. J., & Kuperberg, G. R. (2012). (Pea)nuts and bolts of visual narrative: Structure and meaning in sequential image comprehension. *Cognitive Psychology, 65*(1), 1-38. doi: 10.1016/j.cogpsych.2012.01.003

Duncan, R. (2000). Toward a theory of comic book communication. In K. Fudge & M. R. Lloyd (Eds.), *Academic Forum* (Vol. 17, pp. 71-88). Henderson State University.

Groensteen, T. (1999). *Systeme de la bande dessinée*: Presses Universitaires de France.

McCloud, S. (2000). *Reinventing Comics*. New York, NY: Paradox Press.

McCloud, S. (2006). *Making Comics*. New York, NY: Harper-Collins.

Nalu, A., & Bliss, J. P. (2011). Comics as a Cognitive Training Medium for Expert Decision Making. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 55*(1), 2123-2127.

Omori, T., Ishii, T., & Kurata, K. (2004). *Eye catchers in comics: Controlling eye movements in reading pictorial and textual media*. Paper presented at the 28th International Congress of Psychology, Beijing, China.

Peeters, B. (1998 [1991]). *Case, Planche, et Récit: Lire la Bande Dessinée*. Paris: Casterman.

Short, J. C., Randolph-Seng, B., & McKenny, A. F. (2013). Graphic Presentation: An Empirical Examination of the Graphic Novel Approach to Communicate Business Concepts. *Business Communication Quarterly, 76*(3), 273-303. doi: 10.1177/1080569913482574

Tanaka, T., Shoji, K., Toyama, F., & Miyamichi, J. (2007). *Layout Analysis of Tree-Structured Scene Frames in Comic Images*. Paper presented at the International Joint Conference on Artificial Intelligence, Hyderabad, India.

Wertheimer, M. (1923). Untersuchungen zur Lehre von der Gestalt (Laws of Organization in Perceptual Forms). *Psychol. Forsch., 4*, 301-350.