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School students' attitudes towards unloved biodiversity: insights from a citizen science project about urban rats

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Abstract

Most of biodiversity is not considered charismatic and from human's perspective it can be indifferent, problematic, harmful, disgusting, or dangerous. Secondary school students' attitudes towards an unloved species and how it relates to their feelings of disgust in the context of a biology course were studied during a citizen science project where Finnish lower and upper-secondary school students surveyed the occurrence of urban rats. Questionnaire data was collected including items on four scales: attitude towards rats, interest in learning about environment, disgust, and liking biology as a school subject. It was modelled with an item response theory approach by including respondents' age and gender as fixed variables and school as a random factor. Higher age correlated with a more positive attitude towards the environment and lower level of disgust. There was an interaction between age and gender that male students had more negative attitude towards rats and lower general levels of disgust. Surprisingly, the students with more positive attitude towards rats also not only had a higher liking biology as a school subject and positive attitude towards the environment, but also a higher level of general disgust. The results suggest that disgust in general is not detrimental in learning and appreciating unloved others as parts of biodiversity. The results also raise questions on how personal attitudes towards the individual species relate to attitudes toward more abstract concept of biodiversity or the environment.

Keywords: disgust, biodiversity, citizen science, science education

Introduction

Biodiversity is often framed around the importance of conserving species diversity on Earth as it is useful for humans (Cardinale et al., 2012; Dasgupta, 2021; Van Weelie & Wals, 2002; Whitmee et al., 2015). Nevertheless, a substantial proportion of biodiversity is not useful for humans or especially endearing. For example, more than half of all species are parasites or pathogens, that have by definition negative effects on their host species (Windsor, 1998) and are often considered as disgusting. Of non-parasitic species, many thrive in human presence, and they are considered as *pests*. Indeed, it can be argued that pests are the species that are most suited to live with humans in the Anthropocene. Nevertheless, for sustaining species diversity and to reach a sustainable future, it is important that we also have an interest in protecting life forms that we do not understand, that we are indifferent to or that can even be considered as unappealing or detrimental to humans.

In research, species considered as *unloved others* (Bird Rose & van Dooren, 2011) have received much less attention than agreeable species. Bird Rose and van Dooren (2011) define unloved others as the ones who are disregarded, lost through negligence, disliked, actively vilified, targeted for death, controlled in the name of conservation, and caught in the cross-hairs of conflicting human desires. There are some studies on attitudes towards species usually considered as disgusting (Borgi & Cirulli, 2015; Breuer et al., 2015; Prokop & Tunnicliffe, 2008) and even interventions on trying to probe these feelings in a school context (Fančovičová et al., 2013; Randler et al., 2013). Nevertheless, the broader context of the related attitudes and the demographic drivers are usually not present in these studies. Here the focus is on the attitudes of young people in the context of a citizen science project organized as a part of their school studies in biology. In this study, biodiversity is approached from the point of view of studying single unloved species, urban rats and the aim is to understand how attitudes towards rats and to learning and disgust sensitivity are related to participants' background and to each other.

The brown rat (*Rattus norvegicus*) was chosen as a study species as it presents a great entry point for studying human attitudes towards unloved others (Bird Rose & van Dooren, 2011). In some of cases such as the focal species, rats, unloved others are killed and controlled in the name of conservation, public health, or protecting humans' urban lives. Globally, rats are perceived to be one of the most unloved species, causing friction with humans wherever they are present (Bjerke & Østdahl, 2004; Collins, 1976; George et al., 2016; Kellert, 1985). Rats are highly dependent on humans: they are one of the strictest synanthropes. They are also highly urbanized: for example, in Helsinki, Finland, rats are the only vertebrates able to live in the sewage system. Rats, in general, are considered as the most disgusting of mammals (Polák et al., 2020) due to their association with multiple zoonotic pathogens and historical antagonism. Indeed, the brown rat is a cosmopolitan species present on all continents (though the population on mainland Antarctica is not stable, but present on some Antarctic islands). Much of biodiversity is situated in this difficult middle-ground of individual versus (multispecies) community wellbeing: as a population of species, the brown rat is considered as an invasive species that has detrimental effects for endemic species and its spread has been facilitated by humans (Davis & Thompson, 2000). Thus, it is commonly eradicated in certain areas.

Learning about biodiversity

One of the most pressing current crises in the world is the dramatic loss of biodiversity (Cardinale et al., 2012). For the survival of humankind, minimizing the loss of biodiversity is imperative (Atwoli et al., 2021), but the conservation of biodiversity presents itself as a wicked problem. Often, biodiversity is perceived as a concept that is poorly defined and difficult to teach (Cerda & Bidegain, 2018; DeLong, 1996; Navarro-Perez & Tidball, 2011) and includes multiple, detailed interdisciplinary perspectives (Menzel & Bögeholz, 2009). Indeed, in an Argentinian study, secondary school students perceived biodiversity as first and foremost through simple species

richness (Bermudez & Lindemann-Matthies, 2020). The aim of biodiversity education should be not only to gain knowledge about biodiversity, but also to develop the willingness to act so that biodiversity is protected or at least not lost (Karris et al., 2020; Van Weelie & Wals, 2002).

