

Going with the comics flow: A theoretical and empirical basis for flow in comics

Neil Cohn¹, Filip van der Vegt¹, Fred Atilla², Bruno Cardoso¹

¹Tilburg School of Humanities and Digital Sciences, Department of Communication and Cognition, Tilburg University, Tilburg, Netherlands

² Tilburg School of Humanities and Digital Sciences, Department of Cognitive Science and Artificial Intelligence, Tilburg University, Tilburg, Netherlands

Short title: Comics flow

*Neil Cohn	neilcohn@visuallanguagelab.com	Orcid: 0000-0003-0074-1995
Filip van der Vegt	f.j.vdrvegt@tilburguniversity.edu	Orcid: N/A
Fred Atilla	F.Atilla@tilburguniversity.edu	Orcid: 0000-0003-1061-4420
Bruno Cardoso	Bruno.Cardoso@tilburguniversity.edu	Orcid: 0000-0002-4569-0610

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More information about the TINTIN Corpus and TINTIN Project can be found at:

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Abstract

Comic creators often describe “flow” as a fundamental concept of visual storytelling related to how the composition of panels’ contents direct a reader through their layout on page. Despite its predominance as an artistic concept, little scholarly work has examined flow with either theoretical or empirical approaches. We therefore investigate how flow arises out of an alignment between the implied directionality of a panel’s content and the directionality of the subsequent panel in the layout. With analysis of 417 annotated comics from the TINTIN Corpus (103 countries, 23,169 panels), we show that flow alignment persists on average in 49% of panels in a comic. On an average, 67% of panels on a page were part of a flow sequence, although these sequences often only spanned between 2 and 3 panels long. Flow alignment also differed within segments of layouts (rows, columns, angles), with the most predominant cues for flow being characters’ static or action postures. Realistic comics maintained panels with flow the most, and manga used them the least, but overall flow alignment has been decreasing over time in comics from the 1930s to the 2020s. Overall, this work provides an initial scholarly exploration of a fundamental notion of comics creation that has previously remained the purview of creative intuitions.

Keywords: visual language; comics; flow; composition; layout, visual storytelling

Introduction

“Flow” is a fundamental concept of visual storytelling often described by comics creators to refer to the way that the contents of comic panels direct a reader through the arrangement of panels on page (Figure 1a). Though this idea has been discussed widely in the context of comics creation and criticism, it has received little scholarly attention from either theoretical or empirical perspectives. Here we therefore explore flow by theorizing what flow actually is and then examine it in a subset of the TINTIN Corpus comprising 417 comics from 103 countries.

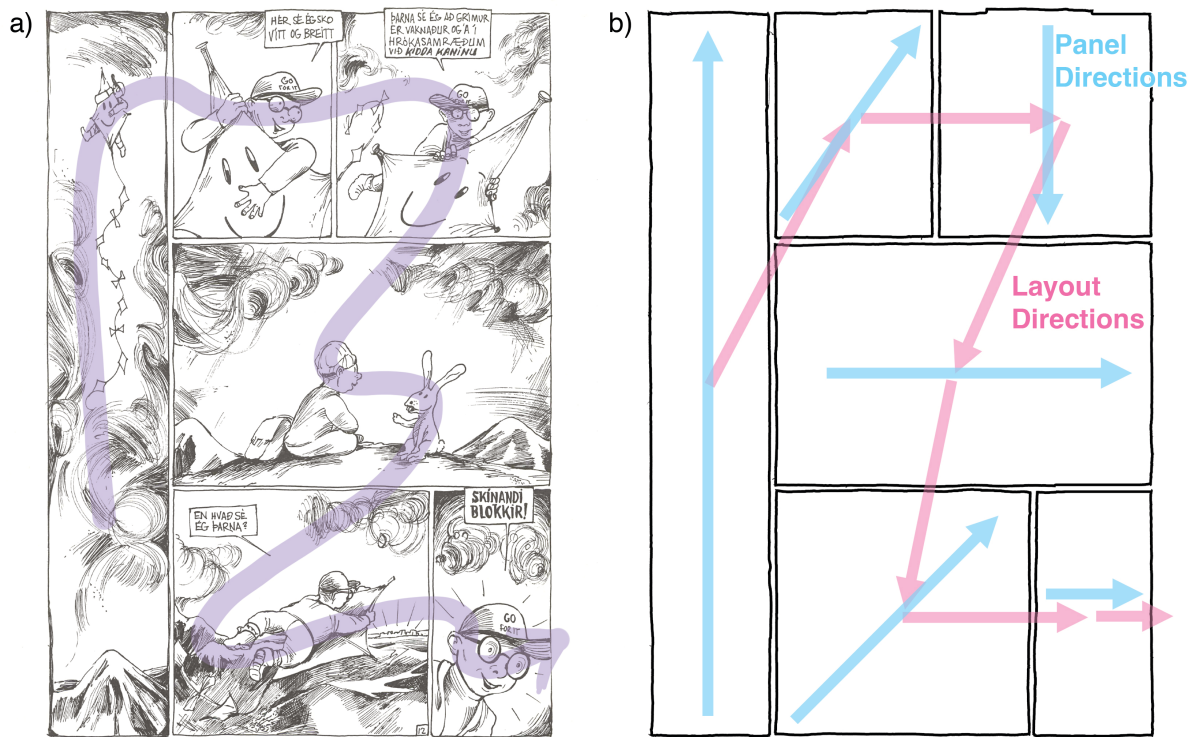


Figure 1. A comic page with a) schematization of “flow” for b) the alignment of directions within the compositions of panels and directions between panels in the layout based on annotations in the TINTIN Corpus. Page from *Skindi Blokkir* by Halldór Baldursson (Gisp! #5, 1992, Iceland).

A question we first need to address is: *What is flow?* Comic creators often describe flow as the ways in which a panel might direct a reader to subsequent panels in the sequence (Talon & Thompson, 2010). This notion therefore involves a relationship between two structures: the *internal* and *external* composition of panels on a comic page.

The *internal compositional structure* (ICS) refers to the arrangement of elements within a panel. This includes all aspects of the graphic components internal to the comic panel as a visual storytelling unit, including relationships between purely graphical elements (colors, lines, etc.), between elements relative to the frame (rule of thirds, golden rule, etc.), and between elements relative to each other (their sizes and/or position). The compositions of panels can be both idiosyncratic and novel, but many compositions within panels are systematic and regularized using templates that persist across creators (Cohn, 2013b).

In contrast, the *external compositional structure* (ECS) refers to the arrangement of panels to each other across a canvas, i.e., their *layout*. Standard layouts have inherited their structure from written language, navigated in a standard Z-path of left-to-right and down, or with the reverse, S-

path (Cohn, Atilla, Lichtenberg, & Cardoso, 2025). Nevertheless, the proximity and alignment of panels can modulate this navigation (Cohn & Campbell, 2015; Kirtley, Murray, Vaughan, & Tatler, 2022), and layouts also involve regularized constructions (Bateman, Veloso, Wildfeuer, Cheung, & Guo, 2016; Cohn, 2024; Gavaler, 2017; Wildfeuer, van der Sluis, Redeker, & van der Velden, 2022).

