Choosing the right pond: Street graffiti clusters by aesthetic quality

# Abstract

Assuming that graffiti writers aspire their work **to be** appreciated, **and** that the presence of higher-quality graffiti **diminishes** appreciation of lower-quality graffiti, we hypothesize that competition between graffiti writers reduces the aesthetic variability of graffiti within the same street segments. We empirically test whether graffiti types of different aesthetic quality have a reduced likelihood of being **co-occurring** in the same street segment. We record the location and aesthetic quality of 13,097 graffiti through systematic social observation in 2,201 street segments by 207 observers in Ghent, Belgium, distinguishing three levels of aesthetic quality: low (tags), high (masterpieces), and medium (stencils, illustrations, throw-ups, and slogans). We calculate Morisita-Horn indices to quantify the co-presence of different graffiti quality levels and compare the observed values with null models that assume graffiti writers are indifferent to the presence and quality of other graffiti. As hypothesized, we find less co-presence of different graffiti types than would be expected in the absence of aesthetic competition. Compared **with scenarios in which** graffiti writers are indifferent to the aesthetic quality of competing graffiti, masterpieces are less likely to be co-present with both tags and medium-level graffiti types, and medium-level graffiti types are less likely to be co-present with tags. Our results suggest that finding the right spot for graffiti is not just a matter of identifying a location with high visibility but also a matter of finding a spot where it can compete with other graffiti. This insight strengthens support for spot theory and might also inform graffiti management.

**Keywords**: Graffiti, Aesthetic Quality, Competition, Spot Theory, Location Choice

*Graffiti is not just art – it is also sport, and the fields of this sporting competition are the spots where graffiti is written.* (Ferrell and Weide, 2010)

# Introduction

Contemporary graffiti is a phenomenon at the intersection of street art and vandalism. It emerged in the 1970s in New York and Philadelphia and has spread across the world since then. Graffiti consists of writings or drawings made on walls and other surfaces, typically in public spaces and without permission. It has been studied through the disciplinary lenses of history, sociology, geography and psychology and in applied fields such as architecture, criminology and urban studies.

One of the key aspects of graffiti is its location, i.e., the question of where it is created and why there rather than elsewhere. Do some areas, streets or buildings get more or different graffiti than others, and why is this the case? What makes the former more attractive to graffiti writers than the latter?

Prior theoretical and empirical work has provided partial and tentative answers to these questions. Spot theory (Ferrell and Weide, 2010) states that graffiti writers seek visibility and, therefore, prefer to target locations that are maximally visible to large audiences. Both ethnographic and quantitative empirical research supports this hypothesis. When graffiti writers talk about prioritized spots, they emphasize locations that are visible and eye-catching. Observational research confirms that graffiti is concentrated in places that attract large crowds.

According to spot theory, aesthetic competition between writers also drives the location of graffiti. Graffiti writers must compete with each other not only for visibility but also for recognition: their work must not only be seen, but it must also be appreciated by its audience. Because graffiti varies greatly in terms of aesthetic quality, when graffiti writers choose a spot for their work, they should not only consider how many people will see it but also take into account the presence and the quality of other writers’ graffiti that may affect the appreciation of their own work.

While spot theory claims that existing spots with high-quality graffiti “by definition” attract new graffiti writers of all skill levels, we argue that the presence of higher-quality graffiti deters writers of lower-quality graffiti because to be positively appreciated, graffiti should stand out and not be dwarfed by the presence of higher-quality graffiti. We thus suggest that graffiti writers care about relative status and, therefore, choose ‘the right pond’ where their graffiti can compete in their own league for recognition (for an elaborate discussion on the role of relative status in human behavior, see Frank, 1985). If our claim is correct, aesthetic competition between writers should discourage the mixing of different levels of aesthetic quality and thereby generate clustering of graffiti by aesthetic quality. The present research aims to test this hypothesis empirically.

Our contribution to the literature on graffiti is that we add systematic empirical research on how competition between graffiti writers influences their location choices, an element of spot theory that has neither been explored extensively nor been tested rigorously with observational data. The findings may help us to better understand how graffiti writers choose graffiti spots. In addition to serving a theoretical goal, an improved understanding of how graffiti writers choose spots might also inform graffiti policies that aim to either broaden or restrict opportunities for writing graffiti or for writing specific types of graffiti.