Knowledge about biodiversity seems to increase the acceptability of biodiversity conservation. For example, students have more positive attitudes towards better known species (Wilson & Tisdell, 2005) and real-life experience with species enhance the positive attitudes towards them (Hosaka et al., 2017; Schönfelder & Bogner, 2017). However, biodiversity relates more to conceptual knowledge and there is a lack of personal experience or affect (Simaika & Samways, 2018). Unsurprisingly, the affective dimension is more important than scientific considerations: for example, a person's attitudes strongly affect the willingness to protect species (Martín-López et al., 2007) and affect is also inherent for policy actors and networks (McKenzie, 2017). The emphasis on certain "charismatic species" that are featured in nature documentaries can cause biases in student understanding of biodiversity, such as prioritizing exotic biodiversity over local species (Ballouard et al., 2011).

For young people, information about biodiversity is usually illustrated through animals or plants. Learning with animals has been proposed to enhance science learning in multiple ways: it encourages cognitive performance through hands-on activities (Dieser & Bogner, 2016; Prokop & Fančovičová, 2017), increases motivation (Hummel & Randler, 2012), facilitates conceptual learning (Morgan & Gramann, 1989; Prokop & Fančovičová, 2017), fosters positive attitudes towards science (Sorge, 2008), and creates empathy for other species (Herbert & Lynch, 2017). Studying animals in a familiar context has the potential to combine the benefits of inquiry-based learning, interest in the near-environment and positive attitudes towards animals (Aivelo & Huovelin, 2020). Nevertheless, the presence or absence of animals in learning environments is not without its problems, including the potential for abuse and exploitation (Spannring, 2017). Indeed, the presence of animals in classroom or while doing fieldwork has a constant tension between

respectful co-learning with an animal as a subject and abuse where the animal is an object used to reach educational goals. Thus, the school can at the same time promote better conceptual understanding of both biodiversity and abusive attitudes towards animals and plants.

Attitudes towards biology learning, animals, and the environment

An attitude can be defined as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993), though attitude objects can also include multiple, conflicting or ambivalent evaluations (Ajzen, 2001). The context of this study is biology lessons during which students studied urban rats in their near-by environment. Thus, the relevant student attitudes include attitudes towards biology as a school subject, attitudes towards learning about the environment, and attitudes towards rats as animals. These attitudes may play a role in collecting data on urban animals during school work in a citizen science project context.

Biology, or more broadly science, is the school subject that is most involved in formal education in biodiversity, animal, and environmental issues (Gayford, 2000). A link has also been found between positive attitude towards biology as a school subject and pro environmental attitudes (Uitto et al., 2011). This link between biology and the environment might be driven by the hands-on experience with nature and the near environment in biology class. For example, Uitto et al. (2006) found that nature experiences were the most important experiences explaining students' interest in "zoology" or "genetics and evolution" (i.e., the two most relevant factors related to biodiversity in their study). Indeed, knowledge about nature, activities in nature and attitude towards the natural environment are correlated (Tikka et al., 2000). In general, attitudes towards science subjects in secondary school vary; research has shown that boys have the most positive attitude towards physics, whereas girls are most positive towards biology (Uitto et al., 2011). The source of gender differences in relation

to these subjects is debated, but it is a combination of sociocultural, historical, and biological factors (Jones et al., 2000; Zelezny et al., 2000).

Environmental attitudes are a broad group of attitudes: in their review Milfont & Duckitt (2010) divide environmental attitudes to twelve scales, such as enjoyment of nature, environmental movement activism and ecocentric concern. In general, these attitudes seem to be linked with actual behaviors (Kaiser et al., 1999, 2007). Adult women across cultures seem to have a higher concern for the environment based on surveys (Bord & O'Connor, 1997; Elert & Lundin, 2022; Franzen & Vogl, 2013; May et al., 2021), and subsequent higher interest in environmental issues has been linked to the perceived vulnerability to the risk, not necessarily ecological sensibilities (Bord & O'Connor, 1997; K. W. Knight, 2019).

Human attitudes toward animals have been conceptualized through utilitarian and zoocentric approaches (Herzog et al., 2015). In Herzog's review (2007), based largely on surveys on Australian and American university students' attitudes toward animals seem to strongly correlate with gender differences: support for hunting and animal research and cruelty to animals are more strongly linked to men than to women, whereas women are more likely to participate in animal rights activism or issues like hoarding large numbers of cats. Furthermore, in interviews American men seem to be more concerned about species preservation and habitat conservation, while women expressed more concern for the welfare of individual animals (Kellert & Berry, 1987). The underlying explanation for gender differences in these attitudes is not well understood (Apostol et al., 2013); indeed, the gender gap varies: in attachment to companion animals the difference is small, whereas in relation to animal rights activism it is large (Herzog, 2007). One of the interesting explanations could be underlying differences in empathic and social dominance orientations (Graça et al., 2018). Thus, it could be expected that attitudes towards individual species might also reflect gender differences that are related to the risks, utility, and aesthetics of the species.

