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Free word association analysis of Germans' attitudes toward insects

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Abstract

In this paper, the results of two free word association tests were analyzed to gain insight into Germans' attitudes toward insects. We used a novel approach in the form of an association network with the help of the software "Gephi" that was originally developed for social network analysis. The influence of attitude on the willingness to donate (WTD) and actual donation to an insect conservation project was investigated as well. Data collection was conducted via an online questionnaire ($n = 515$; $M_{age} = 49.36$, $SD = 16.73$; female = 50.1%). For the first test, participants listed three associations for the prompt "insect." The associations were assigned to the three components of attitude: *affective*, *cognitive*, and *behavioral*. For the second test, participants named insects they pictured when thinking about "insects." The results were taxonomically classified. The WTD was assessed with a Likert-type scale and an actual donation could be made at the end of the online questionnaire. "Bee" was the most frequently named association, followed by "useful," "nature," "pollination," and "pesky." "Pesky" was most often named with "useful," indicating that being aware of insects' usefulness is not enough to supersede negative associations. In the second test, only 6% of the associations were on the species level, which suggests little taxonomic knowledge about or interest in insects. Linear regression revealed that positive affective associations had a positive influence on the WTD and negative affective associations had a negative influence on the WTD, both with a small effect size. We advise educating people not only about the usefulness of insects but also fostering positive, personal encounters to increase positive affective associations and decrease negative ones.

KEYWORDS

association network, attitude, free word association, influence on donation, insect, willingness to donate

Jasmin Vlasák-Drücker and Annike Eylering should be considered as joint first authors.

1 | INTRODUCTION

1.1 | The importance of insects and their decline

Despite their small size, insects are vitally important for the environment and us (Cardoso et al., 2011; Cardoso et al., 2020; Habel et al., 2019), as they provide a vast number of ecosystem services, such as water purification, nutrient cycling and soil formation (Samways, 2019). Losey and Vaughan (2006) estimated the annual value of only four services (dung burial, pollination, pest control, and recreation) to be more than $57 billion in the United States.

Unfortunately, insect numbers have been declining in recent decades (Hallman et al., 2017; Seibold et al., 2019), with anthropogenic factors being the main driver. Intense farming, climate change, habitat destruction, and pollution are only some of the threats to insect diversity and abundance (Cardoso et al., 2020; Habel et al., 2019; Wagner, 2020). Because insects are crucial to our ecosystems, further decline needs to be stopped.

In particular, the popularity of insects in tourist areas shows that in addition to economic aspects, the conservation of insects through local protection measures is important, so that, for example, the phenomenon of worldwide firefly tourism (Lewis et al., 2021) or the phenomenon of aggregating and migrating monarch butterflies in Mexico (Lemelin & Jaramillo-Lopéz, 2019) can be maintained.

To implement necessary conservation measures, non-governmental organizations (NGOs) are often dependent on donations from the public, which in the case of insects can prove difficult to acquire. In a past study, participants were more willing to financially support hypothetical conservation projects for vertebrates than for invertebrates (Martín-López et al., 2007). Moreover, invertebrates receive only 10% of the allocated conservation funds (Cardoso et al., 2011). Therefore, it is of great interest to identify factors that influence the willingness to donate (WTD) and actual donations to insect conservation projects.

The Theory of Planned Behavior (TPB) suggests that attitudes influence behavior (in our case, donating to an insect conservation project) indirectly via the intention to perform the behavior (in our case, the willingness to donate to an insect conservation project, WTD; Fishbein & Ajzen, 1975). While the TPB originally included attitudes toward a specific behavior (e.g., donating toward insect conservation), previous research also found that attitudes toward a being or an object (e.g. insects) can predict intentions and behavior (Dörge et al., 2022). Dörge et al. (2022) found that attitude toward insects was the most important factor influencing the WTD to an insect conservation project. Moreover, the WTD had a positive influence on the actual donation; thus, investigating the attitudes and their influence on the WTD can be useful for NGOs and campaign development.

1.2 | Attitudes toward insects

Kellert (1993) was one of the first to investigate the public's attitude toward invertebrates. In particular, insects and spiders, especially those that can sting, were associated with aversion and fear. More positive attitudes were expressed when the taxa possessed an aesthetic value, like butterflies, or practical value, like bees.

Barua et al. (2012) adapted Kellert's dimensions and found similar attitudes toward invertebrates. Butterflies were the most popular group due to their aesthetic appeal, followed by dragonflies, which also possessed aesthetic appeal, and honeybees, which were liked due to their direct utilitarian value ("direct material benefit for humans"). Mosquitos were the least favorite taxon because they caused bodily harm, followed by leeches, spiders, and wasps.

Butterflies were among the most liked insects in multiple other studies as well (Breuer et al., 2015; Leandro & Jay-Robert, 2019; Prado et al., 2020; Schlegel et al., 2015; Shipley & Bixler, 2017). When compared, butterflies even succeeded mammalian and bird species in terms of favorability, whereas insects in general were viewed with rather mixed feelings (Schlegel & Rupf, 2010).

In the following studies, wasps, mosquitos, and cockroaches were generally disliked insects (Leandro & Jay-Robert, 2019; Shipley & Bixler, 2017). Wasps were associated with their ability to "sting" and "pain" (Sumner et al., 2018), and mosquitos were associated with "illness" and biting (Leandro & Jay-Robert, 2019). Shipley and Bixler (2017) came to the conclusion that a dichotomy of "beautiful bugs" and "bothersome bugs" exists among familiar insect taxa since most of the insects included in their study were clearly labeled as either liked or disliked.

Only bees were seen ambivalently, as they were labeled as both liked and disliked (Shipley & Bixler, 2017). Bees were associated with "fear" (Breuer et al., 2015) and their ability to "sting" (Sumner et al., 2018), similarly to wasps. However, following Kellert (1993) and Barua et al. (2012), they were also highly associated with their usefulness, such as their pollination services and honey production (Leandro & Jay-Robert, 2019; Sumner et al., 2018). Leandro and Jay-Robert (2019) found that bees were the only insects associated with utilitarian values in their study.