The next section elaborates the line of argument outlined above by building on the relevant theoretical and empirical literature. The subsequent sections document the data and methods and present the results of the analysis. The final section concludes by discussing the findings, listing limitations and suggesting routes for future research.

# Theory and hypotheses

Graffiti is the result of purposeful action by the people who create it: graffiti writers. Understanding its geography requires knowing how they select their target locations and knowing the factors that affect this decision. To get there, we need to first understand the motivations behind graffiti writing: Why is it being done in the first place?

There are many possible motivations for getting involved in graffiti writing. They include artistic expression, challenging authorities, influencing public opinions, obtaining status amongst fellow graffiti writers and other peers, and the thrill of danger (Ferrell, 1995; Iveson, 2010; Schacter, 2008; Van Loon, 2014). What these aims have in common is that to achieve them, graffiti must be exposed to an audience, preferably a large audience. Graffiti must be seen by others in order to make a difference. Painting graffiti on your bedroom wall may function as self-expression at best, but is unlike to give a thrill, convince others of a political statement or generate status and recognition amongst peers.

Spot theory argues that because reaching a large audience is such a salient objective for graffiti writers, they prefer to write graffiti in locations with high public exposure (Ferrell and Weide, 2010). This claim has been supported in ethnographic research involving participant observation and interviews with graffiti writers in Lisboa (Campos, 2013), Amsterdam (Van Loon, 2014) and London and New York (Mcdonald, 2001). Quantitative research using systematically collected graffiti observations in San Francisco (Megler et al., 2014) , São Paulo (Tokuda et al., 2021) and Ghent (Kuralarasan et al., 2024) also demonstrates that graffiti is more likely to occur in places where it will be seen by many people.

Because space and the attention of an audience are scarce resources, graffiti writers must compete with each other for locations that have a high public exposure. Any given surface can only have a limited amount of graffiti simultaneously, and any given member of the public can only view a single item at a time. However, according to spot theory, competition between graffiti writers is not only about being the first to exploit the best spot with most exposure, but also about the aesthetic quality of graffiti (Ferrell and Weide, 2010).

Graffiti exists in various styles and forms that vary hugely in terms of aesthetic quality (Phillips, 1999). It has been classified into distinct types, the most common ones being tags, throw-ups, stencils, slogans, and (master)pieces (Dovey et al., 2012). Tags are typically text-based inscriptions that represent the names of the writer or an associated group. Throw-ups are bubble writings or other styles that are typically larger in size than tags. Stencils are applied using spray paint, while slogans are textual, generally political or poetic. Masterpieces are elaborate and complex, involve multiple colors and detailed designs. The differences between these types also reflect an aesthetic ranking within the graffiti subculture, based on the complexity of the graffiti and on the skills, time and effort required for their creation (Dovey et al., 2012). Although the boundaries between types can sometimes blur, there is a general agreement that **masterpieces** are at the top of this ranking, that tags are at the bottom, and that the other types (stencils, throw-ups, illustrations and slogans) rank somewhere in between. This ranking also expresses societal perceptions more broadly. Masterpieces may be sponsored and artists are sometimes encouraged to produce these works to transform public spaces into visually compelling environments (Campos, 2013; McAuliffe, 2012; Zhang & Chan, 2022). Tags, in contrast, are usually perceived by the general public as mere acts of vandalism (Campbell et al., 2008; Vanderveen and van Eijk, 2016).

This idea of competition between graffiti writers begs the question of which role aesthetic quality plays in the location choices of graffiti writers. Ferrell and Weide (2010) claim that spots containing high-quality graffiti “by definition” attract new graffiti writers, although they do not precisely explain why. Do other graffiti writers’ reputations profit from their work being seen in the proximity of a reputable writer’s work? And what about writing new graffiti in a spot dominated by simple tags? And how would such considerations be affected by the skill level of the prospective graffiti writers who are choosing a spot?

Recognizing the role of *relative* status in human decision making (Frank, 1985), we hypothesize that graffiti writers care about relative status and therefore prefer their own league of aesthetic quality when deciding on where to write their graffiti. More specifically, we suggest that in the perception of graffiti writers, to be positively appreciated (by the general public, and within the graffiti community), their own graffiti creations should not be dwarfed by the presence of higher-quality graffiti. If this argument is correct, the presence of higher-quality graffiti should deter writers of lower-quality graffiti, with the collective outcome that graffiti tends to cluster in locations based on its aesthetic quality.