Disgust towards animals

Disgust is a response to a broad range of stimuli that can be related to potential for disease or other unhealthy phenomena (Rozin et al., 2008). Disgust is usually directed to a certain class of animals, considered as possible sources of disease, such as parasites, slugs, flies, or rats (Davey et al., 2003; Randler et al., 2012; Tomažič et al., 2020). Nevertheless, disgust is not merely an evolutionary physiological reaction, but also a response that is mediated through sociocultural lenses; the response may be due to upbringing and cultural context partly determines what humans consider as disgusting. While there are universal aspects to it in relation to animals considered dangerous to humans, there are also ample cultural variations in taboos, food practices and identities of sacred animals (Kolnai, 1924). The dimensions of disgust have been widely explored: Haidt et al. (1994) suggested that disgust consists of seven domains (food, sex, animals etc.), whereas more recently Tybur et al. (2009) has suggested that there are only three domains: pathogens (which includes animal-related disgust), sexuality and morality.

Indeed, it seems that anxiety or disgust can lower motivation during learning tasks (Randler et al., 2013), yet, the disgust towards animals seems to be a response that can be, if not overcome, at least managed (Breuer et al., 2015; Prokop & Fančovičová, 2017; Randler et al., 2012). Interestingly, disgust is an ambivalent emotion as an object or animal that can be considered as disgusting can also elicit curiosity (Breuer et al., 2015). Indeed, in visual culture disgust is a widely used emotion in two functions: pleasure and provocation (Hanich, 2009). Disgust does not equal to fear, but rather it is a learned disposition to be careful, which is nurtured in school and at home (Vernon & Berenbaum, 2002). Thus, initial strong disgust can even change into strong attachment through increased knowledge or positive experiences that prove these dispositions unnecessary (Kleinknecht, 1982; Vernon & Berenbaum, 2002). While there is potential for the use of disgust in education, it has been critically examined in relation to public health, as disgust has been theorized in creating differences between Self and Other, which can facilitate intergroup conflicts (Lupton,

2015). The subversive power of using disgust in education definitely raises several ethical questions (Zembylas, 2020).

Aims and research questions

The aim of this study was to explore the secondary school students' attitudes and sensitivities while they participated in a citizen science study on an unloved species living in their own near-environment. Disgust as a general feeling was chosen as it has been shown to affect learning as outlined above and the focal species is generally considered to be a disgusting species. Furthermore, the focal species not only evokes feelings of disgust, but it is also an actively difficult companion species in urban environments; thus, the specific attitude towards rats was added in the study. Liking biology was added as an attitude as the context of the study was a project held during biology lessons; therefore, students likely considered the activity as part of biology as a school subject, whereas interest in learning about the environment was included as the spatial context was the students' own near-environment. All beforementioned attitudes and affects are known to vary as a function of age and gender; thus, those were included as explanatory variables along the school as a random factor. Furthermore, the school context places a substantial meaning on both age and gender through hidden curriculum which enforces gender roles and age class divisions (Lahelma, 2002). The responses were modelled through an item response theory framework (De Ayala, 2009), which was chosen as it considers an answer to an item as a function of both person and item parameters; thus, it allows for expanding modelling of latent traits to include explanatory factors. Therefore, as the results were not then dependent on the set of items, but rather the particular items used, the best suited items could be used from each scale.

The specific research questions were:

- How does the age and gender of participating students explain their disgust sensitivity in general and attitudes towards rats or learning about the environment when controlling for their gender and liking biology as a school subject?
- How do disgust sensitivity and attitudes towards the environment, biology and rats correlate?

Methods and materials

A quantitative analysis on the students' attitudes after their participation in the Helsinki Urban Rat Project was performed by conducting questionnaire data collection and analyzing those questionnaires through item response theory-based analysis. Additional information on data collection and analysis is given in Supplementary Materials.

Participation in citizen science project

Since spring 2018, 21 different schools have participated in the Helsinki Urban Rat Project (HURP; https://www.helsinki.fi/en/projects/urban-rats), an ongoing multidisciplinary research project. In the citizen science part of the project, the aim is to understand the spatiotemporal variation in the rat population dynamics in the city of Helsinki. The students use trackplates, which are 20x20 cm white plastic plates that are painted with lampblack (Hacker et al., 2016). Thus, if a rat walks across the plates, its paw prints are left to be identified and counted by the students (Figure 1). Hence, the students do not need to directly encounter rats during the study, but there is a possibility that they can identify the actual places where rats have recently moved.

For this study, volunteer lower and upper secondary school (i.e., students from 13-19-years old) teachers were recruited through a Facebook group. The most common context for the participation

was the ecology course in lower or upper secondary school as the Finnish national curricula mandates in learning about biological sciences how to collect and analyze data. The project for individual students included a visit to their classroom by researcher (in person or remotely during the pandemic), a lecture on urban ecology and rats in which the author explained to the students how they could participate in the research. During this lecture, the students were encouraged to share their previous encounters with urban rats. Teachers were then free to organize their students' participation as they wished. Generally, the students were free to set the plates wherever they wanted within the city limits; thus, they generally studied their own near environments, either near the school or near their homes. The students were encouraged to "think like rats" when placing the plates to choose places where rats would actually move. Students set the plates, photographed them for four subsequent days and then collected the plates. They sent their photos and track measurement through the Epicollect5 mobile application (Aanensen et al., 2009).

Figure 1: A photo of the track plate done by a lower secondary school student showing characteristic rat paw prints.