Flow is therefore the *alignment* of the directionality implied by the ICS of a panel with the directionality implied by the ECS of panels in reading order, i.e., how much does the content of a panel and its layout imply the same directionality (Figure 1b)? Because flow supposedly directs a reader to subsequent panels, it is often taken as an important way for comic creators to indicate how a reader should navigate page layouts. With the absence of explicit markers such as arrows or numbering, the directionality implied by the contents of panels would provide an “unmarked” cue to guide a reader through a layout. As layouts have become more complex over time, increasingly deviating from grid patterns that imitate the paths of writing systems (Bateman, Veloso, & Lau, 2021; Cohn, 2024; Cohn et al., 2025), it might have become necessary to signal the proper way to navigate them via other subtle means.

Nevertheless, studies have indicated that the preferred reading orders of comic panels persist even in the absence of any content (Cohn, 2013a; Cohn & Campbell, 2015). Indeed, arrangements of panels often serve as cues for a hierarchic cognitive structure that is both constructed during, and serves as the guide for, the navigation of a page throughout the reading process (Cohn, 2020). Readers’ eye-movements also balance the content of the panels and their layouts. For example, though eyes reliably focus on the primary content of panels—most often characters (Laubrock, Hohenstein, & Kümmerer, 2018)—elements of panels in coherent sequences evoke more focal attention than those in panels that are out of order (Foulsham, Wybrow, & Cohn, 2016). Across layouts, grid patterns reliably evoke eye-movements similar to the Z-path (Foulsham et al., 2016), but this may be broken by certain layouts and their content (Kirtley et al., 2022; Omori, Ishii, & Kurata, 2004). Thus, along with structures involved in layouts themselves, internal compositional structure may be one source of influence on how layouts are navigated.

If panel composition can align with the directionality of the layout, how might this flow be signaled to a reader? There are various ideas about how the content of images may direct a viewer’s attention, and thus may signal a direction toward a subsequent panel. We consider these as possible “flow cues” of panels. A primary flow cue is characters’ postures (Talon & Thompson, 2010). Character’s in action postures imply a directionality of the action (Kourtzi & Kanwisher, 2000), which could therefore indicate a flow direction. Characters’ static postures may also indicate directionality by the way they are facing, or through their eyeline, which provides a strong social cue indicating where a person should look (Langton, Watt, & Bruce, 2000). Action directions can be further cued through the use of visual affixes such as motion lines or other motion cues, which use lines to show the direction of a traversed path (Hacımusaoğlu & Cohn, 2023).

Other cues may be more subtle, and the idea that a creator can direct a viewer’s attention through an image has long been theorized in the context of single image illustrations and photographs. For example, Loomis (1947) advocated for pictures to use “leading lines” that pull a viewer throughout a composition, often to and from a primary focal point which is thought to draw a viewer’s attention. Nevertheless, such leading lines have not reliably drawn viewers’ attention in the ways that creators assume. For example, Kirtley (2018) measured participants’ eye-movements while they viewed images claimed to direct viewers’ eyes in certain directions, following principles of composition proposed by Loomis (1947). In fact, participants’ saccades

did not follow the expected paths throughout the image, but rather, attention was directed mostly at the primary meaningful components of the images (such as figures within a landscape), while their eyes moved fairly unsystematically throughout the composition.

Additional research has reinforced that the “leading lines” proposed by Loomis (1947) do not draw attention as claimed (Torabi & Teeravarunyou, 2021), but some work has shown more reliability of the attentional impact of aspects of visual composition, particularly for photographs (Chuang, Tseng, & Chiang, 2024). For example, expert viewers of photographs have been reported to be more sensitive to the placement of objects in positions along a “rule of thirds” than novice viewers (Torabi & Teeravarunyou, 2021). In addition, attention is drawn to the vanishing points of perspective, implying that converging contours of perspective may be a salient flow cue (Borji, Feng, & Lu, 2016; Crucq, 2020; Mochizuki, Toyoura, & Mao, 2018).

While these studies suggest at least some validity to the idea that the content of panels can direct attention throughout a layout, here we ask more basic questions: how often do comic pages actually maintain this sense of flow throughout their layouts? What factors have influenced this sense of flow: has it changed over time? And, does it differ across cultures or types of comics?

To address these questions, we analyzed the properties of 417 comics, a subset of the TINTIN Corpus (Cohn et al., Under review), an annotated collection of comics designed to allow empirical investigation of properties of comics from around the world. Specifically, we compared whether the annotated directionality implied by cues within panels aligned with the physical vectors between panels in their layout, and explored whether this flow alignment varied across particular directions within layouts and/or whether some cues are used to reinforce flow more than others. Finally, we examined whether these aspects of flow varied across the styles of the comics, the geo-cultural regions that they came from, and/or the year of their publication.

Methods

Materials

The TINTIN Corpus in total consists of 1,030 comics from 144 countries, which were annotated for a variety of analytical categories (Cohn, Hacımusaoğlu, Klomberg, & Krajnović, 2024). The corpus had the primary aim of global coverage, which was achieved through convenience sampling of comics acquired through donations from comic creators and publishers, through resources from international collaborators, and from public domain comics. These comics were created by both professionals and amateurs, and spanned a wide range of styles, genres, publication dates, and other features. This broad focus matches the aim of the TINTIN Corpus to analyze the structural properties of the graphic systems used in comics worldwide, rather than a study of “comics” as social or literary objects (cf., Dunst, 2023).

The full TINTIN Corpus consists of over one million annotations across over 76,000 panels, and many annotation schemes have been analyzed in all 1,030 comics, including external compositional structure which was extracted automatically from panel data (see below). However, only 417 comics (23,169 panels) were annotated for internal compositional structure, and were thus used in the analysis of flow. This selection of comics spanned 103 countries and were published between 1935 and 2023 (Figure 2a). More details about the full TINTIN Corpus can be found in Cohn et al. (Under review), and further bibliographic details about this sample can be found in the dataset for this study in its repository: <https://doi.org/10.34894/6IXCZ7>.