To the best of our knowledge, only two studies have investigated attitudes toward insects in general rather than specific species or taxa. Dörge et al. (2022) used a closed questionnaire with Likert scales and found an overall slightly positive attitude, while Lemelin et al. (2017), who collected free associations in a mental map approach, also found that positive associations (e.g., "amazing" or "beautiful") slightly outweighed the negative ones (e.g., "bad" or "hate").

1.3 | Aims of the study

Most past studies focused on investigating attitudes toward certain insect species or taxa; thus, the current study intends to provide more insights into attitudes toward insects in general. In this study, attitudes are gathered with a free word association test, since such tests capture attitudes more freely than closed questionnaires, and thus far only two studies (Leandro & Jay-Roberts, 2019; Sumner et al., 2018) have used this method to assess attitudes toward insects. The current study aims to expand the knowledge about using this method to research attitudes toward insects. Dörge et al. (2022) have investigated the influence of attitudes on actual donations for conservation projects; however, in their study, attitudes were recorded with Likert scales. Therefore, including a donation in the current study's design, but deriving the attitudes of the German public toward insects from free word association tests, is a unique research approach.

Moreover, to the best of our knowledge, no other study has generated an association network showing which associations with insects were often named together across participants. This method offers a new approach to presenting data visually.

Lastly, with a second free word association test, this study investigates which insect first comes to mind among the German public when thinking about insects, as well as the participant's taxonomic knowledge.

2 | MATERIALS AND METHODS

2.1 | Sample

Data collection took place in Germany in August 2019 and was conducted via an online questionnaire and the access panel of Consumerfieldwork GmbH. The panel book lists 39,306 currently available participants (Consumerfieldwork GmbH, 2020). The criteria for the sample were chosen such that the sample would be representative of the German population regarding age, gender, and federal state. The minimum age was 18 years. Data from a total of 519 participants were compiled, but four participants were excluded from the final analysis. One participant chose the gender option "diverse" and was excluded. Two participants were excluded because they had not yet graduated. One participant was excluded because on questions with Likert scales, the participant exclusively chose the answer option on the left and only entered "asd" in open text fields. Thus, the total sample size included in the final analysis was $n = 515$. The study participants consisted of 49.9% men and 50.1% women, which is nearly the same as the current gender distribution in Germany (49.3% men and 50.7% women; Statistisches Bundesamt [Destatis], 2019). The age of the participants ranged from 18 to 91 years, with a mean of 49.36 years ($SD = 16.73$), which is above the mean age of 44.4 years of the total German population (Statistisches Bundesamt, 2020). The participants had a higher level of education compared with the total German population: 56.2% of the participants had an upper secondary education certificate (*[Fach-]Hochschulreife*, in Germany: 32.5%; KMK 2019), 32.6% had a secondary education certificate (*Realschulabschluss*; in Germany: 23.3%; KMK, 2019) and only 11.3% had a lower education certificate (*Hauptschulabschluss*; 23.3%; KMK, 2019). The average monthly net income was between €2,500 and €2,750, which lies below the German average of €3,399 per month (Statistisches Bundesamt [Destatis], 2019).

2.2 | Questionnaire

The questionnaire was developed in the Department for Biology Didactics at the University of Osnabrück. The questionnaire contains more questions than those analyzed in this study and is available in the supplementary material.

2.2.1 | Free word association tests

Free word association tests were chosen to assess the associations as freely as possible. It is assumed that the less-structured format compared with a closed questionnaire with Likert scales, for example, subjects the answer to fewer constraints and allows "an unrestricted access to mental representations" (Wagner et al., 1996, p. 334). Free word association tests are a viable method to investigate attitudes because participants' perceptions about an object are almost always revealed through their associations with it (Szalay & Deese, 1978). Free word association tests have already been used in the context of insects (Leandro & Jay-Robert, 2019; Sumner et al., 2018), but not for the German public. Notably, the tests were placed at the very beginning of the questionnaire to avoid possible influences by other questions.

The first free word association test had the instruction: "*Which thoughts come to mind when you hear the word 'insects'? Please note the first three associations as quickly as possible (keywords!).*" The second test had the instruction: "*When you think of 'insects', which insect do you picture? Please note the name of the insect as accurately as possible.*"

2.2.2 | Willingness to donate and donation

The WTD was assessed at the end of the questionnaire with a 6-point Likert-type scale ranging from "1 = completely disagree" to "6 = completely agree." The statement was: *"I would donate money to projects that actively support the protection of endangered insect species in Germany."*

The participants received €2 as an expense allowance. The participants were not aware that they could donate their received allowance until they answered the question that measured the WTD, which was phrased as follows: *"What percentage of your remuneration for completing the questionnaire would you like to donate to the protection of endangered insect species in Germany?"*

2.3 | Data analysis

2.3.1 | Working definition of attitudes

Maio et al. (2019) defined attitudes as "an overall evaluation of an object that is based on cognitive, affective and behavioral information" (p. 4). It is also assumed that attitudes consist of the three components *cognitive*, *affective*, and *behavioral* (Eagly & Shaiken, 1993, p. 1; 10). The cognitive component of attitudes refers to "beliefs, thoughts and attributes" associated with an attitude object (Maio et al., 2019, p. 31). "Hardworking" and "quiet" are examples of beliefs and attributes that were associated with insects in our study, so these were sorted into the category *cognitive* during the coding process. The affective component refers to "feelings or emotions linked to an attitude object" (Maio et al., 2019, p. 31–32), such as "fear" or "joy" which were sorted into the category *affective*. Furthermore, the behavioral component of "past behavior or experiences" is related to an attitude object (Maio et al., 2019, p. 32). Examples of the category *behavioral* would be "mosquito bite" or "sleep problems." Additionally to the three categories *cognitive*, *affective*, and *behavioral* that represent the components of attitudes, the fourth category *other* was added. Every association that was not interpretable (e.g., "oxygen"), that could be sorted into two categories (e.g. "food") or were neither *cognitive*, *affective* nor *behavioral* (e.g., "Asia") was sorted into the category *other*.