Questionnaire

Students completed a questionnaire after they had participated in the project. The students generally completed the questionnaire during classroom time, though this was not true for all participants as they might also have done so after school hours. The questionnaires included four different established scales with five items per scale: *Liking biology as a school subject*, *Interest in learning about the environment*, *Attitude towards rats as a species* and *Disgust* sensitivity. *Liking biology* was a modified version of the Fennema-Sherman scale that has been used in Finnish national learning assessments (Fennema & Sherman, 1976; Metsämuuronen, 2012). *Interest in learning about the environment* was selected from the international ROSE questionnaire (Schreiner & Sjøberg, 2004) in which chosen items load onto a single factor (Uitto et al., 2011). *Attitude towards rats as a species* was a scale modified from the shortened version of Animal Attitude Scale to focus the respondents' attitudes on rats, i.e., changing generic animals to rats (Herzog et al., 2015). *Disgust* sensitivity was measured by items from the *Disgust Scale Revised* (Haidt et al., 1994, modified by Olatunji et al., 2007) of which the chosen items form two subscales Core disgust and Animal Reminder. This scale was not modified towards rats as I was interested in general disgust sensitivity and the general disgust level is expected to explain substantial part of the species-specific variation (Lorenz et al., 2014). Each item was measured on a five-point Likert item. Furthermore, the questionnaire included data on the school of the participants, their age and gender. Only responses that did not contain missing data on the background variables (school, age, gender) were included in the analysis: schools with fewer than five respondents were removed.

Statistical analysis: item response theory approach

The relationship between attitudes and background factors was explored through item response theory. Item response theory (IRT) has been used previously due to its versatility in assessing the

attitudes of school and university students in environmental and life science subjects (e.g., Connell et al., 2016; Geiger et al., 2018; Guzey et al., 2016; Romine et al., 2014; Sjaastad, 2013). The data was modelled using a multidimensional latent trait framework that allows modelling the factors explaining variation in the attitude and disgust sensitivity factors. The IRT evaluates each item individually; thus, on the same scale the items can have different response curves (Bortolotti et al., 2013). Person parameters were assumed to be random (i.e., latent) and continuously distributed, whereas item properties were fixed and inherent to items only (Chalmers, 2015); this allowed for a flexible choice of items for each scale (Hambleton, 1993). More details can be found in Supplementary Material, but a general approach is outlined here.

My approach included three phases: exploratory, confirmatory, and explanatory modelling. Exploratory modelling tested whether the chosen items form spontaneously expected factors, confirmatory modelling tested the factor structure and model fit for the *a priori* chosen factors, and explanatory modelling used the factors to model the latent traits. In explanatory analysis, a generalized linear mixed model with age and gender as covariates and school as a random effect was built. For exploratory analysis, the expected number of factors was set to four and the resulting factor loadings were compared to the expected factors. The poorly performing items that either did not load meaningfully to the expected factor or exhibited substantial multidimensionality were dropped. In confirmatory analysis, responses which were not coherent were removed. Thus, exploratory and confirmatory analysis should be seen as quality control phases. In all the modelling, items were modelled with a generalized partial credit model (GPCM; Muraki, 1992) and Metropolis-Hastings Robbins-Monro (MH-RM; Cai, 2010a, 2010b) algorithm implemented in a *mirt* package (Chalmers, 2012) in R (R Core Team, 2013).

The raw data is deposited in FigShare (REDACTED) and the analysis code is shared in GitHub (REDACTED).

Ethical considerations

Participation in the citizen science project was part of the regular schoolwork; thus, the students were compelled to participate. Generally, the participation did not affect student grades, but in some schools, the students wrote scientific reports that could affect their grades. For the questionnaire, participation was voluntary and based on informed consent; it could be ended at any point, and no data was given to the teachers; thus, responding or not responding to the questionnaire did not affect the students' grades.

Research permits were granted by the City of Helsinki on April 5, .2018 and September 22, 2020, respectively, and the permits from individual private schools on May 3, September 7, and October 1, 2018. All participants were informed on the preface of the online questionnaire about the aim of the study and how the materials would be collected, stored, and handled anonymously. No personal data was collected during the study.

Results

A total of 665 students responded to the questionnaire. The estimated number of participants in the citizen science project was approximately 2,500 students; thus, about one fourth of the participating students responded to the questionnaire. Four schools had fewer than five respondents; therefore, those respondents were removed. Full data was available for 501 respondents from 14 schools (with a range of 7-166 respondents per school). The mean age of respondents was 16.50 (± 1.14); in this

case, 54% were females, 42% males, 1% identified as others and 2% did not want to reveal their gender.

Individual statements

In general, the students' opinions in their individual statements relating to the rats were quite evenly divided. Specifically, the students were more positive towards animal experimentation with rats (Figure 2; 41% agrees vs. 32% disagrees), and they agreed that dissecting rats is necessary for learning some aspects of biology (45% vs 24%). In contrast, the students were more negative towards controlling rat occurrences such as killing rats with traps or rodenticides (23% vs. 41%), and generally preventing other species from coming into cities (10% vs. 59%).

Similarly, the disgust factor varied from low disagreement with avoiding cemeteries (5%) to high disagreement on avoiding eating rat meat in all circumstances (77%). In contrast, the students showed a broad liking biology as a school subject (63% agreement with "I like to study biology" and 67% disagreement with "It is boring to study biology); students also presented positive attitude towards learning about the environment (agreement 52% - 81%).

