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## A MULTIMODAL MOVE ANALYSIS OF GRAPHICAL ABSTRACTS IN MEDICINE AND CHEMISTRY

### Abstract

Graphical abstracts (GAs), as other new digital forms of communicating science, have been promoted as tools to escalate the reach of journal articles and move science into unconventional environments such as social media. Despite the rapid and widespread adoption of the GA in various fields, its genre status is still controversial due to its unstable structure and functions. Here, we examine the move structure of 100 GAs published in 2022 in 10 high impact journals in medicine and chemistry. We aim to verify adherence to the Introduction-Methods-Results-Discussion pattern and the role of visual and written resources in move realization. We also discuss selections of multimodal resources that may result from the processes of recontextualization of scientific discourse to audiences other than expert peers. Our findings reveal that move structure varies across fields: in chemistry, only Results are obligatory, while in medicine the obligatory pattern is Methods-Results-Conclusion. Move realization is predominantly multimodal, with visual resources as the key element in the presentation of Methods and Results, while the written mode is characteristic of Conclusion. Acknowledgment of readers other than the peer scientist is evident in three medicine journals whose GAs are not produced by the author of the respective articles, but by graphic designers.

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### Key words

genre analysis, multimodal move analysis, graphical abstract, digital genres, disciplinary discourse, visual literacy.

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## 1. INTRODUCTION

A glance at the table of contents of high impact journals, especially those published in English, reveals some of the efforts scientific communities are addressing in the sector of add-on summaries (Katsampoxaki-Hodgetts, 2022). Highlights, lay summaries, plain language summaries, graphical abstracts, the bigger picture, and video abstracts, to name just a few, have been emerging as additional to the verbal abstract and have not gone unnoticed by the linguistic science, especially that with a focus on the investigation-pedagogization axis.

Needs and purposes around science are in a cyclical feedback relation, triggering endogenous and exogenous interdiscursive movements oriented to the most diverse goals, from raising funds for research to deciding which scientific product to support financially (Calsamiglia & Van Dijk, 2004; Myers, 2003). The emergence of new digital part-genres can be a way to deal with the exponential escalation in the number of scientific publications (Fire & Guestrin, 2019) and to facilitate access to them, due to their predominantly electronic, interlinked and increasingly open nature. In connection with the idea of continuous feedback, the *San Francisco Declaration on Research Assessment – DORA* (Cagan, 2013) strongly claims that funding agencies, institutions, publishers, organizations that supply metrics, and researchers should reevaluate assessment methods, focusing on the validation of the content of research. Thus, in the current scenario of scientific publication, where add-on summaries circulate more easily than research articles, alternative metrics, known as altmetrics, have been employed to map numbers of accesses, uses and shares of research publications and offer a more complex picture of the reach and impact of research findings, beyond traditional citation-based metrics (Fire & Guestrin, 2019; Nishikawa-Pacher, 2022).

Based on the current importance of add-on summaries, in this article we focus on one of them, the Graphical Abstract (GA). A decade ago, analyzing the prototypes of the Article of the Future, launched by Elsevier in 2009, Pérez-Llantada (2013) found that readers recognized the verbal abstract as the most important component of the research article, while GAs were considered much less relevant. Even so, Pérez-Llantada (2013: 232) predicted that GAs would “become typified genre elements in the near future”. Sancho Guinda (2015) also found that university professors value verbal abstracts more than GAs, but are in favor of the permanence of GAs as a non obligatory complement. The participants in her survey also evaluated creativity and appeal as very important criteria in GAs. More recently, Katsampoxaki-Hodgetts (2022) noted a preference for GAs among young researchers compared to experts, pointing to differences in attitudes toward GAs related to social roles, hierarchical positions, and age of the audience. In another study involving audience feedback on GAs, Sancho Guinda (2022) focused on criticism to GAs in blogs and found that adequate literacy is necessary so that the canonical standard of scientific praxis is maintained.

In light of these findings, we analyze the move organization of 100 GAs published in 2022 in 10 high impact journals in chemistry and medicine. Our aim is to examine the adherence to the Introduction-Method-Results-Discussion (IMRD) pattern and the role that visual and verbal resources play in move realization. Ultimately, we explore the presence and nature of visual recontextualization strategies used in GAs to acknowledge the general public as the potential reader.

As language professionals, we believe that successful academic genre pedagogy depends on significant textual, disciplinary and social research. Norris and Phillips (2003: 225) present reading and writing as fundamental meanings of what scientific literacy is and advocate that these meanings be improved and treated seriously, beyond processes of “word recognition and location of information”. For the authors, making science is significantly dependent on texts and the resources they make available; thus, reading of science-related texts – including multimodal texts, such as GAs – is acknowledged as primary access to scientific knowledge, both about academic lexicogrammar and about the epistemology of science.

On the subject of reading and writing texts, we align with genre-based language perspectives, specifically those that view texts as purpose-oriented, textualized by rhetorical moves (Swales, 1990) and permeated by discourses. The notion of rhetorical moves is efficient in tracking in the text what is said, how it is said, and why it is said, which carries in itself a highly pedagogical component. However, as Buehl (2022: 297) points out, “although graphical abstracts have appeared on digital platforms for more than ten years, pedagogical concerns have not been much addressed”.

## 2. LITERATURE REVIEW

### 2.1. Move analysis and multimodality

Move analysis within ESP-EAP research has been a powerful tool to promote academic literacy. The description of functional/formal regularities of genres has rendered rich pedagogical material for ESP-EAP educators and learners, because it simultaneously provides a macro-level view of the rhetorical blocks that form a genre and how they are sequenced (based on the analysis of a representative sample) and a micro-level specification of how each block is linguistically realized. These two levels of information have been increasingly thickened by explanations of why the function and form of a genre are the way they are, adding ethnographic (Guillén-Galve & Bocanegra-Valle, 2021; Paltridge et al., 2016) and critical layers to genre analysis (Bhatia, 2017; Motta-Roth & Heberle, 2015). These layers in ESP-EAP research can help to drive educational practice to “an agenda for social and political change” (Jewitt, 2014, as cited in Archer, 2022: 547).

One aspect of move analysis that seems to need further development is multimodality (Guillén-Galve & Vela-Tafalla, 2020; Prior, 2013; Riazi et al., 2020; Xia,

2020). The “multimodal move analysis” approach has been defined as “an enhanced version of the move/stage analysis method” (Xia, 2020: 147) which acknowledges that the individual moves in multimodal genres may be realized by multiple semiotic resources. This approach is particularly necessary in the current territory of digital academic communication, where non-verbal<sup>1</sup> semiotic modes have gained material and discursive prominence. Guillén-Galve and Vela-Tafalla (2020: 2) advocate for the use of Multimodal Discourse Analysis, as developed by Kress and van Leeuwen (2001), as a “highly convenient” analytical tool in the analysis of multimodal digital research genres. Reid et al. (2016) argue that a lack of studies engaging explicitly with theories of multimodality can leave ESP-EAP practitioners and faculty in Writing Across the Curriculum questioning the relevance of instruction in multimodal literacy.