For the analysis, the component *affective* was split into *affective positive* and *affective negative* to preserve the valence of the associations. *Affective positive* was defined as "positive feelings and emotions toward insects, such as joy or affection" and *affective negative* was defined as "negative feelings and emotions toward insects, such as hatred, fear, disgust or aversion." Since affective positive and affective negative technically represent sub-categories within the category *affective*, they do not appear in the coding section below, but are described in the "Results."

2.3.2 | Coding

All of the rules applied for revision, coding and the original associations with translations are available in the supplementary material.

The associations were corrected for spelling and grammar mistakes in SPSS® software (IBM® v. 26) for both free association tests. Only the results from the first test were imported into MAXQDA (v. 20.4.0) for coding. MAXQDA is a software for qualitative data and text analysis. It is used to support scientific studies in which interviews or texts are analyzed for content (VERBI, 2018). The first coding was used to simplify ideas that were expressed in multiple words or sentences and to summarize words with the same base idea under one code to keep the subsequent analysis of frequency more precise. For example "disgust" (*Ekel*) and "disgusting" (*ekelig*) were both coded as "disgust" and phrases such as "essential for the continuation of life" were shortened and coded as "vital." Hereafter, these adjusted associations will still be referred to as associations, not codes.

Using the creative coding tool in MAXQDA, the associations with similar content were grouped and subcategories were formed inductively. For example, the associations "bee," "mosquito," "butterfly," and all other insects were combined into the sub-category "animals (insects)," belonging to the category *other*. The subcategories were then sorted deductively into the categories *cognitive*, *affective*, and *behavioral* according to the definitions (Table 1). The fourth category *other* contains associations that were not unambiguously assignable to one of the other three categories.

These categories represent the components of attitude (see section 2.3.1), but will be referred to as categories for the rest of the paper. The first coding was performed by the first author. A second coder grouped the associations and created sub-categories inductively using the same method, but independently from the first coder. The sub-

TABLE 1 Shortened category definitions

Category	Definition	Examples
Affective	Feelings and emotions toward insects	Joy, fear, disgust
Behavioral	Past behaviors toward or experiences with insects	Sleep problems, insect spray, mosquito bite
Cognitive	Beliefs about and attributes of insects	Hardworking, quiet, intelligent
Other	Associations that are neither behavioral, affective nor cognitive; can be sorted into multiple categories; or cannot be clearly enough interpreted	Oxygen, food, Asia

Note: The codebook is available in supplemental material.

categories were again sorted into the categories *affective*, *cognitive*, *behavioral*, and *other* according to the definitions. The results were compared with those of the first coder and conflicts were discussed until a consensus was achieved. The sub-categories created and assigned associations were similar or identical between the coders and were all accepted. Uncertainty remained in the sorting of some associations; these were discussed with the last author, but could not be completely resolved. Thus, a code book for the sub-categories with strict definitions was prepared by the first coder and given to a third coder. The third coder sorted the associations into the established sub-categories. Sixty-nine percent of the associations were sorted into the same sub-categories by the third coder and the first coder. After a discussion, a consensus could be reached for all associations, which included sorting them into sub-categories in the category *other* due to differing interpretations.

For this publication, all associations were translated into English. Some German associations could not be translated into distinct words; for example, *Gelse*, *Mücke*, and *Moskito* all have the translation "mosquito"; thus, they were all coded as "mosquito" in the translated MAXQDA file.

To transform the qualitative data into ordinal data for statistical analysis, the Code-Matrix-Browser in MAXQDA was used. The associations were turned into numbers from 0 to 3 for each participant corresponding to how often a participant had named an association from one of the categories. The frequencies of associations per category per participant were imported into the SPSS file. The category *affective* was split into the sub-categories *affective positive* and *affective negative* here to preserve the valence in the analysis (see Section 2.3.1 for definitions).

2.3.3 | Association network

To investigate which words were often named together, the Code-Relations-Browser in MAXQDA was used. The matrix with the translated associations that were named five or more times was imported into Gephi (v. 0.9.2) from MAXQDA. The threshold of five or more was chosen to keep the network from being too crowded. The placement of the associations and their distance between each other is dependent on which layout is chosen in Gephi to create the network; in this case, "Fruchterman Reingold" layout was used. For the sake of clarity, the edges (connections between the associations) were filtered according to weight, so associations that were named with each other fewer than three times do not share visible connecting lines in the graphic.

2.3.4 | Statistical tests

The category *other* was not included in the correlation and regression analysis because it is not a defined component of attitude. Furthermore, the sub-categories in this category differ too much from each other thematically, so the results would be uninterpretable for real-life purposes. The Friedman test with Bonferroni correction was used to determine statistically significant differences between the numbers of associations in each category (Figure 1). In addition, the effect sizes of the pairwise comparisons according to Cohen (1992) were calculated. To determine the effect sizes, we used the calculation of the correlation coefficient r (Field, 2018). Each category was tested for normal distribution with the Kolmogorov–Smirnov test. Normal distribution was not present; therefore, non-parametric tests were chosen for the correlation analysis. A Spearman correlation was calculated to investigate the relationship between the WTD/donation and the number of associations per category per participant. There was no multicollinearity of predictors (VIF $\sim$ 1). Linear regression with a bootstrap (sample size $=$ 2000) was used to determine the influence of the number of associations per category on the WTD/donation per participant. According to Cohen (1992), f^2 is the effect size measure for this multiple linear regression. The bootstrap was used to secure against the residuals that were not normally distributed.

2.3.5 | Classification of insects

Associations from the second free word association test were taxonomically classified with the help of multiple classification books and identification guides (Chandra &

Gupta, 2013; Cole, 2017; Klausnitzer, 2011; Klausnitzer, 2019; Köhler, 2015; Sonenshine & Roe, 2014).

3 | RESULTS

3.1 | Germans' associations with insects

After the coding and translation, 278 distinct associations remained. A list of all associations is available in the supplementary material.

The top 10 associations (Table 2) represent approximately 38% of all associations (1.545). Half of the top 10 associations belong to the category *other* due to the frequent naming of animals.

"Spider" (21), "worm" (2), "crustacea" (1), and "birds" (1) were named despite being non-insect animals. Sixteen answers were coded with "no association," which includes no answer given, and answers like "nothing," "none" or "do not know"; these were sorted into the category *other*.