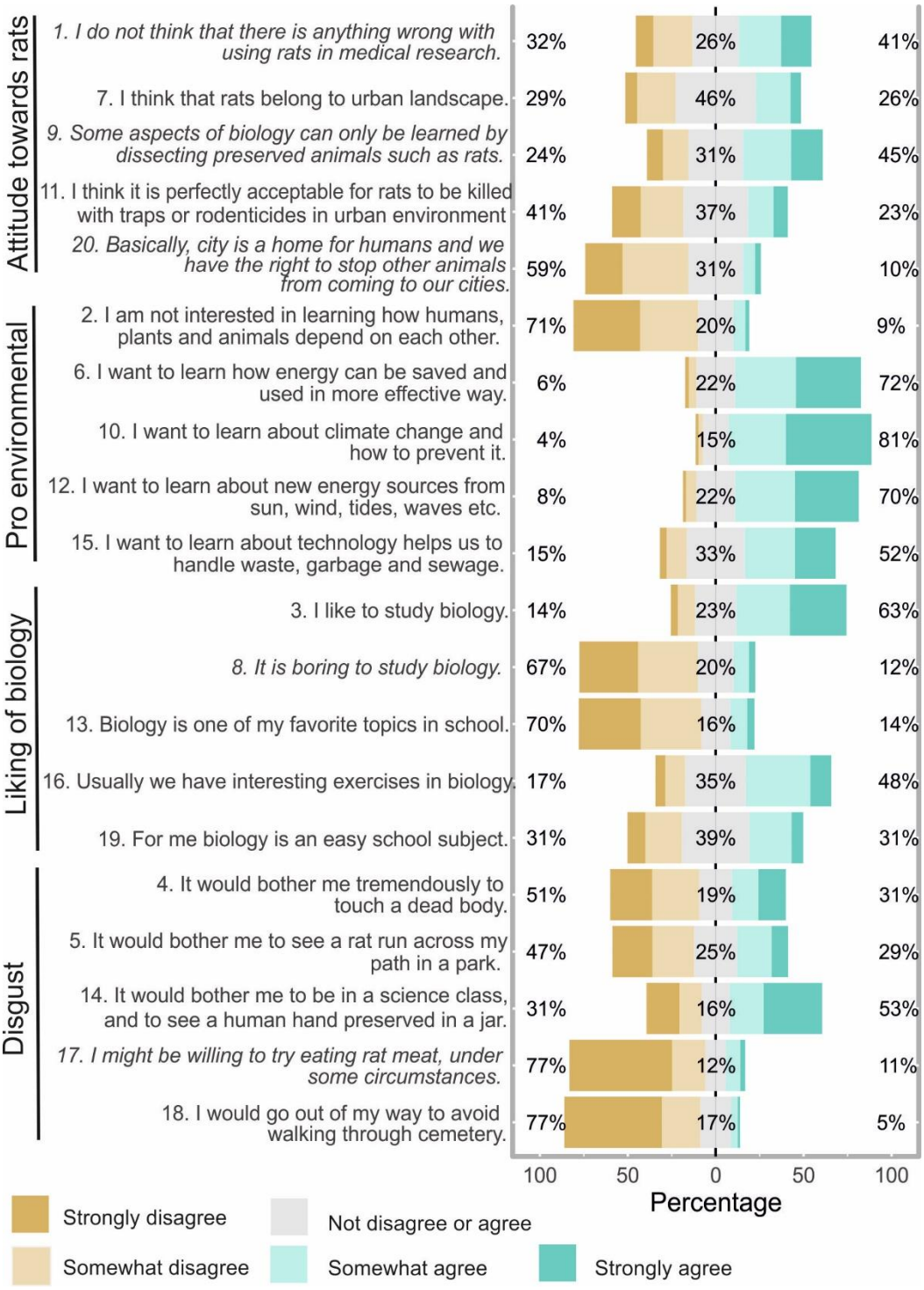

Figure 2: The distribution of the responses for each item in the initial scale. The items are grouped by scales (left side). The value on the left indicated proportions of respondents strongly or somewhat disagreeing, in the middle not disagreeing or agreeing and the right respondents strongly or somewhat agreeing. The item-related statistics are shown in Table S1 and S2.

Student-related variables

Gender was the most important variable in relation to attitudes and disgust sensitivity: Female and male students differed consistently from each other: females had more negative attitude towards rats, more positive attitude towards learning about the environment, they liked biology more as a school subject, and they had stronger feelings of disgust (Figure 3). For other genders, the number of respondents was so low that it was more difficult to draw conclusions.

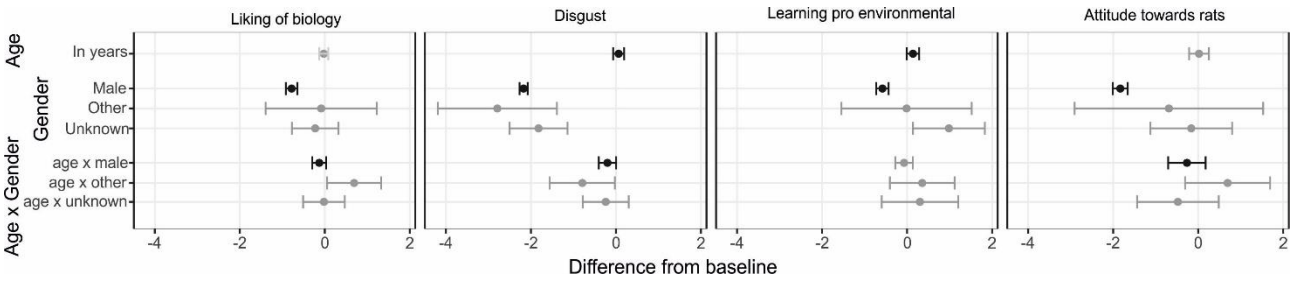

Figure 3: Links between explanatory variables and respondent attitudes. For gender, female is chosen as a baseline and other genders are compared to this (unfilled circles). Values substantially differing from baseline are shown in black, whereas non-substantially differing variables are colored gray.