Informed by the distinction between high-quality, medium-quality and low-quality graffiti, we hypothesize a reduced co-occurrence of graffiti of these three graffiti types.

In ecological studies, niche partitioning describes how different species exploit distinct environmental conditions to reduce direct competition. By analogy, street segments can be viewed as ‘urban niches’ in which graffiti writers ‘partition’ space according to aesthetic quality. When masterpieces, SITS, or tags are less likely to coexist, it mirrors the way species avoid overlapping niches to maximize survival. Here, graffiti writers balance competing needs for visibility, recognition, and subcultural status, much as organisms in nature balance resource exploitation with competition. Employing the Morisita-Horn Index allows us to measure the extent to which these graffiti ‘types’ share or segregate their urban habitats. If we consistently find less co-occurrence among different aesthetic levels than expected by chance, it supports the notion that graffiti writers—like species—deliberately partition their habitat to minimize direct aesthetic competition and enhance their individual standing.

# Data[[1]](#footnote-1)

We investigated graffiti in the city center of Ghent, Belgium. The data were collected using systematic social observation (SSO). SSO involves the direct, systematic observation of physical and social features of neighborhoods, streets and other geographic entities. It is a common method for measuring indicators of physical and social disorder in the community that other sources, such as administrative records or remote sensing technologies, may overlook (Bloch, 2020). We created a structured observation form to classify and document graffiti across all street segments in the city center of Ghent (see Appendix 1). A team of 207 observers, undergraduate-level students from X[[2]](#footnote-2) University, were trained for a month in the use of this form to code observations before they went out into the streets to collect the data.

We adopted street segments as our spatial unit of analysis, aligning with recent research advocating the use of street segments or similarly sized spatial units for measuring and analyzing crime and disorder (Groff et al., 2010; Weisburd et al., 2004). A street segment encompasses both sides of a street between intersections. The size and shape of a street segment naturally corresponds to human observational limitations, in particular those of direct visual perception, making it especially relevant for measuring exposure to graffiti. From nearly any vantage point within a street segment one can see graffiti present elsewhere in that segment, whereas graffiti outside the street segment (e.g., around the corner) is mostly invisible. This unique characteristic is optimal for measuring the ‘competition for attention’ aspect of graffiti and is not shared by smaller or larger spatial units.

We chose to define the geometry of street segments using polygons rather than the more common ‘street midline’ representations. Although street midline representations provide an appropriate approximation of the true geometry of grid-structured street networks, they do does not capture well the complexities of urban spaces in older European cities like Ghent. Our classification of street segments includes bridges, intersections, and standard street segments (refer to Appendix 2 for the map).

We categorized the six graffiti types distinguished on the observation form (see Appendix 1, Type) into a three-level ranking of aesthetic quality based on their visual complexity and production effort. *Masterpieces*, representing the highest level of artistic complexity and the time required to produce them, are at the top of this hierarchy, while *tags*, which are simple and quickly executed, are at the bottom. We combined stencils, illustrations, throw-ups, and slogans into one group of intermediate aesthetic quality, which we label here as **"*SITS*"**. These four graffiti types share a moderate level of artistic complexity and require similar amounts of time and effort to produce: they are more intricate than simple tags but less elaborate than masterpieces. From the total of 2,392 street segments in Ghent city center, we observed 2,201, while 191 street segments were not observed. We excluded 428 street segments that did not have any graffiti instances and 133 street segments (see Appendix 3) that contained 2,759 graffiti instances labeled as “other,” as these could not be classified into any of the six categories defined in the observation form (see Appendix 1, Type).

After excluding street segments without any graffiti and those containing only "Other" graffiti instances, our final dataset includes 13,097 graffiti instances across 1640 street segments (see Appendix 3). Table 1 presents the descriptive statistics of the three graffiti types per street segment.

Table 1: Numbers of graffiti per street segment by aesthetic quality: minimums, maximums, means, standard deviations, totals and percentages. N = 1640 street segments.