Out of 1.545 associations, 2% were categorized as *affective positive* (28), 5% as *behavioral* (77), 10% as *affective negative* (162), 37% as *cognitive* (570), and 46% as *other* (708) (Figure 1). Twenty-two sub-categories were formed, including *affective positive* and *affective negative* (see supplemental material for detailed information on sub-categories).

There was a significant difference between the five categories ($\chi^2 = 725.75$; $p < .001$; $n = 515$). Also, significant effects could be determined, but they were only small. The category *cognitive* had a significantly higher number of associations than the categories *affective positive* ($p < .001$; $z = 1.57$; $r = .07$), *behavioral* ($p < .001$; $z = -1.39$; $r = .06$) and *affective negative* ($p < .001$; $z = 1.09$; $r = .05$), but not the category *other*. *Affective negative* associations were named significantly more often than *affective positive* associations ($p < .001$; $z = -.48$; $r = .02$) and *behavioral*

Associations	Category	Absolute frequency	Relative frequency (%)
Bee	Other	140	9.0
Useful	Cognitive	112	7.2
Nature	Other	54	3.5
Pollination	Cognitive	46	3.0
Pesky	Affective negative	44	2.8
Mosquito	Other	40	2.6
Disgust	Affective negative	38	2.5
Wasp	Other	38	2.5
Fly	Other	36	2.3
Small	Cognitive	35	2.3

TABLE 2 Top 10 associations with corresponding category, absolute frequency, and relative frequency. The total number of named associations is 1.545

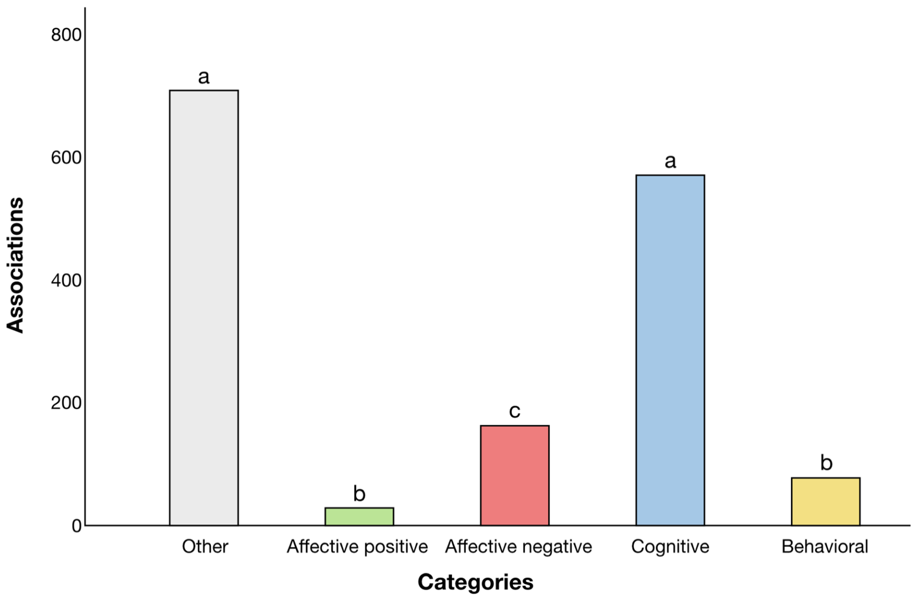

FIGURE 1 Number of associations per category. The total number of associations is 1.545. Categories labeled with the same letter (a, b, c) do not differ significantly in the number of associations