Multimodal move analysis may be a challenge to genre scholars as they need to expand their analytical repertoire to be able to scrutinize non-verbal semiotic modes with a similar level of detail as with verbal language. On a textual level, this implies developing principles, concepts, and accessible technological apparatuses to 1) describe the lexicogrammar of non-verbal modes, 2) understand intermodal interaction and the role each mode plays in move realization, 3) recognize cues of move boundaries in non-verbal modes, and 4) handle large corpora for quantitative data generation. On a contextual level, it implies developing strategies to address the highly specialized disciplinary symbolism of scientific images, informed by experts who themselves may not be sufficiently aware why images in their fields are the way they are. This unawareness has been attributed to the notion that visual scientific literacy seems to be more the result of intuition than of explicit formal training, rarely being part of higher education curricula (Archer, 2022; Reid et al., 2016).

It seems, thus, that the complexity of multimodal genres requires an equally complex toolkit for a comprehensive move analysis. One of the studies cited by Xia (2020: 147) as an example of multimodal move analysis was developed by Hafner (2018) on video methods articles published by *The Journal of Visualized Experiments*. According to Xia (2020: 147), “subsequent to the identification of the moves and steps involved in the genre, the author elaborates on how the written, spoken, and visual modes interplay” in the realization of moves. However, Hafner (2018: 29) himself acknowledges a disadvantage in multimodal move analysis: “constraints of space do not permit a full multimodal analysis of every move”, referring to a word limit. Conversely, his paper displays a significant amount of data generated from contextual analysis, drawing on multiple sources (for example, interviews with community insiders, handbooks, and guidelines). This is one example of how multimodal move analysis produces several layers of qualitative and quantitative data that may not all fit into the space of a traditional 8,000- to 10,000-word research article. The different layers of data may be 1) for each rhetorical move,

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<sup>1</sup> We define non-verbal semiotic modes as all those modes whose realization does not depend on the letters of the alphabet, such as music, image, or gesture. Conversely, we use ‘verbal modes’ to encompass two materializations: written language and spoken language.

qualitative data about linguistic cues in verbal language, cues in visual language, cues in another semiotic mode (sound, for example); 2) data resulting from crossing intermodal cues to determine “division of labour” (Hafner, 2018: 28) between modes in each move; and 3) quantitative data about obligatory and optional modes that realize each move. In the present work, we follow a similar approach to Hafner (2018) in the move analysis of GAs.

## 2.2. Move structure of GAs: previous studies

Current GAs differ substantially from their precedent paper versions. They are publications native to the web, which have expanded in number and range of areas since their inclusion in the Article of the Future project by Elsevier (for a systematic review on the subject, see Buehl, 2022). Web-native GAs have little more than a decade of life and, in terms of studies explicitly oriented to the analysis of the rhetorical moves of this part-genre, there seems to be no conclusive evidence about the predominant organization pattern. However, the works of Sancho Guinda (2015), Yoon and Chung (2017), and the doctoral research of Florek (2018) have provided insightful directions on the topic.

Sancho Guinda (2015: 73) claimed for the existence of a process of “formal dilution of the moves construct”, based on the analysis of teaser-abstracts published by a trans-national engineering association and of 16 models of GAs made available by Elsevier. Her study considered the repercussion of these texts within a small multidisciplinary community of engineering practitioners, in order to “determine moves trends and informants’ reactions” (Sancho Guinda, 2015: 73). The expert informants in her survey showed high dispersion in the identification of moves, which the author explains as an indication that GAs weaken the boundaries of areas of knowledge, making them more permeable for scientific communities from related and remote areas.

Yoon and Chung (2017) analyzed 772 GAs from 68 journals distributed across nine disciplines of Social Sciences in order to demonstrate how the part-genre has been adopted in the field. The authors found that Results was the most recurrent move in GAs across disciplines (48.3%), followed by a move that the authors (2017: 1377) called Overview (26.4%): a summary move that integrates “both the research process and key results (sometimes with the addition of background information)”. Introductions and Methods showed low occurrence (only 12% each). In relation to multimodality, the Results move in 63% of these GAs is realized by visuals that duplicate existing visuals in the manuscript, mainly in the form of quantitative charts and of conceptual diagrams that present “frameworks of conclusions drawn from the study results” (Yoon & Chung, 2017: 1376). As duplicates, these GAs seem to be mainly addressed to specialized readers in the Social Sciences.

Finally, in a study of 30 GAs in the fields of chemistry, engineering, and related interdisciplinary areas, Florek (2018) identified that Results and Methods were

obligatory moves, present in all the GAs. The author considered 15 journals and also conducted interviews with journal editors and GA authors, with the aim of identifying perceptions about form, function, and multimodality. The editors and authors in her work acknowledge the potential of GAs to attract more readers, but mostly expert readers. The authors in particular perceive the task of visually summarizing a paper for the general reader as a challenge to the future of GAs in their fields. In relation to multimodality, Florek (2018) also found Methods and Results are mainly realized by highly specialized visuals, such as chemical schemes, as 30% of the GAs use duplicates and 43.3% show images that are only slightly modified compared to those used in the article, for example, through the addition of color. The use of color may be interpreted as a recontextualization strategy, as discussed in the next section.

### 2.3. Science recontextualization strategies in GAs: previous studies

The salience of non-verbal semiotic modes in digital research genres and part-genres reflects the way knowledge circulates nowadays (Buehl, 2022) in the sense that “the Internet revolution has involved a shift from primarily print media to audiovisual material adapted to mobile devices” (Rowley-Jolivet & Carter-Thomas, 2019: 82). Static images, videos, sound, oral narration, and animations are constitutive in these genres, particularly in “add-on summaries” (Katsampoxaki-Hodgetts, 2022: 2) that orbit around the research article and are offered to readers free of charge across multiple sharing platforms (such as YouTube, Vimeo, Twitter, Instagram, or science blogs). Readers may become aware of a publication not because they searched for it in a journal’s homepage, but because it ‘fell into their lap’ through notification services and in formats that are tangible ‘at a glance’ to satisfy the reading behavior of users in the digital medium, characterized by zapping from one small piece of information to another (Rowley-Jolivet & Carter-Thomas, 2019).

The potentially maximized circulation of research findings (Pérez-Llantada, 2016) promoted by open access part-genres has also raised competition for visibility. Adding differentiating products in the form of new part-genres can be interpreted as a key strategy of journals to gain competitive advantage (Bhatia, 2005), increasing the “chances of being cited” (Cocchetta, 2022: 27).