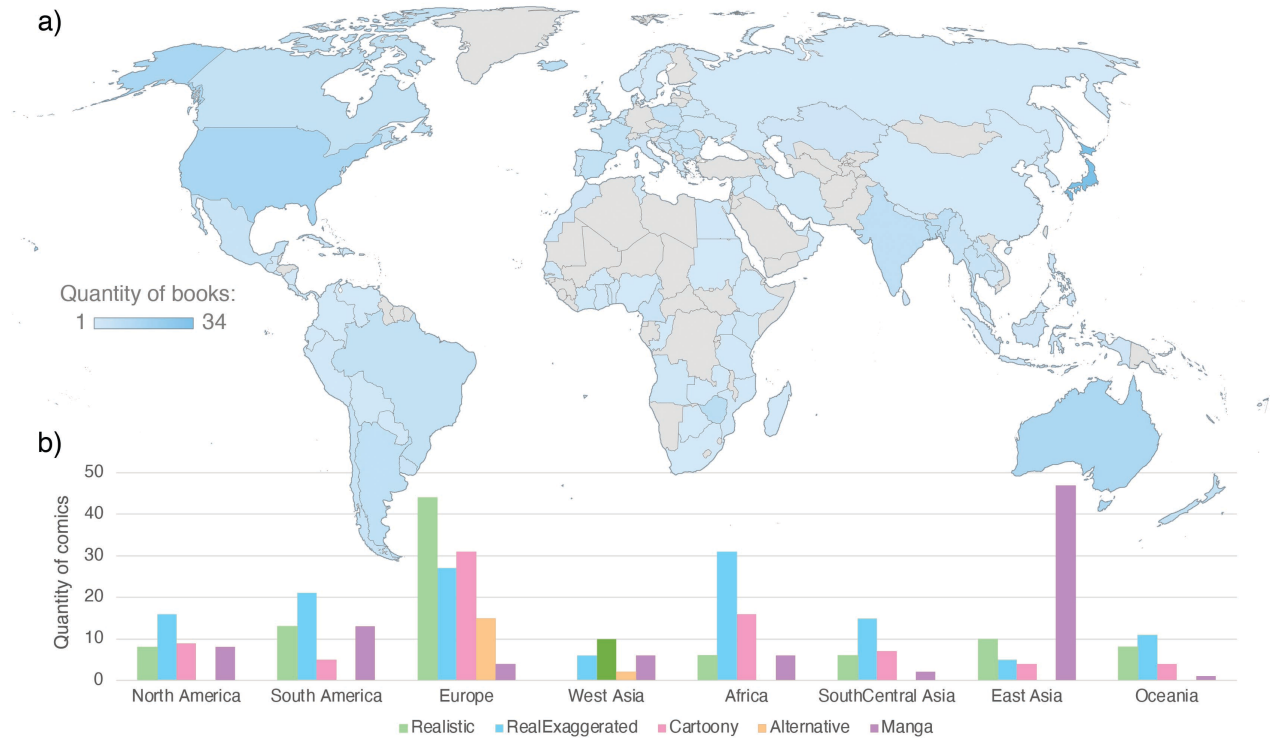


Figure 2. Sample of 417 comics selected the TINTIN Corpus in terms of a) their global distribution from 103 countries, and b) their styles across each global region.

In addition to their global region of origin, we also classified comics based on their “drawing style” as a proxy for differences between graphic systems (i.e., potential “visual languages”). We derived our classifications through a combination of manual annotation and computer vision techniques (for details see Cohn et al., Under review; Titarsolej, Cohn, & van Noord, 2024), resulting in five primary designations: *Realistic* styles maintained true-to-life proportions with less exaggerated features, in contrast with *Real-Exaggerated* styles that also had realistic proportions but with exaggerated features (e.g., “realistic cartoony” and/or “superheroic” styles). *Cartoony* styles had fully exaggerated and unrealistic features, while *Manga* were stereotypical of the style of Japanese manga. Finally, *Alternative* styles used distinctive and/or otherwise unclassifiable representations. The quantity of comics of each style included in each global region are graphed in Figure 2b.

Areas of analysis

Annotation of the TINTIN Corpus was made using the Multimodal Annotation Software Tool, or MAST (Cardoso & Cohn, 2022), where annotators could create graphical vector-based regions around areas of interest on comic pages, and then classify them using various annotation schemes (Figure 3). In this study, we were interested in the annotations related to both layout and internal compositional structure, which were associated with initial annotations of “panels” using the Visual Language Theory: Compositional Structure v. 4 annotation scheme (Cohn et al., 2024). Panels were considered as a unitized expression of a visual sequence including graphic and/or textual content, with or without an encapsulating border. For further details about panel annotation, see Cohn et al. (Under review)

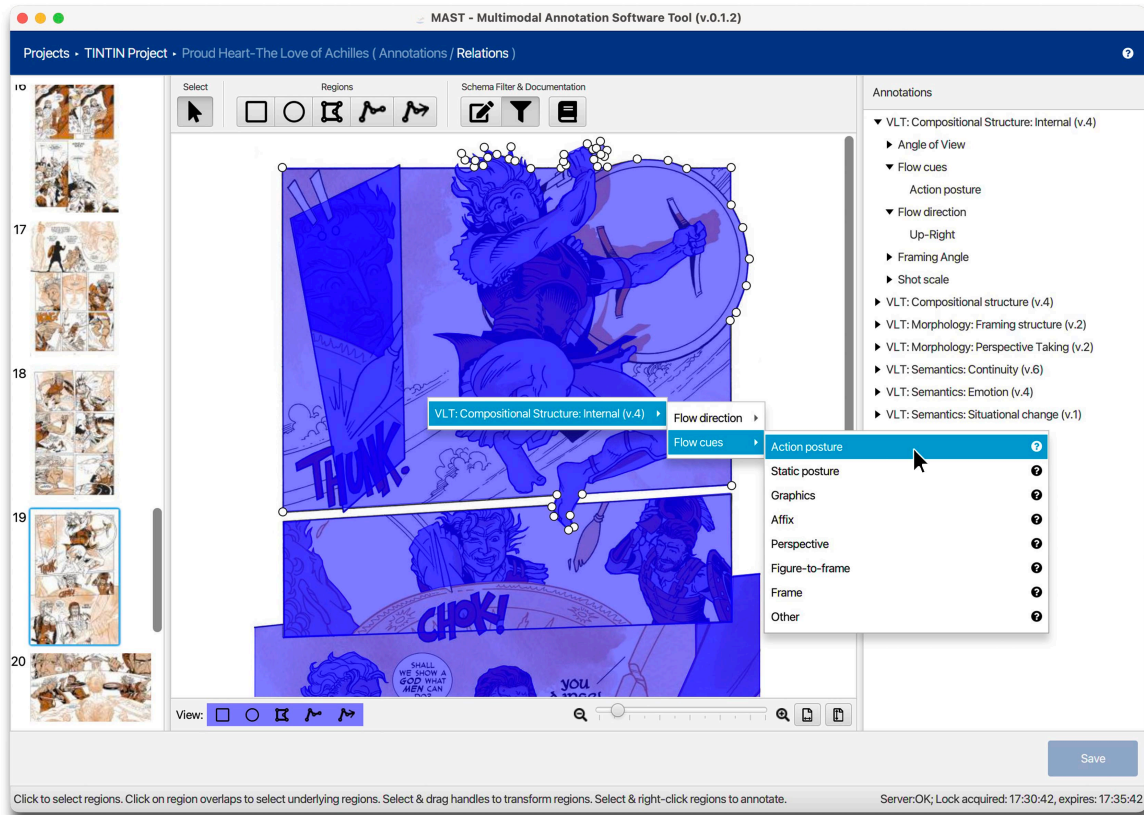


Figure 3. A screenshot from the MAST interface showing the annotation of framing structure for a panel. Page from *Proud Heart: The Love of Achilles* by Gary Proudley and Gary Chaloner (Gestalt Comics, 2017, Australia).

Our primary annotation related to layout was the direction between each panel. We extracted the coordinates for all panel regions, calculated the midpoint of all panels, and then calculated the angle between these midpoints between panels following their annotated reading orders. These numerical angles (0 to 360 degrees) were then converted to 8 directions, i.e., left, right, up, down, and angles in between (for details see Cohn et al., 2025). Here we used each direction that followed a given panel of interest (i.e., the direction recorded between the first and second panels of a page was allocated to the first panel). For the final panel of the page, we assigned the lateral direction towards the edge of the page (i.e., rightward for a layout with a left-to-right reading path).

Panel regions were also used for annotations of the internal compositional structure, which used the Visual Language Theory: Compositional Structure: Internal v. 4 annotation scheme (Cohn et al., 2024). We were specifically interested here in the annotation classes of *Flow Direction* and *Flow Cues*, which were considered as associated classifications. Flow direction characterizes the implied directionality of a composition, while flow cues are the visual markers that signal that directionality. Flow direction included the 8 primary directions (left, right, up, down, and angles in between) along with classifications for centered, inward, outward, or none. Each panel was assigned only one flow direction.