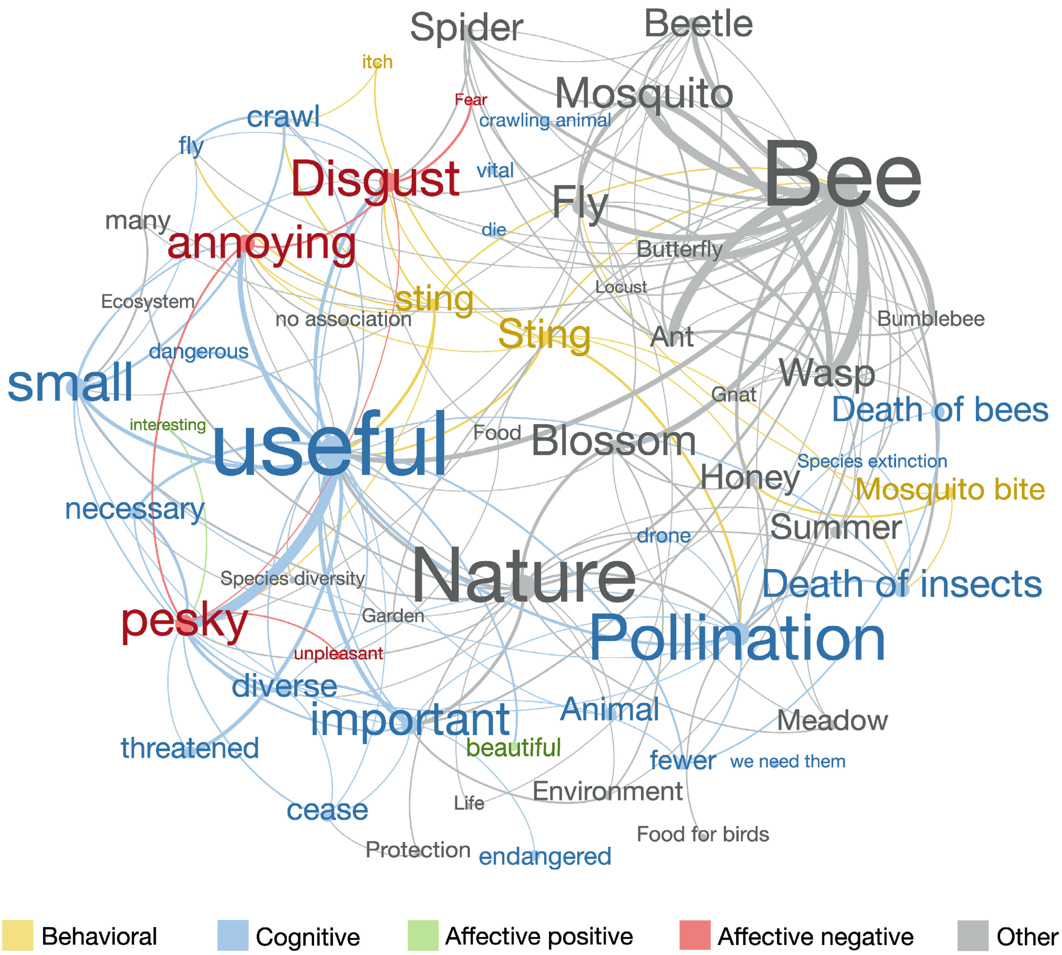

FIGURE 2 Association network for the prompt "*insects*". Only associations named five or more times were included in the network and colored according to category. Nouns were capitalized. The more frequently an association was named, the bigger it appears in the network. The more often an association is named with another, the thicker the edge between them. For the sake of clarity, the edges (connection between associations) were filtered according to weight, so associations that were named with each other fewer than three times do not share visible connection lines in this graphic

associations ($p = .025$; $z = -.30$; $r = .01$) and significantly less than associations categorized as *other* ($p < .001$; $z = -1.16$; $r = .05$). The number of *behavioral* associations was not significantly higher than the number of *affective positive* associations, but was significantly lower than the number of associations from the category *other* ($p < .001$; $z = -1.46$; $r = .06$). The *other* category had significantly more mentioned associations than the category *affective positive* ($p < .001$; $z = -1.64$; $r = .07$).

3.2 | Pesky but useful - associations frequently occurring together

A visual presentation of the data in the form of an association network was created in Gephi (Figure 2). The Gephi file can be accessed in the supplementary material.

Notably, only two *affective positive* associations appear ("interesting" and "beautiful"). Participants often named animals together, most often with "bee," which shows up as a gray cluster on the top right of the network and is reflected in the top 10 most frequently occurring word pairs (Table 3). The *cognitive* association "useful" was most frequently named with the *affective negative* association "pesky" (Table 3), but also occurred with "annoying" and "disgust" (Figure 2).

3.3 | Frequently named insects and taxonomic knowledge

In the second test, the most frequently named insect by far was "bee," followed by "wasp," "fly" and "mosquito" (Table 4). The four most frequently named insects also appeared in the top 10 from the first association test (Table 2), with "bee" being the most frequently named in both tests.

Honeybee (15) and wild bee (5) also occurred. One participant named a species by its Latin name (*Apis*

TABLE 3 Top 10 most frequently named association word pairs

Word pair	Absolute frequency	Word pair	Absolute frequency
Bee – Wasp	25	Mosquito – Wasp	14
Useful – pesky	24	Bee – Bumblebee	14
Bee – Ant	23	Bee – Fly	13
Bee – Mosquito	19	Bee – Blossom	12
Bee – Butterfly	16	Bee – Beetle	12

TABLE 4 The 10 most frequently named insects in the second free word association test

Association	Absolute frequency	Relative frequency (%)	Scientific classification	Taxonomic level
Bee	227	44.1	Apidae	Family
Wasp	41	8.0	Hymenoptera	Order
Fly	39	7.6	Brachycera	Suborder
Mosquito	32	6.2	Nematocera	Suborder
Ant	32	6.2	Formicidae	Family
Beetle	18	3.5	Coleoptera	Order
Spider	16	3.1	Araneae	Order
Bumblebee	15	2.9	Bombus	Genus
Honeybee	15	2.9	*Apis mellifera*	Species
Butterfly	9	1.7	Lepidoptera	Order

mellifera) and another named a species (atlas beetle, *Chalcosoma atlas*) that is not naturally occurring in Germany. Along with "spider" (16), the only other non-insect named was "tick" (1). In total, 35 distinct associations were noted, not including the various answers summarized under "not interpretable answer" (13), which included the answer "none" and sentences that did not name a classifiable animal, such as "I am thinking of multiple ones."

Out of all associations (515), 32% were named on the order and suborder levels, 56% on the family and subfamily levels, 4% on the genus level, and 6% on species level.

3.4 | Influence of the categories on willingness to donate and donation

The influence on the WTD was further investigated with a linear regression model, whereas the influence on the donation was not analyzed due to the lack of correlation. The model calculated through multiple linear regression was able to explain 7.6% of the variance of WTD ($R^2 = .076$, $p < .001$). The number of associations in the category *affective negative* had a negative influence on the WTD ($r = -.438$, $p < .001$); thus, the more negative associations the participants had, the lower their WTD to an insect conservation project. The number of associations in the category *affective positive* had a positive influence on the WTD ($r = .728$, $p < .001$). The effect size for both is small (*affective positive* $f^2 = .02$, *affective negative* $f^2 = .04$). *Cognitive* and *behavioral* associations did not exhibit a significant influence on the WTD (Table 5).

TABLE 5 Regression table for the predictors of the willingness to donate ($n = 515$)

	b	SE_b	β
Constant	4.2	.30	
Gender	−.17	.11	−.07
Age	−.01	.003	−.06
Cognitive associations	.11	.06	.08
Behavioral associations	−.08	.13	−.02
Affective positive associations	.73***	.25	.13
Affective negative associations	−.44***	.10	−.20

Note: $R^2 = .076$ ($p = < .001$), adj. $R^2 = .065$, ***$p < .001$.
Abbreviations: b: unstandardized beta, SE_b: standard error of unstandardized beta, β: standardized beta.

4 | DISCUSSION

In both free word association tests, "bee" was the most frequently named association, suggesting that bees are very present in the mind of the German public. This was surprising because bees were not the first insects to be thought of in other studies. Instead, ants (Leandro & Jay-Robert, 2019, city setting; Shipley & Bixler, 2017), butterflies (Leandro & Jay-Robert, 2019, natural landscape setting), and flies (Lemelin et al., 2017) were at the top of the lists.