The literature on digital research genres (e.g. Buhuel, 2022; Cocchetta, 2022; Sancho Guinda, 2022) has consistently observed the presence of interdiscursivity in these genres, in which the discourse of science interacts with the discourses of media (advertising and journalism) as a means to be appealing to readers with various degrees of expertise, who may be practitioners from the same field, researchers from other fields, or non-researchers. This “mediatization of science” (Rowley-Jolivet & Carter Thomas, 2019: 81) or colonization of science by “promotionalism” (Sancho Guinda, 2015, 2016) recognizes that non-technical readers play a role in increasing the visibility of a research paper, as has been argued in studies of science popularization discourse, and that knowledge transfer is not

linear from science to the public, but cyclical (Myers, 2003: 266). As explained by Coccetta (2022: 28), if a scientist and/or a journal is able to engage, for example, policy makers, journalists, and bloggers through a video abstract, because they “understand it, find it interesting”, chances are that it will be shared and that the article will be cited. These citation practices, despite unconventional from the standpoint of the scientific tradition, have been measured by altmetrics, which have been increasingly incorporated into journal homepages with the assumption they may influence impact factor parameters (Fire & Guestrin, 2019; Nishikawa-Pacher, 2022).

Promotional strategies in digital research part-genres can be analyzed under the concept of recontextualization by which textualizations of knowledge are adapted as they move from context 1 (science/academia) to context 2 (mass media) to meet the rhetorical expectations of context 2. This adaptation may involve translating or re(con)textualizing meaning from one semiotic mode into another<sup>2</sup>. According to Sancho Guinda (2016: 86), these movements demand “changes in the modern researcher’s role”, not because scientists would not reach out to the public before, but because “the Internet has immeasurably enlarged the variety of repertoires, contexts, and genres, in which scientists can present and discuss their work (Rowley-Jolivet & Carter-Thomas, 2019: 82).

The study of visual recontextualization strategies of scientific discourse has received some attention in the literature (Hendges & Marques, 2018; Luzón, 2019; Miller, 1998). In the context of science popularization news, Miller (1998) discussed the role of visual elements in a comparison of articles from *Science* and *Nature* with their popularizations in *Time*, *Newsweek* and *The New York Times* and popularizations within the academic journals themselves. The author argues that visuals in academic articles are designed to prove, while in popularization discourse they are designed to attract. According to the author, both functions are a question of persuasion, but the readers of research articles are seen as interested but unbelieving, while the readers in the context of popularization are seen as uninterested generalists. The author classifies the persuasive power of visuals in research articles as dependent on their propositional content, while the persuasive power of popular science images relies on the symbolic connections they establish with readers. As observed by Miller (1998: 40), these connections may be achieved through the *use of cartoons* (as readers can relate to them based on their knowledge of popular culture), the presentation of *simplified findings*, the depiction of *implications of the findings*, the use of *bright colors* with a modal function of attracting, the use of *individual creatures that the reader can identify with*, and the use of *narrative layout* that absorb the reader into a story instead of requiring the establishment of comparisons (as with the layout of tables).

In another study about images in 60 science popularization news from *BBC News International*, *Scientific American*, *ABC Science* and *Nature*, Hendges and

<sup>2</sup> We would like to thank Luzón (2019) for calling our attention to this definition of recontextualization that explicitly addresses the concept of semiotic mode, particularly relevant to our work with GAs.

Marques (2018) observed four visual recontextualization strategies: *popularization of the source* (use of stock pictures instead of replicating original images of research articles), *modalization* (use of photographs containing lifeworld scenes or characters instead of abstract coded scientific images), *grammatical simplification* (use of images with simple structures: one process and one participant) and *thematic generalization* (use of images that summarize the topic of the research article next to the title of the news report instead of images that address only a specific part of the research article, such as quantitative data).

In the context of digital research genres, visual recontextualization strategies have been discussed by Luzón (2019) and categorized into four groups: 1) *establishing authority and credibility* (through images that show researchers' affiliation, academic settings, and as experts "doing science" using scientific equipment, explaining aspects of their research); 2) *supporting arguments and claims* (through images that support the narrative, represent uses or applications, provide evidence for what is being said); 3) *tailoring information* (through images that represent/describe an object mentioned verbally, explain disciplinary procedures through video footage, facilitate understanding of concepts explained verbally by researchers' through symbolic representation); and 4) *engaging the audience* (through images that represent researchers in everyday situations to create intimacy and involvement, that represent the content mentioned in speech and that show expressions of feelings or emotional reactions).

In a previous work (Hendges & Florek, 2019), we explored GAs with an emphasis on its ties with "old" genres, which then seemed to be more directly related to the discourse of science, namely of research articles, particularly abstracts and visuals used in articles. Our results showed that GAs in chemistry and engineering were composed predominantly of exact or slightly modified reproductions of the visuals used in the original articles, which require a high degree of expert visual literacy to be produced, but, more importantly, to be interpreted, making GAs less accessible to non-technical audiences. The use of coded scientific images was also found to be most encouraged by editorial policies in the year 2016. In the current study, in addition to move analysis, we examine to what extent and how the general public is addressed in recently published GAs.

### 3. METHOD

In order to achieve the purpose of this study, our multimodal move analysis of the IMRD<sup>3</sup> structure in GAs relied heavily on classical genre analysis (Swales, 1990, 2004), which consists of identifying and labeling the functional units (i.e., rhetorical moves) of a sample of texts of the same genre, as well as patterns of organization of these units

<sup>3</sup> Swales (2004: 235) indicates that IMR[DC] and IMRC are also used in articles and suggests that due to this proliferation of options, the D in IMRD is best read as the sections that come "After the Results".



into a more or less fixed sequence. Paltridge (1994: 295) argues that the identification of moves and move boundaries is grounded on “a search for cognitive boundaries in terms of convention, appropriacy, and content rather than as a search for linguistically defined boundaries; that is, there are non-linguistic, rather than linguistic, reasons for generic staging in texts”. The identification process is based on: i) rich cues (verbal and/or non-verbal) and ii) paralinguistic information from the context (documents, insiders’ discourses). We use the terms ‘rich cues’ or ‘rich features’ following Barton (2004: 66), as particular linguistic configurations that appear repeatedly “in a text or a set of texts” with the same meaning and function in context.