**[Insert Table 1 here]**

# Methods

Our analytical approach is borrowed from methodologies used in ecological studies to assess co-occurrence and competition between species (Gotelli and Graves, 1996). In ecology, the Morisita-Horn Index (MHI) is widely used to quantify the degree of co-presence of different species in the same habitats (Horn, 1966; Krebs, 1989). By analogy, in this study we treat street segments as habitats for graffiti and employ the MHI to quantify the co-presence in the same street segments of each of the three pairs of graffiti types distinguished here, i.e. masterpiece-tag, masterpiece-SITS and SITS-tag. For two graffiti types *x* and *y*, The MHI is calculated as follows:

|  |  |  |
| --- | --- | --- |
|  |  | (1) |

Where ​ is a measure of the joint presence of graffiti type *x* and graffiti type *y* (either masterpiece, SITS or tag), is the number of graffiti items of type *x* as a proportion of all graffiti items in street segment *i* , is the number of graffiti items of type *y* as a proportion of all graffiti items in street segment *i* and *n* is the total number of street segments. The MHI can range from 0 to 1 (Horn, 1966). A value of 1 implies complete co-presence, meaning that both graffiti types are always co-present in the same street segment. An MHI value of 0 indicates the complete absence of co-presence, i.e. the two graffiti types are never present in the same street segment.

In our dataset, the distribution of graffiti types is quite uneven, with tags comprising 80.50 percent of the observations and masterpieces comprising only 1.37 percent. Uneven distributions affect the calculation of the MHI, with highly frequent graffiti types having a disproportionate impact. To reduce this impact, it is suggested to apply a transformation to the observed frequencies of graffiti per street segment that reduces the impact of quantitively dominant categories​ (Horn, 1966; Wolda, 1981). We applied a logarithmic transformation[[3]](#footnote-3).

To assess the statistical significance of the observed overlaps, we implemented a Monte Carlo permutation test with 1,000 iterations to generate a null model representing random distribution of graffiti types. In each iteration, we randomized the assignment of graffiti types to street segments while preserving the total number of graffiti incidents per segment, thereby maintaining the overall distribution of graffiti activity but removing any type-specific patterns. For each randomized dataset, we recalculated the MHI for the same pairwise comparisons. By comparing the observed MHI values to the distributions generated under the null model, we determined whether the observed overlaps significantly deviate from what would be expected by chance.

# Results

Figure 1 presents the observed MHI values for the pairwise co-presence of masterpieces, SITSs and tags, alongside their distribution under a null model that assumes graffiti writers are indifferent to the aesthetic quality of other graffiti present in the street segment they target.

The upper panel shows that the co-presence of masterpieces and tags (MHI = 0.118) is much lower than the mean co-presence of 0.252 across the permutations. No MHI value in the 1000 permutations was below the observed value, indicating a significance level of p < 0.001. This result suggests that graffiti writers who create either masterpieces or tags are not indifferent but avoid the co-presence of their work with graffiti of a different (lower or higher) aesthetic quality.

The middle panel reports on the co-presence of masterpieces and SITSs. Both the observed and permutated MHI values indicate that masterpieces have somewhat higher observed (0.163) and mean permutated (0.305) co-presence with SITS graffiti than with tags, but the co-presence of masterpieces and SITSs is also significantly (p < .001) smaller than under the null model of indifference. This suggests that graffiti writers create masterpieces and those who create SITSs avoid the proximity of each other’s creations.

**Figure 1**: **MHI values for pairwise co-presences of masterpieces, SITSs and tags. The vertical dashed lines represent observed MHI values, the histograms represent the frequencies of the MHI values across 1000 permutations of the data.**

**[Insert Figure 1 here]**

Finally, the bottom panel shows the co-presence of tags and SITS. Again, the observed co-presence of both types (0.688) is significantly (p < .001) below the mean values across the 1000 permutations (0.799), suggesting that writers of tags and SITSs tend to avoid their graffiti being co-present in the same street segments.

# Discussion

In this study, we explored whether graffiti clusters by aesthetic quality. In particular, we tested whether a difference in aesthetic quality between two graffiti types makes them less (or more) likely to be both present in the same street segment. Inspired by spot theory (Ferrell & Weide, 2010) we hypothesized that competition for relative status between graffiti writers will make them choose locations where they compete within their own league and thus avoid locations with lower-quality or higher-quality graffiti. Utilizing the Morisita-Horn Index to quantify co-presence in the same street segment, our findings confirm this hypothesis: For each combination of masterpieces, SITS, and tags, their co-presence in street segments is systematically lower than we should expect if the locations of these three graffiti types were independent, i.e. if graffiti writers were indifferent to the quality of nearby graffiti.