Panels could be assigned multiple possible flow cues. *Action postures* were poses by figures that implied directionality through the actions that they were undertaking (Figure 4a). *Static postures* were contrastingly still, but implied a direction through where they were facing and/or

their eyelines (Figure 4b). *Affixes* were typically non-iconic visual morphemes that signaled a direction (Figure 4c), most often being types of motion lines or zoom lines (Cohn, 2013b; Hacimusaoğlu & Cohn, 2023). *Perspective* cues created a sense of direction through the contours of the lines converging towards a vanishing point (Figure 4d). *Figure-to-Frame* was a sense of direction created by the relative position of a figure within a frame (Figure 4e), e.g., a figure placed two-thirds to the left in a rectangular frame implying a leftward direction. *Graphic* cues signaled directionality from no other content other than the graphic lines, shapes, or colors (Figure 4f). Finally, a *frame* cue implied directionality because of the shape of the panel's frame, usually an atypical shape like triangular or diagonal rather than the canonical rectangular shape (Figure 4g).

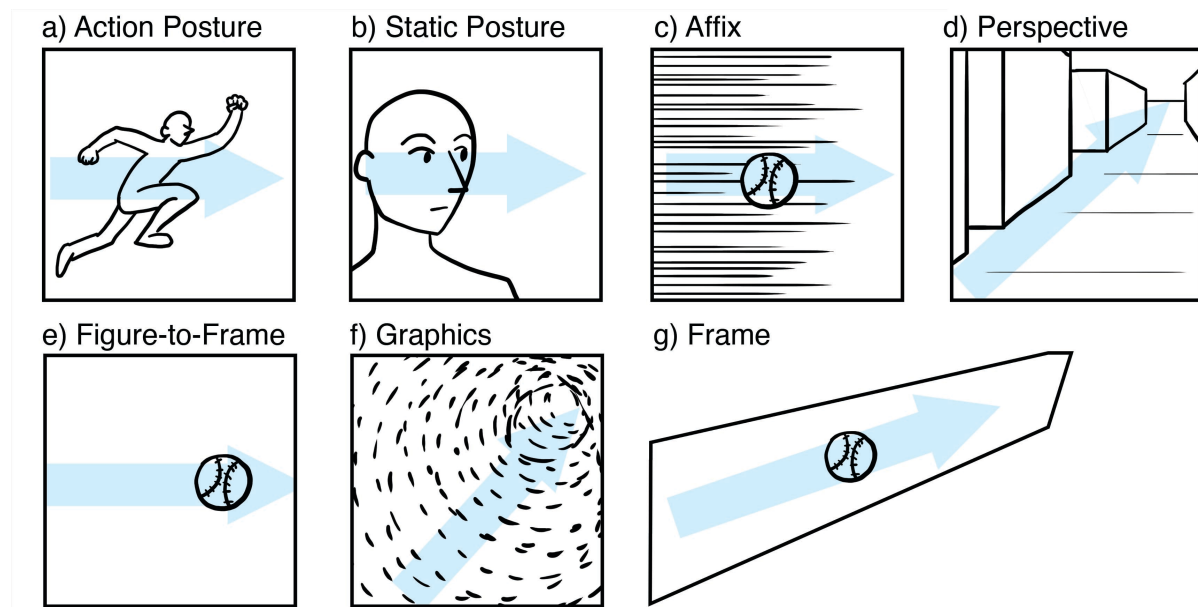


Figure 4. Different examples of flow cues of images to imply a directionality to the composition.

Because directions are inherent to cues, and because multiple directions could be implied in a panel, both flow direction and flow cues were based on a ranking of the influence of the cues. Action postures were considered as the most salient and important, followed by affixes, perspective, static posture, figure-to-frame, frame, and graphics. This ranking was based on the perceived relative overttness of how cues convey directions. Annotators chose the most salient cue of a panel along this ranking together with its corresponding direction, but additional cues could also be marked as present if they supported the direction of the most salient cue (ex. an action posture indicated a rightward direction as the most salient cue, but so did a motion line and point perspective).

All aspects of flow were annotated along with other classes of internal compositional structure by 6 independent annotators. All annotators received training in the theoretical constructs of internal compositional structure using the guide for the Visual Language Theory: Compositional Structure: Internal v. 4 annotation scheme (Cohn et al., 2024). All annotators coded multiple practice comics within MAST which were then checked and discussed with supervisors. After annotation procedures reached sufficient proficiency, they progressed to annotate the TINTIN Corpus where annotations were checked by at least one other supervisor and then discussed in weekly meetings where questionable annotations were resolved. To confirm that annotators were

not a source of variance, we ran additional analyses including annotators as a random effect in our models (see below). Results did not differ depending on the presence or absence of annotators in the model, indicating that they were not a source of variance in the data.

Data Analysis

Our primary questions all related to the analysis of flow, which we considered as an alignment between the flow directions annotated in internal compositional structure and the angles derived from the directions between each panel. *Flow alignment* was considered as a match between the direction of the panel and its subsequent layout direction to the next panel. However, we considered there to be several different types of alignments depending on the characteristic mapping between internal and external compositional structure.

Exact alignment was when the directions for panels and layout were completely the same, such as down-right in both layout and panel content (Figure 5a). A *nearest neighbor alignment* was assigned for matches along just one dimension of an angle following either the lateral or vertical directionality (Figure 5b). Thus, a right direction in ICS could also match in laterality with up-right and down-left, while a down direction could match in verticality with down-right and down-left. Since a down-right angle in ICS has two dimensions, it could have a nearest neighbor match of either right or up-right (matching for laterality) or down or down-left (matching for verticality). Finally, an *axis alignment* considered that flow may operate on the vector of a whole axis rather than in a specific singular direction (Figure 5c), meaning that a match could be considered for a direction with its direct opposite direction. Here, a down-left angle for the layout between panels might be matched by an up-right panel composition, both aligning to the same 45° line of an axis. All other direction relations were considered as *misaligned* (Figure 5d), including ICS annotations of centered, inward, outward, and none.

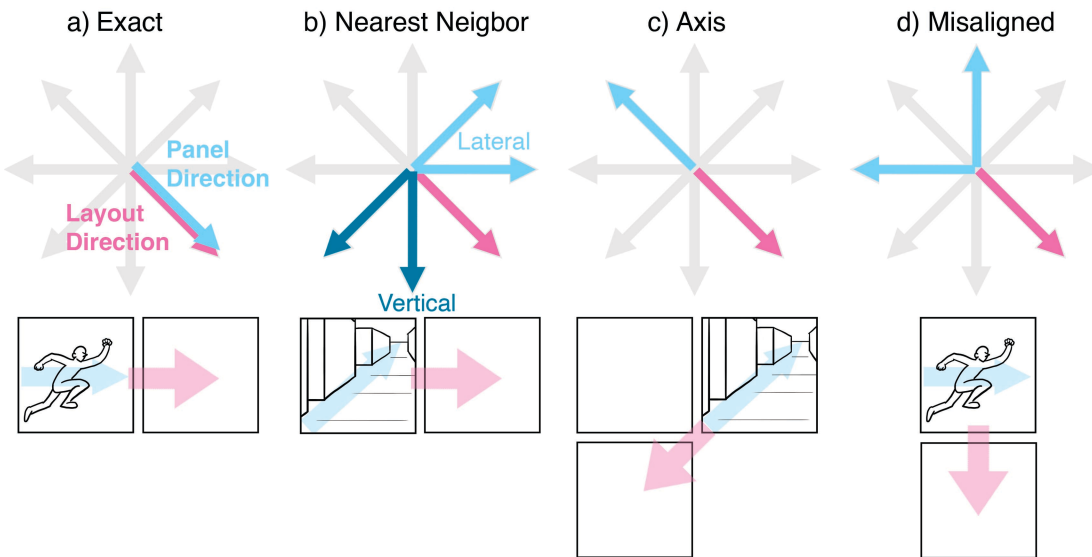


Figure 5. Different types of flow alignment based on relationships between the direction implied by the panel content and the layout.