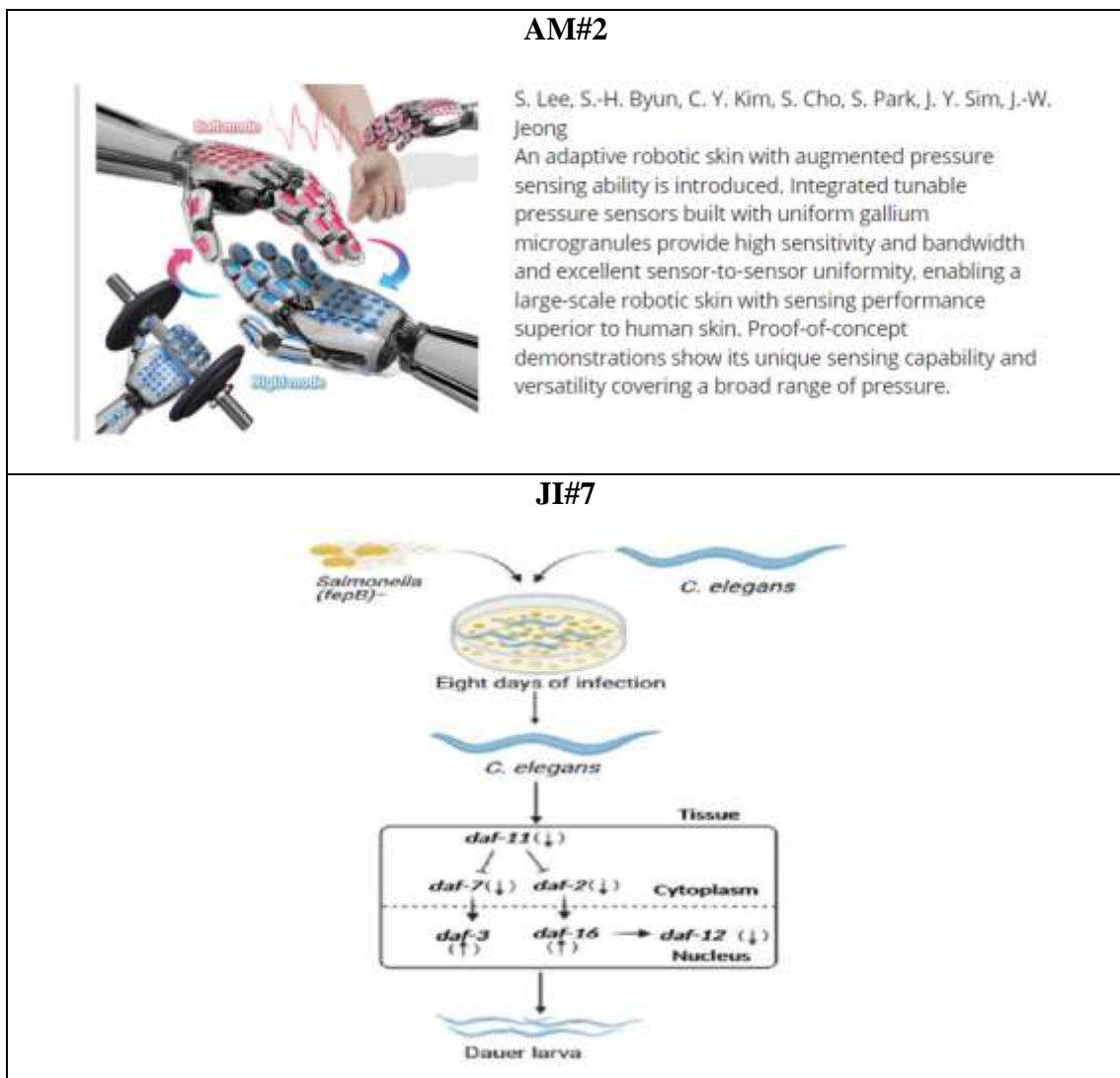
We examined 100 GAs (for a full list of sources see Appendix 1) 50 selected from five high impact chemistry journals and 50 selected from five high impact medicine journals (Table 1) (see Appendices 2 and 3 for high resolution examples in chemistry and medicine, respectively). The selection criteria were the following: i) relevance of academic publishers (cf. Larivière et al., 2015; Nishikawa-Pacher, 2022); ii) relevance of the journal within the publisher (cf. Thomson Reuters Impact Factor, 2021); and iii) order of appearance of the GA, from the most recent to the oldest, up to a total of 10 GAs per journal. The contextual counterparts were the GA guidelines of the 10 journals (written directions, templates, and/or examples) and of the publishers.

CHEMISTRY				MEDICINE			
Publisher	Journal	Acronym	GA status	Publisher	Journal	Acronym	GA status
Elsevier	<i>Joule</i>	JOULE	Obligatory	Elsevier	<i>Journal of Infection</i>	JI	Obligatory
Wiley	<i>Advanced Materials</i>	AM	Optional	Wiley	<i>European Journal of Heart Failure</i>	EJHF	Optional
American Society of Chemistry/ACS	<i>Accounts of Chemical Research</i>	ACR	Optional	American Medical Association/AMA	<i>Journal of the American Medical Association</i>	JAMA	Optional
Royal Society of Chemistry/RSC	<i>Energy &amp; Environmental Science</i>	EES	Optional	British Medical Association/BMA	<i>British Medical Journal</i>	BMJ	Optional
Springer	<i>Microchimica Acta</i>	MA	Optional	Massachusetts Medical Society/MMS	<i>The New England Journal of Medicine</i>	NEJM	Optional

**Table 1.** Journals in the sample and the status of GAs

In order to develop a discipline-sensitive strategy for the identification of rhetorical moves and move boundaries in the GAs, each author initially examined one set of 10 GAs from a single journal: author 1 examined the 10 chemistry GAs of *Joule* and author 2 the 10 medicine GAs of *European Journal of Heart Failure*. Based on this pilot examination, we determined that the following minimum “input” units

should guide our multimodal move analysis: headings, reading path (left-right, top-bottom or other indicated by vectors), space gaps (implicit framing), explicit framing, types of visual (tables, graphs, and charts typically associated with the presentation of data). Next, we also established a coding scheme to quantify the predominant semiotic mode(s) that realizes each move in the GAs: WI = words & images, W = words, and I = images. Tables or figures that present, for example, single words in table cells, labels for vertical and horizontal axes, numerical data, were classified as I = images, because we consider these types of written bits as inherently part of those types of visuals. To exemplify, the portion on the left in AM#2 and the whole JI#7 (Figure 1) were both classified as Results being realized by image-only, because the words that are present function exclusively as labels.



**Figure 1.** Examples of the Results move realized by the semiotic mode of image

With these tools in hand, each author then individually analyzed the remaining 40 GAs in the respective field: first author – in chemistry, second author – in medicine. This involved a manual and gradual route from skimming to scanning, against the backdrop of the Instructions for Authors of each journal and of previous literature on GAs. In the last stage, the results of the coding process were exchanged between authors and dubious instances were debated and classified after agreement of both authors.

The identification of moves in medicine GAs of BMJ and JAMA was straightforward, guided by section headings.<sup>4</sup> These can thus be called “structured GAs”, following the known label for verbal abstracts in medicine (Hartley, 2014; Hartley & Sydes, 1997; Nakayama et al., 2005), which were introduced “to assist clinicians in quickly finding articles that are both scientifically sound and applicable to their practices” (Nakayama et al., 2005: 237). Move recognition was also facilitated by the template design of the NEJM GAs, with each move placed in the same position, with standard color scheme and font type. In the other 20 GAs (of JI and EJHF), move identification was strongly guided by contextual awareness in relation to the role and content expected of GAs, supported by previous studies and journal guidelines.