While spot theory emphasizes the importance of visibility, audience, and risk in location selection (Ferrell and Weide, 2010), it does not extensively elaborate how considerations of aesthetic quality enter the location choices of graffiti writers. Our findings demonstrate that graffiti clusters by aesthetic quality, and we suggest that this clustering is due to aesthetic competition. The presence of masterpieces, being highly elaborate and visually dominant, may deter graffiti writers with more modest skills (who create SITS or tags), who may avoid the spot to prevent their work from being overshadowed. And the presence of SITS types of graffiti may, in turn, deter writers who create tags, forcing them to find spots elsewhere.

Our results underscore that graffiti writers’ motivations extend beyond simply maximizing visibility; they also appear to strategically position their work relative to existing graffiti of similar or different aesthetic caliber. This notion of ‘competitive clustering’ highlights the importance of relative status considerations, reinforcing the idea that graffiti writers selectively choose environments where their work has the best chance of garnering recognition. Moreover, these findings suggest that efforts to manage or regulate graffiti could inadvertently shape these competitive dynamics. For instance, creating legally sanctioned walls for high-quality artworks might attract master-level graffiti while simultaneously deterring simpler tags, further segregating the aesthetic landscape of urban graffiti. Conversely, a lack of structured opportunities for higher-level pieces could potentially lead to more heterogeneous graffiti environments if no dominant style emerges to discourage others.

Overall, this study broadens the theoretical scope of spot theory by illustrating how aesthetic considerations interact with the quest for visibility in graffiti writers’ spatial choices. Future investigations might refine these insights by employing longitudinal data, capturing temporal shifts in which new graffiti overwrites or complements pre-existing artworks. Additionally, qualitative research involving graffiti writers themselves—through interviews or ethnographies—could shed light on their perceptions of ‘competitive advantage’ and how this influences their preference for, or avoidance of, certain sites. Such perspectives would further illuminate how individual strategies collectively shape the visual and cultural tapestry of city streets.

By interpreting these results within a broader socio-spatial context, we also open a window onto how symbolic boundaries within the graffiti subculture align with—and occasionally subvert—established societal hierarchies. The strategic avoidance of higher-quality pieces by less skilled writers, for instance, mirrors social dynamics in which individuals choose environments where comparisons are more favorable. Conversely, writers confident in their skill might strategically place their masterpieces among well-regarded works to compete directly for prestige. Such positioning decisions can inform not only policy interventions—like designating legal walls—but also community dialogues about who gets to shape public space and why. The patterns observed here thus reflect both subcultural logics and larger-scale issues of accessibility, cultural capital, and neighborhood identity.

Another angle to consider is how technological advancements and online platforms might amplify these competitive dynamics. As images of street art circulate on social media, graffiti writers are no longer constrained by local audiences alone; a skillfully executed masterpiece can gain international exposure overnight. This increased visibility may heighten the stakes of aesthetic competition and accelerate the clustering process, as writers become more strategic about where they place their work to optimize both physical and virtual acclaim. At the same time, the global reach of social media could erode local norms, creating tension between the subcultural “rules” of a specific region and a broader, digitally influenced understanding of what constitutes valuable graffiti. Such shifts underscore the importance of viewing aesthetic clustering not merely as a static phenomenon, but as part of a constantly evolving dialogue between urban space, social media, and the cultural aspirations of graffiti writers.

## Limitations

As all research, our study has some limitations. The first one refers to interpretation. Although the clustering of masterpieces, SITS and tags that we demonstrated is robust, our interpretation of this finding in terms of aesthetic competition by graffiti writers may be challenged. In our research, competition is assumed, but it is not directly observed. There may exist other plausible explanations of the empirical findings. One potential explanation is that street segments differ in how suitable they are for different types of graffiti. For example, some street segments may not offer good opportunities to create masterpieces because they have no suitable objects that are large enough, or because they are busy 24/7 and do not allow graffiti writers to work undisturbed for more than a few minutes. Masterpiece writers will avoid these street segments and go elsewhere. As a result, these street segments may become dominated by SITS or tags, but in this case, competition is not the underlying mechanism of the clustering. In other words: clustering of graffiti types can also occur in the absence of aesthetic competition, because street segments offer unequal opportunities for different types of graffiti.