From the results, it is not clear whether the participants thought about the honeybee (*Apis mellifera*) or a species of wild bee when associating "bee" with the prompt "insect." "Wild bee" (5), "bumblebee" (15), and "honeybee" (15) only appeared as associations in the second test, and notably less often than "bee" (227). This suggests that some participants were aware that there are different types of bees, but for most, this distinction seemed to be unimportant. The lack of distinction between species can become problematic when the public mistakes the most commonly known species of bee, the honeybee, as an endangered species. The honeybee is not endangered in Germany, and since their presence can pose a competition to wild bees (Henry & Rodet, 2018; Lindström et al., 2016; Mallinger et al., 2017), this distinction needs to be communicated more clearly so that truly endangered species can receive the needed protection.

In the first test, the most frequent association after "bee" was "useful"; thus, the general public seems to be aware that insects in general are of use to us. This is emphasized further through "pollination" being the fourth most frequently named association. In other studies, bees were associated with being pollinators (Leandro & Jay-Robert, 2019; Sumner et al., 2018) and having practical value (Barua et al., 2012; Kellert, 1993). The knowledge about usefulness and important services, such as pollination, does not seem to counter the *affective negative* associations with insects, however, since "useful" was most often named with "pesky." "Useful" was also named together with "annoying" and "disgust" (see Figure 2), but less often.

That insects were most often named together, and insect species in general comprised a large portion of all associations, suggests that people had specific associations when thinking about insects, but none that indicated attitudes toward insects. Next to "bee," the animals "fly," "wasp" and "mosquito" were the most frequently named insects from the first and second test. This is in line with the findings of Lemelin et al. (2017). They have used a hybrid visual mapping approach in form of a Personal Meaning of Insects Map (PMIM): flies, bees, and mosquitos were among the most frequently cited associations, even though they did not ask specifically for insect species. In the study by Leandro and Jay-Robert (2019), "mosquito," "fly" and "bee" were also in the top five insects named when participants were asked to note insects they knew occurring in the city.

That only 6% of the named associations from the second test were classifiable insect species, shows that the general public thinks about insects more on the order and family levels than on the species level. Other studies had similar results, which indicates that the lack of taxonomic knowledge about insects is a common phenomenon. In previous studies, insects were named more often on the order and family levels compared with vertebrates (Leandro & Jay-Robert, 2019) and in general (Lemelin et al., 2017; Shipley & Bixler, 2017). Approximately, 3% of the participants associated "spider" with the prompt "insect," which further emphasizes disinterest or the lack of systematic knowledge.

Of the relevant categories, *cognitive* was the largest, suggesting that the German public has many beliefs and ample knowledge about insects. *Affective negative* was the second-largest category, with significantly more associations than *affective positive*, which indicates how poorly perceived insects in general still are, as also reported by Fukano and Soga (2021), and despite other studies finding the opposite: Dörge et al. (2022) reported a slightly positive attitude in general and Lemelin et al. (2017) found that participants associated more positive affective terms with insects than negative ones.

The top 10 associations were exclusively comprised of *cognitive*, *affective negative*, and *other* associations, which leads to the conclusion that *behavioral* associations (past behaviors toward or experiences with insects) and *affective positive* associations were less present in participants' perception of insects.

Since *affective positive* and *affective negative* were the two categories with a direct influence on the WTD, it is advisable to work toward decreasing the negative associations and increasing the positive ones. Although the effect was small, this is still a point worth considering. Notably, Dörge et al. (2022) also found a positive influence of attitudes on the WTD. An influence of the attitude associations on the actual donation could not be determined.

To change the public's negative attitude toward insects and to increase the positive associations, education focused solely on insects' importance or usefulness appears to be insufficient; rather, it is advised to use positive, personal encounters with different types of insects instead. In the case of children, a field trip with snakes, an animal usually seen as unpopular and potentially fear inducing, that included direct handling of the animals was able to decrease fear and increase positive attitudes toward the animals, including the willingness to protect them (Ballouard et al., 2012).

5 | CONCLUSION

The German public has more *affective negative* associations with insects than positive ones. Although the effect size is small, both had a significant influence on the WTD. The more negative affective associations a participant had, the less willing they were to donate money for insect conservation. Participants who had more positive associations were more willing to donate to insect conservation. It is advised to concentrate future efforts on changing the public's perception through, for example, positive, personal encounters so that they associate more *affective positive* terms with insects. Solely relying on educating people about the importance of insects and the ecosystem services they provide to decrease negative associations is not recommended. Being aware of the usefulness and services, such as pollination, does not seem to alleviate the negative associations, since "useful" was most often named with "pesky" and also occurred with "annoying" and "disgust."

In general, Germans do not possess a vast knowledge about species (Frobel & Schlumprecht, 2016) and tend to name families or even orders when asked to give an insect name. This lack of species knowledge, which is a common phenomenon for insects (Leandro & Jay-Robert, 2019), could be addressed through identification exercises in biology classes, which are ideally followed by excursions to observe the insects in their natural habitat. Excursions outside of the school context that focus on the local insect fauna could increase the species knowledge of adults (Randler, 2010). Species knowledge is important to be able to distinguish between endangered and non-endangered species within a commonly known order or family of insects. In the case of the "bee," which was the most frequent association in both tests, this lack of knowledge can be problematic. It is unknown whether "bee" evokes honeybees or wild bees in the public's mind; thus, it is important to educate people to ensure that honeybees are not mistaken as endangered. In addition to species knowledge, an effective strategy would be to convey that valuing and conserving insects is essential for human and insect well-being (Samways et al., 2020). For example, fostering attitudes by educational measures about the ecosystem services provided by insects (Samways, 2019; Cardoso et al., 2020).

Limitations of the study

The assessment of the WTD and the actual donation was placed at the end of the questionnaire and therefore could have been influenced by preceding questions.

One-word associations proved to be difficult to interpret in terms of their assignment to one of the attitude dimensions due to missing context and background information. To make the final coding as objective as possible, three researchers independently sorted the associations into sub-categories and the results were discussed multiple times, including with a fourth researcher. The supplementary material contains the code book, the original associations, and the translations to make the process as transparent as possible and to enable others to reconstruct this study themselves.