For contextual analysis, AntConc 4.2.0 (Anthony, 2023) software was used to map information about the discursive practice in Author guidelines, based on the recurrent designations for the practice: graphical abstract, visual abstract, and TOC graphic. We mapped general discursive information about GA such as definition, status in the journal, place of appearance, purpose, target audience, genres with which it is associated and explicit references to the IMRD pattern and to strategies to address non-experts in the fields of chemistry and medicine.

## 4. RESULTS AND DISCUSSION

### 4.1. IMRD in GAs

We found that the GAs in our sample do not adhere to the IMRD pattern. If our results were generalizable to the whole sample, we could say that the pattern that predominates is R, as only Results is an obligatory move, occurring in all 100 GAs (Table 2). Nonetheless, our findings show significant disciplinary variation, justifying a separate treatment for each discipline. Thus, while the R (Results) move pattern holds true for the GAs in chemistry, in the medicine GAs, Methods and Conclusion were also typical (90% and 80% respectively), so their move pattern is MRC (Methods – Results – Conclusion).

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<sup>4</sup> Headings used in BMJ GAs: Summary, Study Design, Population, Outcomes, Results; in JAMA GAs: Question, Conclusion, Population, Locations, Intervention, Primary Outcome, Findings.

	INTRODUCTION		METHODS		RESULTS		DISCUSSION		CONCLUSION	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Chemistry	6	12	3	6	50	100	2	4	8	16
Medicine	27	54	45	90	50	100	–	–	40	80
<b>TOTAL</b>	<b>33</b>	<b>33</b>	<b>48</b>	<b>48</b>	<b>100</b>	<b>100</b>	<b>2</b>	<b>2</b>	<b>48</b>	<b>48</b>

**Table 2.** Adherence to the IMRD move pattern in the sample of chemistry and medicine GAs

Across journals, there is more standardization within chemistry than within medicine (Table 3). In chemistry journals, the occurrence of the Introduction, Methods, Discussion, and Conclusion is very low; only in the journal AM is the Conclusion used in 50% (*n* = 5) of the GAs, still considered low for genre analysis purposes.

		INTRODUCTION	METHODS	RESULTS	DISCUSSION	CONCLUSION
Chemistry	ACR	–	–	10	1	–
	AM	4	3	10	1	5
	EES	1	–	10	–	1
	JOULE	1	–	10	–	2
	MA	–	–	10	–	–
	<b>TOTAL</b>	<i>n</i>	<b>6</b>	<b>3</b>	<b>50</b>	<b>2</b>
	%	<b>12</b>	<b>6</b>	<b>100</b>	<b>4</b>	<b>16</b>
Medicine	BMJ	7	10	10	–	10
	JAMA	10	10	10	–	9
	NEJM	–	10	10	–	10
	EJHF	6	7	10	–	6
	Jl	4	8	10	–	5
	<b>TOTAL</b>	<i>n</i>	<b>27</b>	<b>45</b>	<b>50</b>	–
	%	<b>54</b>	<b>90</b>	<b>100</b>	–	<b>80</b>

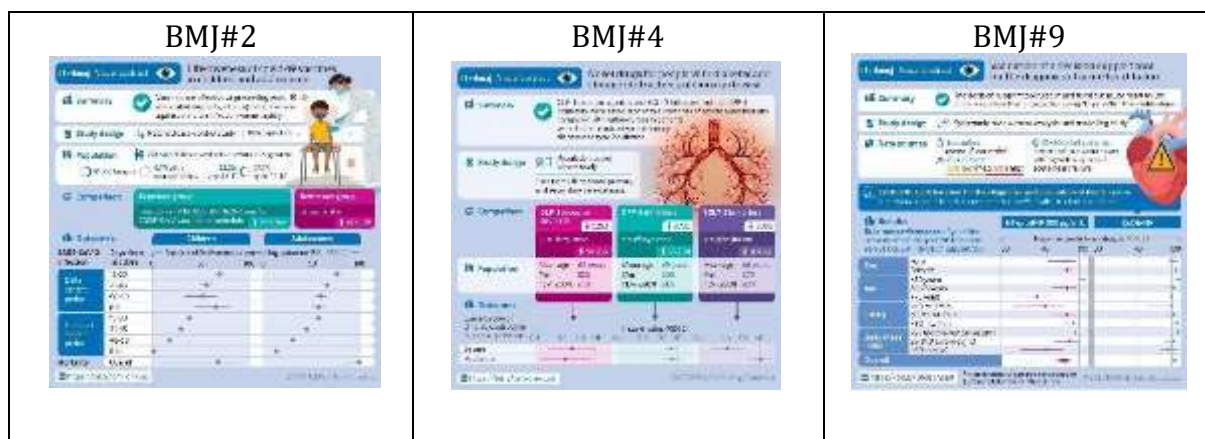
**Table 3.** Adherence to the IMRD move pattern in GAs across journals

Among the medicine journals, findings indicate that JAMA GAs have four obligatory moves – Introduction, Methods, Results, and Conclusion, while in NEJM and BMJ, Methods, Results, and Conclusion occur systematically, and that also Methods (70%) in BMJ is highly frequent. In the samples of Jl and EJHF, only Results are consistent in all the GAs, although Methods also occur frequently (80% and 70% respectively).

Although the use of GAs in medicine journals may be a recent practice – in BMJ they were introduced in 2018 (Stahl-Timmins et al., 2019) – they are highly standardized at least in BMJ, JAMA and NEJM. This regularity may be explained by

the number of contextual similarities these journals share in terms of long history, clinical scope (instead of theoretical/conceptual), primary readership (medicine doctors: general practitioners, primary care physicians) and representativeness, in that all hold top positions in the 2021 *Journal Citation Report* (Clarivate, 2022). They are thus direct competitors for visibility, which, from a marketing point of view, may boost similarity (in terms of copying what works well), while simultaneously pushing for ‘product differentiation’ (Bhatia, 2005). The similarity in their GAs is evident in that all three journals use template graphics, i.e., predefined designs that follow standardized structures and visual and verbal resources (layout, headings, color schemes, framing, and types of illustrations) to present content (Figure 2). The uniqueness is achieved by the different design aesthetics each journal adopts, for example, color saturation and differentiation are bolder in BMJ and NEJM GAs compared to the GAs of JAMA, whose color scheme is softer and closer to monochromatic.

In the remainder of medicine journals – JI and EJHF – GAs are more similar to those in the five chemistry journals in that they are author-submitted and each one has an individual visual style. This result is consistent with previous findings about diversity in GA designs and content (Hendges & Florek, 2019; Sancho-Guinda, 2015), and has been interpreted as a challenge to the status of GAs as a genre, while raising discussions about generic stability-flexibility (tensions between centripetal and centrifugal forces), generic multi-functionality (attracting, reporting, persuading), and generic symbiosis (evolution and inter-dependency ties within genre families) (see discussions in Pérez-Llantada & Luzón, 2019).