Higher age seemed to correlate with more positive attitude towards learning about the environment. Additionally, the interaction between age and gender showed that male students had more negative attitude towards rats, liked biology less and showed a lower general disgust sensitivity as age increased (Figure 4).

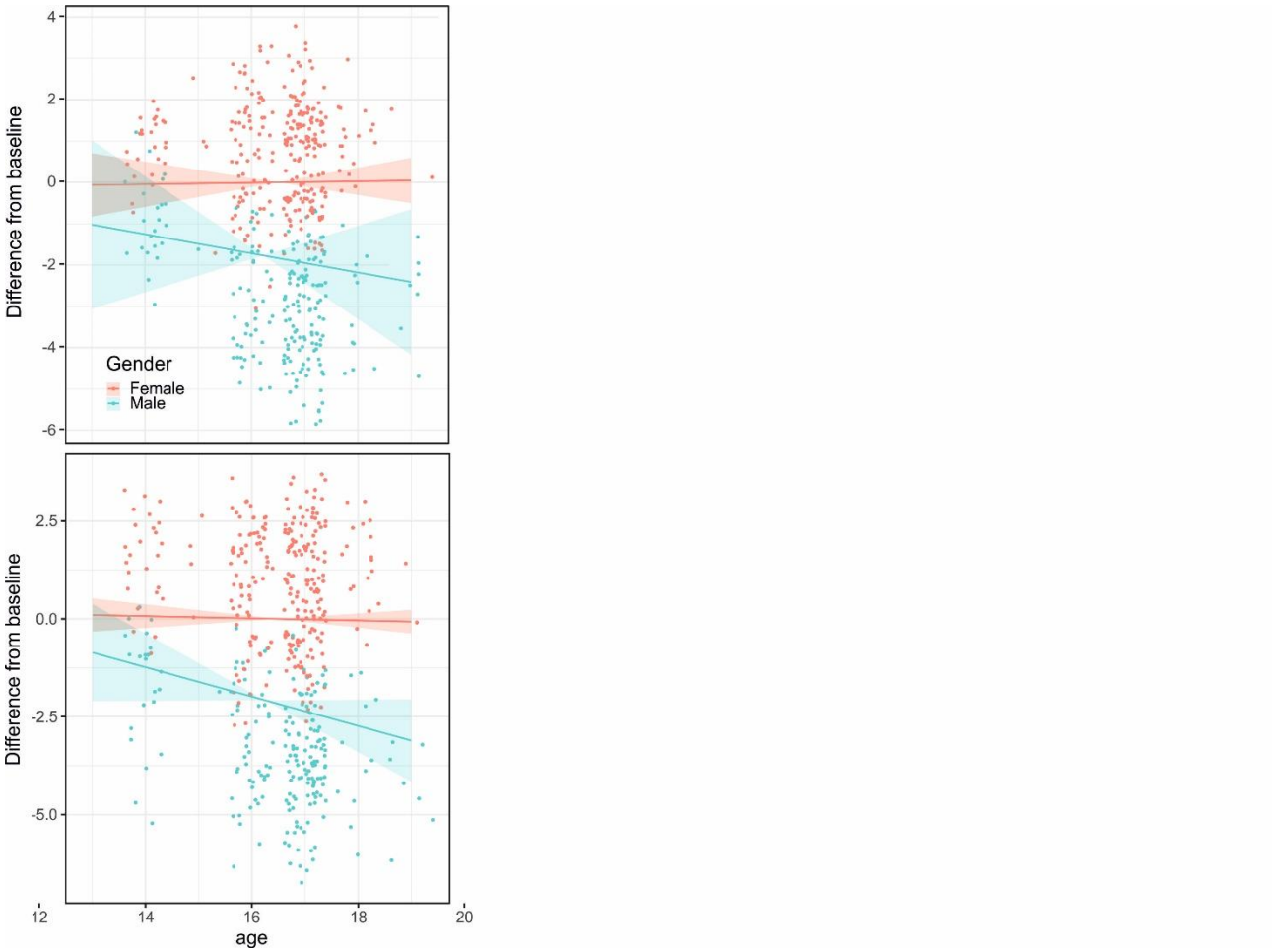

Figure 4: The effects of age and gender on (a) attitude towards rats and (b) disgust attitudes. The raw estimates are plotted for female and males and linear trend lines represent the fixed effects of age and interaction between age and gender with 95% confidence interval of slope coefficient. The age is an integer but here jittered to better show the variation in underlying data.

Correlation between factors

There was substantial correlation between some of the factors when considering age, gender, and school (Table 1). The strongest correlations were between attitudes towards rats and the environment, suggesting that students who have a more positive attitude towards learning about the environment also have a more positive attitude towards rats. Similarly, a positive correlation was found between liking biology and a positive attitude towards learning about the environment. The students with a more positive attitude towards rats also showed a higher tendency to like biology,

but also a higher level of disgust. There was no substantial correlation between disgust and liking biology.