Our first analysis asked about the relative prevalence of types of flow alignment. For each comic we calculated the average number of panels with each flow alignment type out of the total

number of panels in that book. We used linear mixed models setting mean flow alignment as the dependent variable, and fixed effects of flow alignment type (exact, nearest neighbor lateral and vertical, axis, misaligned), the global region where the comics came from, the style of the comics, and the year of publication of the comic. Random effects were each comic.

We next asked whether flow alignment types varied in different segments of the layout. We took different layout directions as indicative of segmentation in the layout, with lateral (right, left) taken as indicating segments of rows, verticals (up, down) as indicating segments of columns, and angles (up/down-right/left) as the breaks between rows and columns (Cohn, 2024; Hacımusaoglu, Klomberg, & Cohn, 2023). For each layout segment, we calculated the proportion of panels using different flow alignment types per comic out of the total number of those segments per comic (i.e., total panels with flow alignment for lateral segments out of all lateral segments per comic). Because layout segments inherently included directions (lateral rows and vertical columns), we did not make this distinction within nearest neighbor alignments themselves. We used linear mixed models with average flow alignment per book as the dependent variable, and fixed effects of flow alignment type (exact, nearest neighbor, axis) and layout segments (row, column, angle). Random effects were each comic.

We additionally asked about the prevalence of flow cues. We used linear mixed models setting the means for each flow cue for each comic as the dependent variable, and fixed effects of the cue types, global region, style, and the year of publication. Random effects were each comic.

Finally, we asked about sequences of panels that contiguously maintained flow alignment, which we termed a *flow run* (i.e., 3 panels one after each other in order that all had flow alignment would be a flow run of 3). As flow is a property of individual page layouts, we restricted our calculation of flow runs to each page, and they could not extend across pages. We first asked about the proportion of flow runs per comic by calculating the number of flow runs on each page out of the total number of pages in a comic. We next asked about the flow run length by calculating the number of panels involved in each run, and then averaging the lengths of all runs for each comic. Both run proportion and length were then analyzed as the dependent variables of linear regression models with style, global region, and publication date as predictors. Finally, to analyze this relationship between flow runs and layout structure, we calculated the proportion of panels involved in runs in different layout segments out of the total number of layout segments per comic.

Results

We first looked at the frequency of flow alignment and their types across comics. Model comparison suggested that the best model contrasted alignment types, the style of the comics, and their publication date. This model suggested that flow alignment differed across alignment types, $\chi^2(4) = 45.6$, $p < .001$, and flow alignment as a whole differed across styles, $\chi^2(4) = 11.9$, $p < .05$, but that there was no interaction between alignment types and styles, $\chi^2(16) = 17.1$, $p = .374$.

The main effect of alignment types occurred because, as in Figure 6a, misalignments were the most frequent, followed by exact, lateral nearest neighbors, axis, and vertical nearest neighbor alignments (all $ps < .001$). It is worth noting that, though misalignments were the most prevalent specific type (.378), when all the flow alignment types were added together (.489), they were more prevalent than misalignments.

The effect of styles occurred because, collapsing across alignment types, styles differed in their rates of flow alignment (all $ps < .001$). As in Figure 6b which excludes misalignments,

realistic comics had the highest rates of flow alignment, while manga had the lowest rates. Alternative, cartoony, and real-exaggerated all had intermediate rates of flow alignment.

We also observed an interaction between alignment type and publication date, $\chi^2(4) = 12.0$, $p < .05$. This occurred because all alignment types changed over time. As in Figure 6c, misalignments have grown much more frequent over time, $r(415) = .536$, $p < .001$, while exact alignments have especially decreased, $r(415) = -.498$, $p < .001$, as have axis alignments, $r(415) = -.338$, $p < .001$. Lateral nearest neighbor alignments showed no change over time ($p = .205$), while vertical nearest neighbor alignment trended towards increasing over time, $r(415) = .085$, $p = .084$.