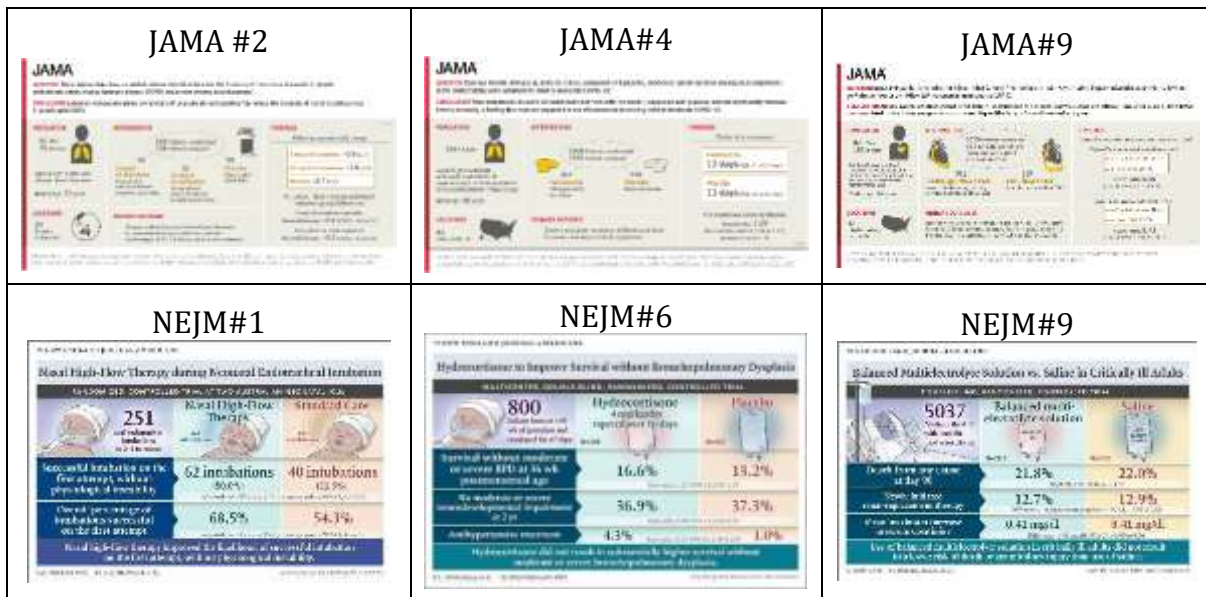


Figure 2. GAs as template graphics in the three high impact medicine journals

Previous studies on GAs considered samples published until 2016, and variety was interpreted as a symptom of the earlier stage of the genre when “most effective practices” were still under construction (Hendges & Florek, 2019: 77). Our current sample, however, is of GAs published in 2022, and except the “template” GAs of BMJ, JAMA, and NEJM, diversity is still a dominant feature. Because they share a communicative purpose with advertisements, GAs may never become as stable in form as other research genres, because advertisements are “one of most dynamic and versatile genres of public discourse today, in that it can boast of some of the most varied and innovative uses of lexico-grammatical and discoursal forms and rhetorical strategies” (Bhatia, 2005: 214). However, some stability or “controlled flexibility” (Sancho Guinda, 2015: 85) is expected for the sake of genre recognition and reproduction, as clarity in the representation of rhetorical moves in GAs has been evaluated as crucial to interpretation (Sancho Guinda, 2015: 83).

It could be expected that the two sets of journal from the same publishers – in chemistry and medicine respectively JOULE and JI from Elsevier; AM and EJHF from Wiley – would show similarities in the IMRD pattern of GAs. Elsevier in particular proposes a template of “how to produce a good visual abstract”, which presents three horizontally parallel frames, with two possible types of move patterns: pattern 1 – I (“introduce the context of your research”) + M (“here is where you showcase your methodology”) + R/D/C (“finally this panel is for explaining your main outcome”) or pattern 2 – “make your first point” + “make your second point” + “finally this panel is for [...] hosting the third point”. In both JOULE and JI, GAs are obligatory, but no regularity was observed across journals or within them. The same is true for the GAs of the Wiley journals, AM and EJHF.

Finally, in relation to the sequence of the moves, the most interesting finding is that the Conclusion comes before the other moves in 25 of the 48 GAs (52.1%) that show this move. This position for research conclusions has been observed in popular science genres, following the conventions of newsworthiness-first of journalism. This interdiscursivity of GAs with news discourse is explicitly acknowledged by the graphic designers of the medicine BMJ GAs (Stahl-Timmins et al., 2019), who explained that the two first GA prototypes launched by the journal in 2018 had the Conclusion at the bottom, but it was moved to the top after a survey with 77 doctors revealed that they “were struggling to get an overview of the study findings until they had finished reading the entire abstract” (Stahl-Timmins et al., 2019: 106). It can be inferred from this struggle that the BMJ GA is not readable “at a single glance”, as is often recommended for this part-genre, and one reason may be that there is a significant amount of verbal language in GAs in the form of paragraphs, which take more time than a single picture to be read (spatial vs. temporal logic). In the following section, we explore move realization in relation to multimodality.

#### 4.2. Multimodality in the IMRD of GAs

The findings about multimodality reveal, expectedly, that images are central in move realization. In other words, 71.9% of the moves include some degree of graphic material. In the realization of Results, images (I) are obligatory, either as an exclusive mode (52%) or in combination with words (WI) (48%). Table 4 shows how multimodality works in GA move realization.

	INTRODUCTION			METHODS			RESULTS			DISCUSSION			CONCLUSION		
	WI	W	I	WI	W	I	WI	W	I	WI	W	I	WI	W	I
Chemistry	1	3	2	–	3		19	–	31	1	1	0	–	7	1
Medicine	2	18	7	38	5	2	29	–	21	–	–	–	12	28	–
<b>TOTAL</b>	<b>3</b>	<b>21</b>	<b>9</b>	<b>38</b>	<b>8</b>	<b>2</b>	<b>48</b>	<b>0</b>	<b>52</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>12</b>	<b>35</b>	<b>1</b>
%	9.1	63.6	27.3	79.2	16.7	4.2	48	0	52	50	50	0	25.5	74.5	2.1

**Table 4.** Semiotic modes in the GA IMRD realization

The central role of images in the presentation of Results is consistent across disciplines, but more salient in the chemistry GAs, because Results are the only obligatory move and they are visual-only in 62% of cases (31 GAs). In the remaining 19 GAs that present multimodal Results, written language is realized mostly by long noun-phrases as headings of a graph, table, or diagram.

The most frequent multimodal move in the GAs is Methods, realized by verbal and visual language in 79.2% of the sample as a whole, but this is only generalizable

to the medicine GAs, whose Methods are obligatory. Images are frequently used to represent the population, part of the world, or specific part of the body, virus, or bacteria under study; and the written language provides details about the population (age, gender, health condition) and the methodological procedures, typically in the form items on a list. Finally, written language has a central role in the realization of Introductions and Conclusions in both disciplines. These moves are predominantly realized by writing only, through whole sentences or short blocks of text. This result is more significant in medicine GAs, in which these moves are more present.