Table 1: The association between different factors calculated from the residual correlations among different factors when fixed effects (age, gender) and group random factors (school) are accounted for. Values shown with 95% confidence intervals.

	Attitude towards rats	Pro environmental attitude	Liking biology
Pro environmental attitude	0.42 (0.35 – 0.48)		
Liking biology	0.27 (0.12 – 0.39)	0.39 (0.33 – 0.45)	
Disgust	0.31 (0.26 – 0.38)	0.01 (-0.02 – 0.04)	-0.02 (-0.18 - - 0.05)

Discussion

Quite surprisingly, I found no negative associations among disgust, attitude towards disgust-evoking species, and attitude towards learning about environmental issues in the context of studying urban rats. This poses a question of whether an attitude towards disagreeable animal species presents a challenge in terms of biodiversity education or conservation as has been previously suggested (Castillo-Huitrón et al., 2020; Prokop & Fančovičová, 2017; Randler et al., 2013). Secondly, my study shows that there were substantial differences between genders and along ages in students' attitudes towards rats, learning about the environment, liking biology and disgust sensitivity. This is in line with previous research as gender differences in all these attitudes and disgust is well-documented. Interestingly, an increase in age or years of schooling seems to drive different magnitudes in response in men and women. The studies between disgust and age seem to suggest either no relation or lower disgust at an older age (Berger & Anaki, 2014; Kim et al., 2013; Quigley et al., 1997), but no clear interaction with gender has been shown. While older female students were not more negative towards rats, the men were more negative; in addition, there had

already been a substantial difference in their younger years. This accords with the general previous finding that younger persons tend to have more positive attitudes towards animals (Driscoll, 1992; Kellert, 1985) and specific finding by Bjerke and Østdahl (2004) that attitude towards rats is negatively correlated with age.

Unloved species within biodiversity

The results suggest that the relationship towards an unloved species is more complex than simply a disgust sensitivity: while students might perceive some wildlife species as disgusting, it does not preclude them having in general more positive attitudes towards such species. Indeed, disgust might be a curiosity-evoking emotion (as shown by Breuer et al., (2015), Hanich (2009) and Vernon and Berenbaum (2002)), which has allowed students to explore rats as species during the citizen science project. It was not measured whether disgust towards rats would elicit curiosity in the students towards rats nor the actual effects of the citizen science project as there was no pre-participation survey. Furthermore, it is possible that participation in the project has altered one but not all of these dimensions. This could explain the absence of the correlation between disgust and attitude towards rats, if, for example, participation might have affected the acceptance of rat presence in the urban environments, but not disgust as such. In general, it would not be expected that the short intervention would substantially alter the measured factors with probably the exception of the attitude towards rats (Aivelo & Huovelin, 2020; Ajzen, 1991), though a specifically planned intervention might (Maggiulli, 2022; Wu et al., 2020).

The generalizability of the study needs to be carefully considered. Only one aspect of "unloved others" or disliked biodiversity, namely rats, was studied. Rats are a specific case of animal considered as disgusting as they are a genuine ecological and public health risk due to their

invasiveness and ability to carry zoonotic pathogens; this is different from endangered amphibian or invertebrate species that are unloved due to their physical appearance. Participation in the citizen science project concerning rats forces students to reflect on their relationship with rats or at least to notice that rats are part of the urban environment. This thought might not have occured to them prior to participation in urban rat research. Indeed, in general, citizen science helps develop student interest in science, animal attitudes and perceived mastery (Kelemen-Finan et al., 2018). Thus, the participating students might be positively attuned to rats compared to other school students. The previous interviews with students would seem to corroborate this idea: the students suggested that they have more positive attitude towards rats after participation (Aivelo & Huovelin, 2020). Furthermore, the participants were non-randomly selected: first, the teachers volunteered to participate in the citizen science project, and then their students voluntarily participated in this questionnaire. Thus, these results cannot be readily generalized to young citizens or broadly to other elements of disliked biodiversity.

Interestingly, the results suggest that understanding of biodiversity through its component species might not require the lessening of disgusting experiences or avoiding those, but rather going towards disgust through reflection and discussion might help in driving curiosity towards different aspects of biodiversity. In line with previous studies showing the potential for linking disgust and curiosity (Breuer et al., 2015; Prokop & Fančovičová, 2017; Randler et al., 2013; Zembylas, 2020), the current study suggests that the interplay between curiosity and disgust should be more explored in relation to the animals that people consider as disagreeable or annoying.