Even though our observations apply to co-presence of graffiti in street segments and not to graffiti overwriting, a subcultural ban on overwriting other writers’ graffiti might be raised as an alternative narrative to explain the observed aesthetic clustering. Within the graffiti subculture it is a normative rule that to respect other writers one should not overwrite their graffiti (Ferrell and Weide, 2010; Van Loon, 2014). If this rule is applied conditionally to the aesthetic quality of existing graffiti, which seems plausible given that aesthetic quality is one of the criteria by which graffiti is judged, and if graffiti spots are so scarce that there is no alternative to overwriting, the rule could be framed as an alternative explanation. However, whether labeled as ‘subcultural norm’ or as ‘competition’, it refers to the same mechanism whereby writers of lower-quality graffiti avoid writing in street segments that contain higher-quality graffiti.

Another limitation is that we did not account for street segment characteristics that might have differentiated effects on their suitability for different graffiti types. Factors such as the presence of facilities likely to attract higher footfall, the presence of surveillance cameras and lighting, and the availability of suitable surfaces will significantly impact where graffiti appears, and the impact may vary across graffiti types. For example, surveillance cameras might deter masterpieces more than they deter tags, and some street segments may lack physical structures suitable for masterpieces, whereas tags can be placed on almost any surface. Furthermore, there may be reporting bias in our data. Masterpieces are often tolerated compared to other graffiti types, so that SITS and tags are more often reported and subsequently removed.

A final limitation of our study is that it focuses on a single area, the city center of Ghent, which limits the generalizability of our findings to other urban contexts. In particular, gang graffiti is nonexistent in Ghent (Kuralarasan et al., 2024). In cities where gang graffiti is prevalent, the dynamics must differ significantly, because gang graffiti is closely tied to territorial claims and inter-gang competition (Bloch, 2019) and not driven by considerations of aesthetic quality and individual recognition. Including gang graffiti in future research could reveal additional layers of spatial dynamics not captured in this study.

## Future research

Future research could expand on the competitive dynamics among graffiti writers. Whereas the grounded spot theory developed by Ferrell and Weide, (2010) was an important resource in formulating our hypothesis, additional qualitative research, such as interviews with graffiti writers, could provide further insights into motivations and competition in the graffiti subculture, including the role of internet in social media in making graffiti visible to larger audiences.

From a broader perspective on how graffiti writers make location decisions, and thus not limited by the concepts of competition and aesthetic quality, future research could explore the impact of urban planning, law enforcement strategies, and graffiti removal practices on the location choices of graffiti writers. Factors such as the presence of facilities likely to attract higher footfalls, surveillance cameras, lighting, and visibility should be included in future studies to assess their influence on graffiti occurrences. Studying the tolerance levels within different street segments and their correlation with graffiti incidents could provide insights into social acceptance and its influence on graffiti writing.

Further, the use of longitudinal observational data would allow a better understanding of how graffiti writers are affected by pre-existing conditions (including pre-existing graffiti) when choosing a site. Since our current data provides only a snapshot in time, we cannot determine the conditions at the time graffiti was created, or the order in which multiple graffiti was created, or account for graffiti that has been removed. Longitudinal data collection would better capture these temporal dynamics.

Additionally, scaling up observational research using tools like Google Street View for data collection, and employing AI for coding images, could enable generalization across multiple places and larger samples without requiring huge resources.

## Conclusion

Aligning with spot theory, a grounded theory on how graffiti writers choose locations for their artwork, this study demonstrated that graffiti types of different aesthetic quality have a reduced likelihood of being both present in the same street segment and suggests that this clustering is driven by competition for status between graffiti writers. This insight could inform agencies who have a stake in either promoting, deterring or otherwise affecting the role, placement and aesthetic quality of graffiti in urban environments.

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1. The dataset and script used and/or analyzed during the current study are available from: <https://anonymous.4open.science/r/Graffiti-Choosing-the-right-pond-2A2B/README.md> [↑](#footnote-ref-1)
2. University name is anonymized for peer review process [↑](#footnote-ref-2)
3. Because both the decision of transformation itself and the choice of a specific transformation is somewhat arbitrary, we tested the outcomes for robustness across different options. More specifically, we ran the analysis (1) without transformation (2) with a square root transformation (3) with a logarithmic transformation adding a value of 0.5 to the frequency before taking the logarithm (4) with a logarithmic transformation adding a value 1 to the frequency before taking the logarithm. We present the results of the last transformation option. All alternative options yield different MHI values but the same substantive findings (see appendix 4). [↑](#footnote-ref-3)