Figure 3 summarizes the generic structure of GAs giving emphasis to the semiotic modes that primarily realize each move, inspired by Cheong (2004: 165).

<b>Visual moves</b>	<i>Results</i> (obligatory in chemistry and medicine)
<b>Multimodal moves</b>	<i>Methods</i> (obligatory only in medicine) <i>Results</i> (obligatory in chemistry and medicine)
<b>Written moves</b>	<i>Introduction</i> (optional in chemistry and medicine) <i>Conclusion</i> (obligatory only in medicine)

**Figure 3.** Generic structure of GAs with an emphasis on the realization modes

Figure 3 helps to highlight the key role of visual language in the realization of the obligatory moves Methods and Results, that is to say, in those moves that characterize this part-genre.

#### 4.3. Visual recontextualization strategies in GAs

The analysis of visual recontextualization strategies in scientific discourse in GAs was inspired by categories proposed in previous work (Hendges & Marques, 2018; Luzón, 2019), but was also based on our first impressions about GAs, because both of us (the authors) are part of the general public to whom these strategies may be addressed. Simultaneously, we both have experience with general conventions of academic discourse of research articles as to the use of color, the types of illustrations used for data visualizations and word highlighting options. We believe these social positionings helped in our interpretations, although we are aware that even within the same level of expertise (be it expert or non-expert), interpretive abilities may vary considerably among individuals and interpretation is not infallible.

With this in mind, we identified seven types of strategies that may contribute either to attracting non-technical readers or to aid comprehension of the scientific process-product summarized by the GAs (Table 5). These are two major functions of the recontextualization of scientific discourse that respectively relate to promotional discourse and to pedagogic discourse (Luzón, 2013: 437).



Four strategies seem to be promotion-oriented: the use of color with interpersonal value (93%), the use of images showing elements of everyday life that readers can relate to (52%), salient typeface through size and/or color (40%), and humor (1%). Three strategies seem to contribute mainly to identifying the type of content that each visual cluster in the GA deals with and the proposed reading trajectory: the use of explicit frames to delimit blocks of information (84%), the use of vectors and/or parallel panels to indicate sequence of information (68%), and the use of explicit headings to introduce visual clusters (28%).

		INTERPERSONAL COLOR	EXPLICIT FRAMES	VECTORS/PANELS NARRATIVIZATION	EVERYDAY-LIFE ELEMENTS	SALIENT TYPEFACE	EXPLICIT HEADING	HUMOR
BMJ		10	10	10	10	10	10	–
JAMA		10	10	10	10	10	10	–
NEJM		10	10	10	10	10	–	–
EJHF		8	10	4	3	4	6	1
JI		9	7	9	6	5	2	–
TOTAL Medicine	n	47	47	43	39	39	28	1
	%	94	94	86	78	78	56	2
ACR		10	2	4	3	–	–	–
AM		8	10	4	4	–	–	–
EES		10	10	5	1	1	–	–
JOULE		8	10	3	2	–	–	–
MA		10	5	9	3	–	–	–
TOTAL Chemistry	n	46	37	25	13	1	–	–
	%	92	74	50	26	2	–	–
<b>TOTAL</b>		<b>93</b>	<b>84</b>	<b>68</b>	<b>52</b>	<b>40</b>	<b>28</b>	<b>1</b>

**Table 5.** Visual recontextualization strategies across journals and disciplines

Across disciplines, two strategies – one for each purpose (attract and clarify) – are consistently salient: the use of color and the use of frames for grouping content. Nonetheless, in medicine GAs another three strategies are also highly frequent: the use of vectors (86%), the use of images that show everyday activities, objects, and situations (e.g., drawings of people, internal organs, syringes, IV bags, stethoscopes, geographical maps, pills) (78%), and salient words and numbers (78%). These almost overlapping cues for achieving clarity are consistent in the three journals – BMJ, JAMA, and NEJM – intended for healthcare professionals and relate to the clinical applied nature of the studies they disseminate.

In chemistry GAs, a more theoretical field, all the strategies are more subtle than in the medicine GAs, and the degree to which they influence the attention of non-technical readers is disputable. In previous work (Hendges & Florek, 2019) we found that experts in chemistry rarely see GAs as intended to the general public.

Sancho Guinda (2022: 11) observes that some types of “prettifications” in chemistry GAs such as “cartooning and comic book techniques” may lead to misinterpretation even among experts. In general terms we observed that GAs in chemistry have evolved from the 2016 sample in one aspect: the images in the GAs are produced exclusively for this purpose because they are no longer reproductions of the images used in the body of the article. This can be attributed in part to journal policy, as three journals either ban (Joule and ACR) or discourage (EES) reusing article visuals in GAs. Other than that, the author guidelines give little detail about recontextualization strategies, but emphasize clarity by the indication of clear reading paths from top to bottom or from left to right (as shown earlier in section 4.1., this is achieved by cues such as vectors and explicit framing).

These findings suggest that the different natures of each disciplinary culture and the scope of each journal affect degrees of recontextualization in GAs. Hence, in addition to the cues found in the textual materiality of GAs, it is also central to reflect about contextual aspects in their production and consumption processes. For example, a key feature in the production process of the medicine GAs of BMJ, JAMA and NEJM is that they are elaborated in-house by the journals’ graphic designers, in interaction with authors. Will Stahl-Timmins (2021), the lead GA graphic designer of BMJ, explains that the journal chooses which article will have a GA and they ask authors “to extract data from their paper” in a standard template which will then be transformed into a GA by the graphic design team. Thus, the first non-expert audience of these papers seems to be the graphic designers, who need a reasonable understanding of the study reported in the article to make decisions about how to ‘transform’ it into a GA. A similar situation takes place when science journalists write popular science news (Calsamiglia & Van Dijk, 2004; Myers, 2003). This similarity with popular science journalism may be observable in the distribution of the moves in the GAs of BMJ and JAMA, in the placing of the Conclusion at the top portion, as pointed out earlier.

As the literature on the GA has indicated (Hendges & Florek, 2019; Sancho Guinda, 2015, 2016), reception studies are needed to determine to what extent the addition of color and drawings contribute to make the GAs in Figure 1 palatable to the general reader, assuming that is the purpose of these GAs.

## 5. CLOSING REMARKS

In 2012, the Article of the Future user-centered design team (Aalbersberg et al., 2012) stated that the project offered authors opportunities for increased exposure and readers opportunities to optimize the relation with research themes. In this study, we were able to verify, through a multimodality-based study, whether these two main purposes have been achieved and how, with a focus on GAs.

We hope that our analysis of a relatively consistent sample of GAs from two areas recognized for their strong adherence to the genre can bring useful insights for ESP-EAP research and practice, mainly in relation to the multimodal

performance of rhetorical moves and visual popularization strategies. For example, because of the recontextualization strategies found in the GAs of BMJ, JAMA and NEJM, these could be an interesting material for introductory levels of English for Medical Purposes, in the teaching and learning of multimodal reading and/or writing (García-Ostbye & Martínez-Sáez, 2023).