AUTHOR CONTRIBUTIONS

Jasmin Vlasák-Drücker: Methodology, Formal analysis, Writing – Original Draft, Visualization. **Annike Eylering:** Validation, Formal analysis, Writing – Review & Editing, Visualization. **Jasmin Drews:** Investigation, Methodology, Software. **Gesa Hillmer:** Validation, Data Curation. **Vera Carvalho Hilje:** Validation, Data Curation. **Florian Fiebelkorn:** Conceptualization, Investigation, Methodology, Writing – Review & Editing, Resources, Supervision, Project administration.

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CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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REFERENCES

Ballouard, J. M., Provost, G., Barr, D., & Bonnet, X. (2012). Influence of a field trip on the attitude of schoolchildren toward unpopular organisms: An experience with snakes. *Journal of Herpetology*, *46*(3), 423–428. https://doi.org/10.1670/11-118

Barua, M., Gurdak, D. J., Ahmed, R. A., & Tamuly, J. (2012). Selecting flagships for invertebrate conservation. *Biodiversity and Conservation*, *21*, 1457–1476. https://doi.org/10.1007/s10531-012-0257-7

Breuer, G. B., Schlegel, J., & Rupf, R. (2015). Selecting insects as flagship species for Beverin Nature Park in Switzerland - a survey of local school children on their attitudes towards butterflies and other insects. *Journal on Protected Mountain Areas Research and Management*, *7*, 5–16. https://doi.org/10.1553/eco.mont-7-1s5

Breuer, G. B., Schlegel, J., Kauf, P., & Rupf, R. (2015). The importance of being colorful and able to Fly: Interpretation and implications of children's statements on selected insects and other invertebrates. *International Journal of Science Education*, *37*(16), 2664–2687. https://doi.org/10.1080/09500693.2015.1099171

Cardoso, P., Barton, P. S., Birkhofer, K., Chichorro, F., Deacon, C., Fartmann, T., Fukushima, C. S., Gaigher, R., Habel, J. C., Hallmann, C. A., Hill, M. J., Hochkirch, A., Kwak, M. L., Mammola, S., Ari Noriega, J., Orfinger, A. B., Pedraza, F., Pryke, J. S., Roque, F. O., … Samways, M. J. (2020). Scientists' warning to humanity on insect extinctions. *Biological Conservation*, *242*, 108426. https://doi.org/10.1016/j.biocon.2020.108426

Cardoso, P., Erwin, T. L., Borges, P. A. V., & New, T. R. (2011). The seven impediments in invertebrate conservation and how to overcome them. *Biological Conservation*, *144*, 2647–2655. https://doi.org/10.1016/j.biocon.2011.07.024

Chandra, K., & Gupta, D. (2013). Studies on rhinoceros beetles (Coleoptera — Scarabaeidae — Dynastinae) from Madhya Pradesh, Central India. *Colemania*, *34*, 1–9.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155–159. https://doi.org/10.1037/0033-2909.112.1.155

Cole, T. C. H. (2017). *Wörterbuch der Wirbellosen / Dictionary of Invertebrates*. Springer Spektrum. https://doi.org/10.1007/978-3-662-52869-3

Consumerfieldwork GmbH (2020). Panel Book Germany.

Dörge, L., Büscher, M., Drews, J., Eylering, A., & Fiebelkorn, F. (2022). German laypeople's willingness to donate toward insect conservation – Application of an extended protection motivation theory. *Frontiers in Psychology*, *12*, 1–14. https://doi.org/10.3389/fpsyg.2021.773913

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Harcourt Brace Jovanovich College Publishers.

Field, A. (2018). *Discovering statistic using IBM SPSS statistics* (5th ed.). SAGE.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research. Addison-Wesley Publishing Company*. https://doi.org/10.2307/2065853

Frobel, K., & Schlumprecht, H. (2016). Erosion der Artenkenner. – Ergebnisse einer Befragung und notwendige Reaktionen. *Naturschutz und Landschaftsplanung*, *48*(4), 105–113.

Fukano, Y., & Soga, M. (2021). Why do many modern people hate insects? The urbanization-disgust hypothesis. *Science of the Total Environment*, *777*, 146229. https://doi.org/10.1016/j.scitotenv.2021.146229

Habel, J. C., Samways, M. J., & Schmitt, T. (2019). Mitigating the precipitous decline of terrestrial European insects: Requirements for a new strategy. *Biodiversity and Conservation*, *28*, 1343–1360. https://doi.org/10.1007/s10531-019-01741-8

Hallmann, C. A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., Stenmans, W., Müller, A., Sumser, H., Hörren, T., Goulson, D., & De Kroon, H. (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLoS One*, *12*, e0185809. https://doi.org/10.1371/journal.pone.0185809

Henry, M., & Rodet, G. (2018). Controlling the impact of the managed honeybee on wild bees in protected areas. *Scientific Reports*, *8*, 1–10. https://doi.org/10.1038/s41598-018-27591-y

Kellert, S. R. (1993). Values and perceptions of invertebrates. *Conservation Biology*, *7*, 845–855. https://doi.org/10.1046/j.1523-1739.1993.740845.x

Klausnitzer, B. (2011). *Exkursionsfauna von Deutschland Band 2*. (11 ed.). Spektrum Akademischer Verlag. https://doi.org/10.1007/978-3-8274-2452-5

Klausnitzer, B. (2019). *Exkursionsfauna von Deutschland Band 1*. (9th ed.). Spektrum Akademischer Verlag. https://doi.org/10.1007/978-3-662-55354-1, https://doi.org/10.1007/978-3-8274-2452-5

KMK (2019). The Education System in the Federal Republic of Germany 2017/2018. Bonn. Retrieved from https://www.kmk.org/fileadmin/Dateien/pdf/Eurydice/Bildungswesen-engl-pdfs/dossier_en_ebook.pdf

Köhler, G. (2015). Müller/Bährmann Bestimmung wirbelloser Tiere. In *Bestimmung wirbelloser Tiere* (7th ed.). Springer. https://doi.org/10.1007/978-3-642-55395-0

Leandro, C., & Jay-Robert, P. (2019). Perceptions and representations of animal diversity: Where did the insects go? *Biological Conservation*, *237*, 400–408. https://doi.org/10.1016/j.biocon.2019.07.031