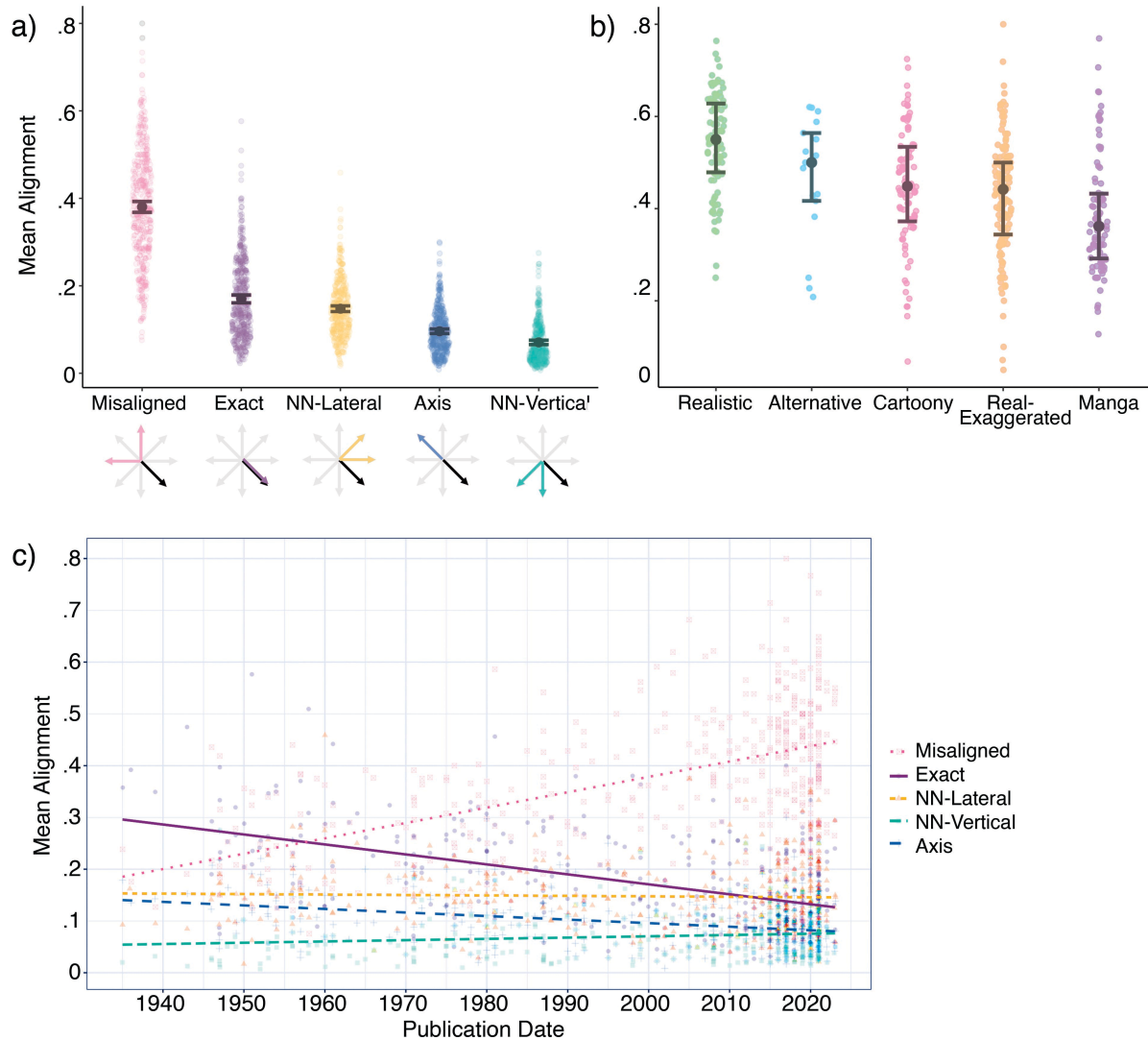


Figure 6. Mean rates of flow alignment a) across alignment types, b) across styles (excluding misalignment), and c) across the year of publication of comics.

Our next question was whether alignment types varied based on where they occurred in different segments of the layouts. Here we calculated the proportion of flow alignment across types used in different segments of layouts (row, column, angle). A main effect of layout segments, $\chi^2(2) = 164.5$, $p < .001$, indicated that vertical segments occurred more often than angles, which occurred

more than lateral segments (all z s > 73.3, all p s < .001). These overall proportions are the inverse of the mean frequency of those segments, where lateral shifts ($M = 27.7$, $SD = 22.1$) are more prevalent than angles ($M = 17.7$, $SD = 10.8$), which are more prevalent than vertical shifts ($M = 8.2$, $SD = 7.1$).

There was also an interaction between alignment types and layout segments, $\chi^2(6) = 862.2$, $p < .001$. As in Figure 7a, alignment types differed substantially in which layout segments were more or less prevalent. Misaligned panels were most frequent in columns, then angles and rows (all p s < .001). Exact alignments were most frequent within layout segments (rows, then columns) beyond panels suggesting flow toward another segment (angles). Nearest neighbor alignments instead were most prevalent for angles and then columns more than rows, while axis alignments were more prevalent for columns over both rows and then angles.

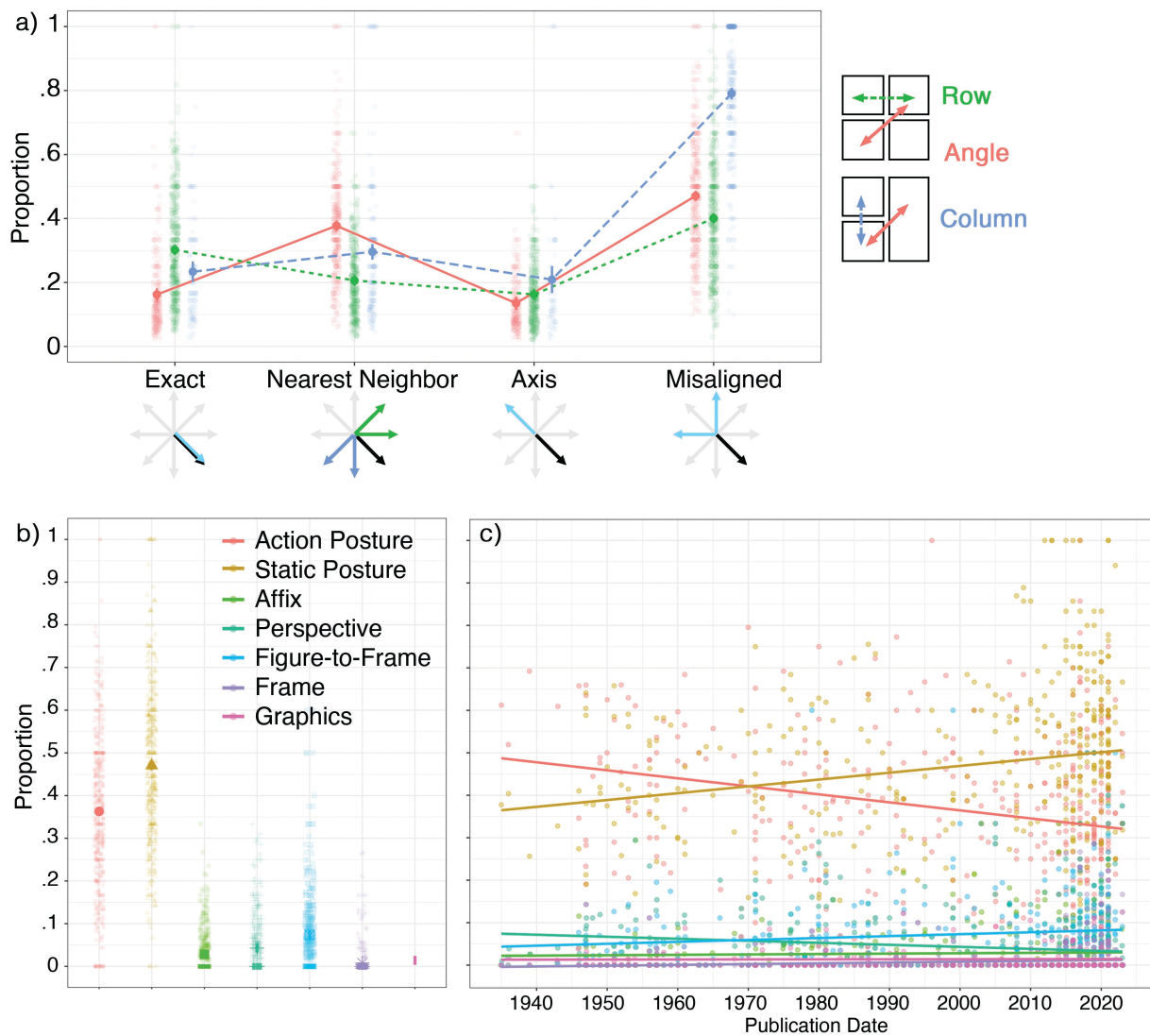


Figure 7. a) Mean proportion of flow alignment types in different segments of layouts, and b) proportion of flow cues appearing in contexts of flow alignment, and c) how those proportions of flow cues have changed over time. Error bars represent 95% confidence interval.

We next asked about the prevalence of different flow cues in the context of flow alignment. We again compared linear mixed models with a dependent variable of the proportion of flow cues per book when flow alignment was present (i.e., excluding misalignment), and we had fixed effects of flow cues, style, and publication date. The best model included only flow cues and publication date, where flow cues differed from each other, $\chi^2(6) = 124$, $p < .001$, and also were shown to change over time, $\chi^2(6) = 125$, $p < .001$.