Personal relationships versus abstract environmental attitude

Broadly, the residual correlations among factors were generally as expected. As there is a substantial component of environmental sciences in biology teaching in Finland, it is not surprising that liking biology and interest in learning about the environment correlate strongly. Similarly, biology is the school subject where students learn about animals; thus, a positive correlation between liking biology as a school subject and having positive attitude towards rats is logical. This seems to further strengthen the idea that unloved species could be used as an efficient entry-point to help students develop a more diverse understanding of biodiversity. The question of a personal relationship towards species relates to a more general attitude towards biodiversity is an open one. In school setting, carefully planned exposure to specific species at least can lead to an increased nature connectedness (Cho & Lee, 2018; Lankenau, 2018). In addition, in relation to the self-reported pro environmental behaviors, a sense of connection to animals seemed to be a strong predictor of people's connection to animals in zoo enclosures (Grajal et al., 2017). However, in the wild in citizen science projects, the outlook is different: the sense of connection to animals did not seem to be an important aspect in the most wonderful nature experiences of Dutch biodiversity citizen scientists, but this was rather dominated by target species identity (Ganzevoort & Van Den Born, 2019), whereas in coastal project in the United States, the connection was felt by those who observed a sheer number of birds (Haywood, 2016). In a school-related hummingbird citizen science project, no change in nature connectedness was detected (Williams et al., 2021). These examples suggest that the aesthetic value of animals and nature experiences in general is important in relation to environmental attitudes, but does not necessarily deepen students' personal relationship with animals. Thus, the question presents itself: how would people be able to form a connection to the mundane animals when they are in the wild? Furthermore, how important are the attitudes to biodiversity in relation to understanding biodiversity? Is it even important to form a positive attitude towards any particular species? Hence, citizen science projects should be mindful of the type of the connection they are promoting between humans and wildlife.

As a negative attitude towards rats is not caused by stronger disgust, it begs the question, why older students hold more negative attitudes. It is not clear whether this attitude is related to increased life experience, learning biology and concepts such as invasive species or rather just a general effect of age as found previously by Bjerke and Østdahl (2004). Indeed, much of school education is relatively anthropocentric as animals are contrasted to humans and rats are presented as pests. In contrast, older students across genders have more positive attitude towards environmental issues. Interestingly, when the employees of Finnish municipalities were asked about their attitudes towards rats, the older respondents were less likely to believe in peaceful coexistence between humans and rats in cities (Nygren & Tuomas, 2022). This brings up a possibility of the effect of so-called "perception of choice", a situation in which people are more likely to have a positive attitude toward animal objectification if they perceive no alternative (S. Knight et al., 2010). Thus, if people are more likely to see no peaceful coexistence between humans and rats, they might be more inclined to hold negative attitudes towards rats in cities. Rats are conceptualized as pests; thus, by definition, no peaceful coexistence between humans and rats could be easily seen.

Nevertheless, it might be worthwhile to emphasize that disgust is a strong feeling and that not all "unloved others" are encountered with strong emotions: unloved others also include those species that humans approach with indifference or do not understand. Thus, while rats encounter strong hatred from humans, it does also make them more likely to encounter empathy than those animals that are not considered at all.

One of the possible avenues to understand this issue of biodiversity versus human-animal relations would be to move away from the individual to the question of connectedness and more-than human communities (Whatmore, 2004). As biodiversity is an abstract concept, more research should be

done on the correlation between personal relationships towards different species and how biodiversity is conceived in general. For example, connection to nature seems to facilitate students' understanding of how their personal experiences relate to climate change (Duke & Holt, 2022). Recently, approaches such as "common worlds" (Taylor & Giugni, 2012) or "relational paradigms" (Walsh et al., 2021) have been used to decenter human individual and highlight relationality in interspecies understanding. The question arises what consequences might be expected if the relationship between humans and unloved others are conceptualized through personal relations rather than on a more abstract level (through concepts such as invasive species or pest species) and how that changes understanding and attitudes towards biodiversity.

Limitations

The response rate was notably low across the schools. This likely means that the respondents are not a representative sample of all students, but rather a selected sample where those who were most interested in the topic were likely to answer. In some schools, the students were prompted to respond to the online questionnaire during regular class time, whereas in other instances teachers reminded them about responding through emails or online learning environments.

Students from both lower and upper secondary schools took part in data collection. While as a rule, almost all young students take part in lower secondary schools (i.e., students are 13-16-years old), only approximately half of the young people attend upper secondary school (16-19-years old; the other half go into vocational school). Thus, the older students were a more selective group. While exploring whether there is a substantial difference between those two school levels, such as discontinuity in age trends, no differences were found. In general, it was estimated that the response

rate was lower for lower secondary schools, which might mean that the larger bias in respondents in lower secondary school would lead to evening out the bias overall.

The scales used in this study are not as closely related as would be optimal for the theoretical framework: the students' broad attitude(s) towards biodiversity were not measured, but rather the attitude toward a specific species and a general pro environmental attitude were assessed. Similarly, the disgust sensitivity was measured and not specific disgust towards rats. While these were dictated by the availability of well-functioning scales, further research should analyze more closely the universal versus specific in these attitudes and emotions. The scales for attitude towards rats and pro environmental attitude did not perform as well as the two other scales; while they performed adequately, these factors would need to be refined in later studies.

Conclusion

The results suggest that disgust is not an emotion that can be seen as detrimental for the students' attitude towards rats, an animal species often considered as disgusting. Thus, potentially, disgust can even be used as a curiosity-evoking emotion in relation to those parts of biodiversity that are considered unlikable. Interestingly, the increasing age correlated with lower feelings of disgust and more negative attitude towards rats, especially in men. This might suggest that either school education or cumulative life experience led to a more negative outlook on problematic biodiversity. This might be related to the focus on invasive species or indoctrination related to the species considered as pests. Nevertheless, the older respondents had more pro-environmental attitudes. This interesting interplay between different aspects of biodiversity, especially unloved species, requires further research.

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Competing interests

No potential competing interest was reported by the author.

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