An interesting finding of our study is the perceptible cline in the recontextualization process in GAs from chemistry to medicine, with chemistry GAs closer to the end of specialist readers and medicine GAs closer to the end of non-specialists. Signals of popularization are found in both areas, but notably in medicine, whose audience crosses university boundaries and reaches health professionals in the field, unlike chemistry, which, due to its nature as a basic science, contributes more to other academic areas. Corroborating this perception, GAs in medicine maintain a strong relationship with the structured written abstract, presenting verbal and visual resources in a more balanced way. They present more moves, introduced by section headings, demanding a longer reading time than GAs in chemistry, which focus on research results and are strongly visual.

According to the results of the present study, it seems clear that the stability of a specialized genre strongly depends on its reading against the contextual background. GAs in particular perform more than the function of a part-genre, since they function as add-on summaries (that is, texts to appear together with similar others with the same encapsulating purpose), but differ significantly in register, regarding the interpersonal relationships they establish with the intended readership.

Studies like this one can be refined by increasing their sampling volume, their number of contrasted disciplines, and by incorporating a deeper ethnographic or intermodal focus. Due to constraints of space, we were not able to include a closer analysis of the nature of the images that realize each move, a topic that deserves attention in future works. In any case, we believe our results provide interesting insights to pedagogization for the purposes of scientific and multimodal literacy.

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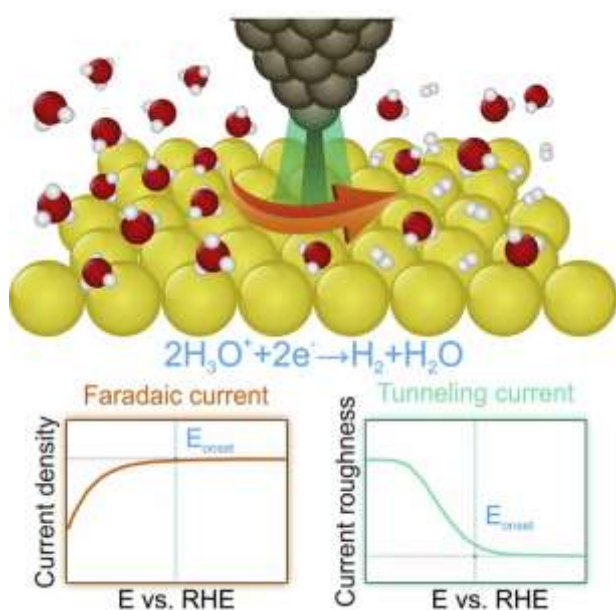
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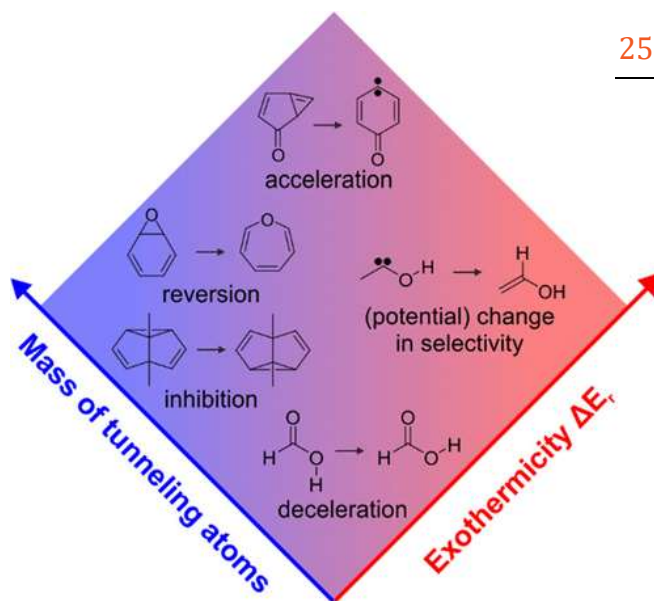
[Appendix 1: Access to GA sources](#)

**Appendix 2: Examples of GAs in Chemistry**



JOULE#8

<https://doi.org/10.1016/j.joule.2022.02.010>

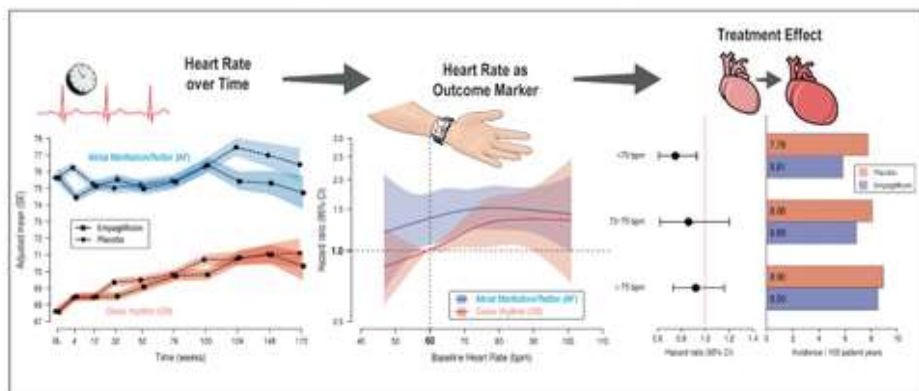


ACR#6

<https://doi.org/10.1021/acs.accounts.2c00151>

**Appendix 3: Examples of GAs in Medicine**

Key question(s)	Key finding(s)	Take-home message
Does resting heart rate in sinus rhythm or atrial fibrillation associate with outcomes in atrial fibrillation or sinus rhythm and modifies the treatment effect of empagliflozin.	Empagliflozin did not change heart rate over time. The primary outcome increased with resting heart rate only in sinus rhythm but not in atrial fibrillation. Baseline resting heart rate had no influence on the treatment effect of empagliflozin.	Resting heart rate associates with outcomes only in sinus rhythm but not in atrial fibrillation. Empagliflozin reduced outcomes over the entire resting heart rate spectrum without increase of adverse events.



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### Mitapivat vs. Placebo for Pyruvate Kinase Deficiency

PHASE 3, RANDOMIZED, CONTROLLED TRIAL

80 Adults with pyruvate kinase deficiency	Mitapivat (N = 40)	Placebo (N = 40)
Sustained increase $\geq 1.5$ g/dl in hemoglobin level from baseline	40%	0%
Average change in hemoglobin level	1.7 g/dl	-0.1 g/dl
Adjusted difference, 39.3 percentage points; 95% CI, 24.1–54.6; two-sided $P < 0.001$		
Difference, 1.8 g/dl; 95% CI, 1.2–2.4; two-sided $P < 0.001$		
Mitapivat increased hemoglobin level, decreased hemolysis, and improved patient-reported outcomes.		

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