Out of all cues used in contexts of flow alignment, as in Figure 7b, static postures (47%) and action postures (36%) were annotated as the most salient cues more than all others, followed far behind by figure-to-frame (7%), perspective (4%), affix (3%), graphic, (1%) and frame (1%) cues (all $z > 2.8$, all $ps < .005$). Follow up analyses looking at each cue over time (Figure 7c) showed that salient action postures and perspective cues have gone down over time (all $rs < -.17$, all $ps < .001$), while static postures, figure-to-frame, and frame cues have all increased over time (all $rs > .1$, all $ps < .05$).

Our final set of questions asked about sequences of panels that maintained flow alignment, a *flow run*. We first asked how common flow runs were across books by looking at the proportion of pages with flow runs out of all pages in a comic. Within pages, 67% (SD = .38) of panels per page were involved with flow runs. Styles differed in how many panels per page used flow runs, $R = .34$, $R^2 = .12$, $F(4,412)=13.3$, $p < .001$. Manga and real-exaggerated styles had fewer panels per page involved than cartoony and realistic comics (all $ps < .001$, Figure 8a). An additional model suggested that the amount of panels in flow runs per page also changed over time (Figure 8b), $F(9, 411)=18.5$, $p < .001$, R^2 change = .069, as they became less frequent over time, $\beta = -.36$, $t = -5.9$, $p < .001$. We found no interaction between style and publication dates.

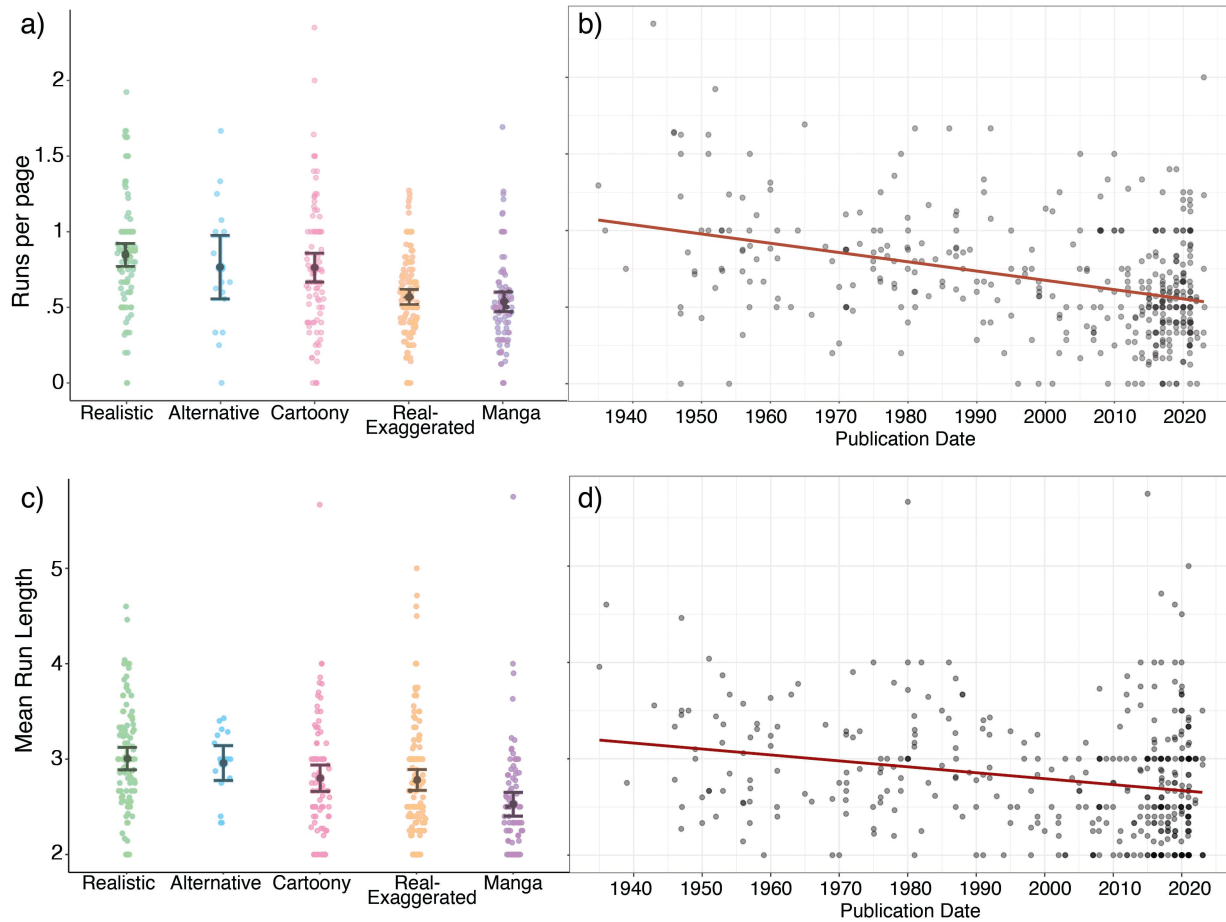


Figure 8. A flow run is a series of consecutive panels maintaining flow alignment, with a) showing the difference across styles for runs per page, b) showing the change in runs per page over time, c) showing the mean length of runs, and d) showing the change in run length over time.

Nevertheless, the length of flow runs themselves were quite short. Flow runs on average were only 2.7 panels in length ($SD = .8$), meaning that there were typically between only two and three panels in row that consistently maintained flow alignment. A linear regression suggested that styles did significantly predict run length, $F(4,412)=4.6$, $p < .001$, but this explained only a marginal amount of variance ($R = .208$, $R^2 = .043$). As shown in Figure 8c, this occurred because manga only had shorter run lengths ($M = 2.4$, $SD = .7$) than realistic comics ($M = 2.9$, $SD = .7$), $t(412) = -4.2$, $p < .001$, with all other styles falling in between. A model adding publication dates of the comics was also significant, $F(5, 411)=5.0$, $p < .001$, but again only explained a marginal amount of more variance (R^2 change = .014). This suggested that run length has reduced over time $\beta = -.159$, $t = -2.4$, $p < .05$, as in Figure 8d. A model with an interaction between style and publication date was not significant.

We last asked about how flow runs aligned with the segments of layouts. We calculated the proportion of panels involved in each layout segment type per book (row, column, angle) out of all segments per comic. A linear mixed model showed that segments differed, $\chi^2(2) = 70.1$, $p < .001$. This occurred because flow run panels were used more in rows ($EMM = .61$, $SE = .01$) than

angles (EMM = .55, SE = .01), which were used more than columns (EMM = .40, SE = .02), all $z > 36$, all $ps < .001$. There was no interaction with styles ($p = .082$).

Discussion

This paper analyzed flow in comics as an alignment between the internal composition of panels' contents and the external composition of panels' arrangements in a layout. Although comic creators have often discussed flow as an important characteristic of the artistry of comics, it has not been overtly theorized or studied empirically. We therefore defined flow as the alignment between panel compositions and layout directions and investigated it across styles, how it has changed over time, and what cues motivate it.

Our initial finding was that flow alignment occurred on average in 49% of panels compared to 38% with misalignments. Higher proportions of panels (67%) in pages are arranged as sequences with flow alignment, i.e., a flow run, although these runs were often fairly short, between 2 and 3 panels long.

It is notable that misalignments here occurred both when directions did not adhere to our flow alignment types, but also to directions of panel content that had no theorized alignment with layout directions. These included panel compositions that were centered, had inward or outward directions, or had no implied directionality. Because they did not overtly depict one of the eight directions that could align with layout directions, they would have yielded misalignments, but it is possible that they allowed for flow alignment of a type we had not yet theorized, which would result in lower misalignments overall.