Lemelin, R. H., Dampier, J., Harper, R., Bowles, R., & Balika, D. (2017). Perceptions of insects: A visual analysis. *Society & Animals*, *25*, 553–572. https://doi.org/10.1163/15685306-12341469

Lewis, S. M., Thancharoen, A., Wong, C. H., López-Palafox, T., Santos, P. V., Wu, C., Faust, L., De Cock, R., Owens, A. C. S., Lemelin, R. H., Gurung, H., Jusoh, W. F. A., Trujillo, D., Yiu, V., López, P. J., Jaikla, S., & Reed, J. M. (2021). Firefly tourism: Advancing a global phenomenon toward a brighter future. *Conservation Science and Practice*, *3*(5). Portico. https://doi.org/10.1111/csp2.391

Lindström, S. A. M., Herbertsson, L., Rundlöf, M., Bommarco, R., & Smith, H. G. (2016). Experimental evidence that honeybees depress wild insect densities in a flowering crop. *Proceedings of the Royal Society B Biological Sciences*, *283*, 1–8. https://doi.org/10.1098/rspb.2016.1641

Losey, J. E., & Vaughan, M. (2006). The economic value of ecological services provided by insects. *Bioscience*, *56*(4), 311–323. https://doi.org/10.1641/0006-3568(2006)56[311:TEVOES]2.0.CO;2

Maio, G. R., Haddock, G., & Verplanken, B. (2019). *The psychology of attitudes and attitude change* (3rd ed.). SAGE Publications Ltd.

Mallinger, R. E., Gaines-Day, H. R., & Gratton, C. (2017). Do managed bees have negative effects on wild bees?: A systematic review of the literature. *PLoS One*, *12*, e0189268. https://doi.org/10.1371/journal.pone.0189268

Martín-López, B., Montes, C., & Benayas, J. (2007). The non-economic motives behind the willingness to pay for biodiversity conservation. *Biological Conservation*, *139*, 67–82. https://doi.org/10.1016/j.biocon.2007.06.005

Prado, B. G., Puig, B., & Evagorou, M. (2020). Primary pre-service teachers' emotions and interest towards insects: An explorative case study. *Journal of Biological Education*, *1–16*, 61–76. doi:10.1080/00219266.2020.1756896

Randler, C. (2010). Animal related activities as determinants of species knowledge. *Eurasia Journal of Mathematics, Science and Technology Education*, *6*(4), 237–243. https://doi.org/10.12973/ejmste/75244

Samways, M. J., Barton, P. S., Birkhofer, K., Chichorro, F., Deacon, C., Fartmann, T., Fukushima, C. S., Gaigher, R., Habel, J. C., Hallmann, C. A., Hill, M. J., Hochkirch, A., Kaila, L., Kwak, M. L., Maes, D., Mammola, S., Noriega, J. A., Orfinger, A. B., Pedraza, F., … Cardoso, P. (2020). Solutions for humanity on how to conserve insects. *Biological Conservation*, *242*, 108427. https://doi.org/10.1016/J.BIOCON.2020.108427

Samways, M. J. (2019). *Insect conservation - a global synthesis* (1st ed.). CABI Publishing.

Schlegel, J., Breuer, G., & Rupf, R. (2015). Local insects as flagship species to promote nature conservation? A survey among primary school children on their attitudes toward invertebrates. *Anthrozoös*, *28*, 229–245. https://doi.org/10.1080/08927936.2015.11435399

Schlegel, J., & Rupf, R. (2010). Attitudes towards potential animal flagship species in nature conservation: A survey among students of different educational institutions. *Journal of Nature Conservation*, *18*, 278–290. https://doi.org/10.1016/j.jnc.2009.12.002

Seibold, S., Gossner, M. M., Simons, N. K., Blüthgen, N., Ambarl, D., Ammer, C., Bauhus, J., Fischer, M., Habel, C., Linsenmair, K. E., Nauss, T., & Penone, C. (2019). Arthropod decline in grasslands and forests is associated with drivers at landscape level. *Nature*, *574*, 1–34. doi:10.1038/s41586-019-1684-3

Shipley, N. J., & Bixler, R. D. (2017). Beautiful bugs, bothersome bugs, and FUN bugs: Examining human interactions with insects and other arthropods. *Anthrozoös*, *30*, 357–372. https://doi.org/10.1080/08927936.2017.1335083

Sonenshine, D. E., & Roe, R. M. (Eds.). (2014). *Biology of ticks* (Vol. 1, 2nd ed.). Oxford University Press.

Statistisches Bundesamt (2020). Durchschnittsalter der Bevölkerung in Deutschland nach Staatsangehörigkeit am 31. Dezember 2019. Statista. Retrieved from Statista website: https://de.statista.com/statistik/daten/studie/723069/umfrage/durchschnittsalter-der-bevoelkerung-in-deutschland-nach-staatsangehoerigkeit/

Statistisches Bundesamt (Destatis) (2019). Statistisches Jahrbuch Deutschland und Internationales. Retrieved from https://www.destatis.de/DE/Themen/Querschnitt/Jahrbuch/statistisches-jahrbuch-2019- dl.pdf;jsessionid=C2A913386C55F8F4A27C28B640411424.internet8742?__blob=publicationFile

Sumner, S., Law, G., & Cini, A. (2018). Why we love bees and hate wasps. *Ecological Entomology*, *43*, 836–845. https://doi.org/10.1111/een.12676

Szalay, L. B., & Deese, J. (1978). *Subjective meaning and culture: An assessment through word associations*. Lawrence Erlbaum Associates, Inc.

VERBI. (2018). MAXQDA 2018 (no. 2018). VERBI software GmbH

Wagner, D. L. (2020). Insect declines in the anthropocene. *Annual Review of Entomology*, *65*, 457–480. https://doi.org/10.1146/annurev-ento-011019-025151

Wagner, W., Valencia, J., & Elejabarrieta, F. (1996). Relevance, discourse and the "hot" stable core of social representations - a structural analysis of word associations. *British Journal of Social Psychology*, *35*, 331–351. https://doi.org/10.1111/j.2044-8309.1996.tb01101.x

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