Despite the positive value that comic creators give to layouts that maintain flow, misalignments may also play a functional role, rather than as the absence of achieving the preferable alignment. If flow alignment is meant to move a reader's gaze from panel to panel, then misalignments can be purposeful to slow down or keep a reader's gaze within a panel for longer. If half of panels in a comic use flow in runs of 2 to 3 panels long for pages that are on average 5 to 6 panels long (Cohn et al., Under review), it means that a page may have a few panels maintaining flow, then misalignment(s), then more flow. This on/off nature may give a sense of movement through layout, then lingering, movement, lingering, etc. contributing overall to the sense of rhythm that can occur across layouts, as discussed by comics theorists (Eisner, 1985; Natsume, 1997; Natsume, Holt, & Fukuda, 2021).

Panels differed in the ways that they achieved flow alignment. The most common method was an exact match between the direction implied within a panel and that of the layout, implying that comic creators are indeed attentive to aligning compositions of panels and the direction towards another panel. Yet overall, exact alignment accounted for only 17% of panels per comic, and was followed by nearest neighbor alignments of lateral directions (14%) which were more prevalent than those aligning in verticality (6%). Alignment along a common axis constituted 9% of panels.

While the lateral directions of nearest neighbor alignments were overall more frequent than those of vertical direction, proportionally nearest neighbor directions were used the least often within rows compared to those that were used in columns. Yet, these both appeared less often than nearest neighbors in layout angles, which suggests that the signaling between rows and columns often aligns on only one directional dimension (i.e., lateral or vertical), and indeed layout angles were the least prevalent context for exact and axis alignments. Exact alignments were more common in the contexts of rows, perhaps emphasizing their normative baseline qualities, while axis alignments were more common in columns.

An example of why axis alignment may occur in columns could stem from depictions like in the page shown as an annotation example in MAST in Figure 3. Here a character is jumping upward in the second panel with an action posture, but the subsequent panel is downward. The oppositional flow thereby reinforces the content, so that after the upward jump, the gaze flows downward along the layout with the character's subsequent descending action.

These flow directions and alignments arise from various cues, but clearly characters' postures are the most salient. Static postures (47%) were the most frequently used salient cue in contexts of flow alignment, followed by action postures (36%). Following these character-based cues, figure-to-frame cues were the next most common, but only at 7% of all cues used in flow alignment context. Even smaller proportions persisted for perspective (4%), affixes like motion lines (3%), the panels' frame shape (1%), or graphics alone (1%). The prevalence of characters' postures as the most salient cues should perhaps be unsurprising given that they are the focal points of narratives and indeed are aspects of images that draw the most attention (Kirtley, 2018; Laubrock et al., 2018). Within static postures, eyelines of characters provide strong social cues for directing attention (Langton et al., 2000), while action postures also suggest the directionality of the action (Kourtzi & Kanwisher, 2000).

The focus of postural cues has also changed over time, with action postures decreasing in proportion while static postures increased. This observation could be due to the overall types of panels being used in comics in the corpus across different publication dates, with later books adding more genres of slice of life, drama, or romance to the action-oriented comics. This may align with observations that shallower increases over time also occurred for figure-to-frame and frame cues, which are also more "static" in nature than the dynamism of cues like action postures and affixes.

Yet, the decline in action postures also reflects the general decrease over time of flow alignment (and increase in misalignments), and for the number and length of flow runs. The broad indication is that, at least in the corpus represented here, flow as an aspect of the artistry of comics has grown less prevalent.

One possible explanation for this decrease in flow alignment over time, and the high proportion of misalignments in general, may be from the relative expertise of the comic creators in the TINTIN Corpus. The corpus includes a mix of comics produced by professionals via established publishers and works by amateurs, especially in more recent works. However, analysis of a subset of the data with works only from the United States, Japan, and Belgium—almost all published professional comics—showed no substantive difference in proportions of flow alignment than the broader corpus.

Another possible explanation is the shift in technology used to read comics. Over the last several decades, some readership of comics has shifted from printed books to digital delivery through webcomics or digital reading software (Benatti, 2024; Missiou & Tapsis, 2023). In some cases, web-based works eschew traditional page layouts to instead feature layouts with scrolling through panels, which would have less need for emphasizing flow alignment between panel content and layout since layouts are relatively simple and more straightforward in navigation (i.e., "scroll downward"). Indeed, a substantial number of the books in the TINTIN Corpus do come from webcomics, but they still maintained traditional page-based layouts as a criterion of inclusion.

Other insights come from comparing flow across styles. Realistic comics had the highest frequency of flow alignment, while manga had the lowest, with lower values also observed in cartoony and real-exaggerated (e.g., superheroic, etc.) styles. These relative distinctions across styles persisted also across the number of flow runs per page and their length. Though other styles

did occur in the corpus prior to the 1980s, realistic comics were much more prevalent in earlier comics. Given the lower prevalence of flow alignment in manga overall, and observed influences of Japanese manga on the structures of worldwide comics since the 1980s (Brienza, 2015; Cohn, 2024), it's possible that flow is simply less of a concern for manga and this has in turn affected other global comics since that time. Manga do feature more variability in the directions between panels in their layouts compared to other styles (Cohn, 2024; Cohn et al., 2025), although this would not rule out flow alignment within those layouts. It is worth reiterating that “manga” in our corpus spans across the world, not just Japan, so this is unlikely to be a cultural effect.

Yet, it's worth noting that we observed no changes over time for styles, so such differences would merely arise as byproducts of the publication dates of styles, but not changes taking place within the styles themselves over time. Thus, overall questions remain about why flow has decreased over time and appears less frequently in some styles of comics than others.

Overall, this study has revealed that flow does occur across the panels of comics, in certain segments of layout, and is motivated by particular cues. While this study elucidates flow's presence in comics, it does not inform about how flow alignment may actually affect readers of comics and their comprehension. The claim from comic creators has been that flow helps guide a reader through a comic, i.e., the composition within a panel helps provide cues for directing readers' attention to the next panel (and/or misalignments creating a motivation to linger).

Studies so far have indicated that eye movements to comics are affected by the arrangements of panels in layout (Bateman, Beckmann, & Varela, 2018; Kirtley et al., 2022; Omori et al., 2004), and in the coherence of the sequence of panels' content (Foulsham et al., 2016). Moreover, smoother reading paths through the layouts of comics are observed by participants with more proficiency in reading comics (Nakazawa, 2002; Zhao & Mahrt, 2018). However, no studies have yet indicated that panel content serves as a cue for motivating readers' subsequent eye-movements. It is possible that the effect of flow might arise in subtle ways, such as parafoveal vision that would indicate predictive processing prior to the eyes' subsequent movement to the next panel (Laubrock et al., 2018). A next step in furthering the empirical study of flow would thus be to examine the effect of flow alignment and cues on actual comics reading behaviors.

Altogether, this study provided the foundations for a theoretical analysis of flow in comics, and used a corpus analysis to analyze these constructs to show that flow can be characterized by an interaction between the composition with panels and their arrangements in a page layout. This results in various types of alignment, which differ in proportion across aspects of page layouts, and are cued by various parts of panels' content, particularly characters' postures. This work therefore establishes a foundation to further investigate this fundamental aspect of the craft of comics creation that has until now been characterized by intuitions alone, rather than scholarly study.

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