Received: 17 June 2020 | Accepted: 20 October 2020

DOI: 10.1002/pan3.10168

RESEARCH ARTICLE

PEOPLE AND NATURE | BRITISH ECOLOGICAL SOCIETY

Socio-psychological factors, beyond knowledge, predict people's engagement in pollinator conservation

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Funding information
Natural Environment Research Council, Grant/Award Number: NE/L002434/1 and NE/P011217/1; The Halpin Trust; Economic and Social Research Council, Grant/Award Number: ES/P000630/1; Biotechnology and Biological Sciences Research Council, Grant/Award Number: BB/M009122/1; European Regional Development Fund

Handling Editor: Carla Morsello

Abstract

1. Nature conservation often depends on the behaviour of individuals, which can be driven by socio-psychological factors such as a person's attitude, knowledge and identity. Despite extensive ecological research about pollinator declines, there has been almost no social research assessing the drivers of people's engagement in pollinator conservation.
2. To address this gap, we used a large-scale, online questionnaire in the United Kingdom, broadly framed around the Theory of Planned Behaviour. We received a total of 1,275 responses from a wide range of ages, incomes and education levels, despite a selection bias towards people with a pre-existing interest in pollinators.
3. A range of socio-psychological factors predicted people's pollinator conservation actions and explained 45% of the variation. Respondents' diversity of nature interactions and perceived behavioural control (feeling able to help pollinators) were consistently important predictors of people's pollinator conservation actions, whilst the importance of other socio-psychological factors depended on the particular action.
4. Notably, knowledge was far less important overall than people's perceptions and other socio-psychological factors, highlighting a knowledge-action gap. Further unexplained variation in people's behaviour could partly be due by structural and contextual factors, particularly regarding social norms around tidiness.
5. From a practical perspective, our findings reveal three main insights. First, several simple, low-cost pollinator conservation actions (reduced mowing, leaving areas unmown and creating patches of bare ground for ground-nesting bees) are currently under-utilised so should be priorities for pollinator conservation programmes.
6. Second, strategies are needed to overcome reported practical barriers, for example by providing free resources (e.g. seeds of pollen- and nectar-rich plants) and communicating simple beneficial actions that can be carried out with limited time, space and money.

Jessica L. Knapp and Benjamin B. Phillips contributed equally to the work and are joint first authors.

7. Third, knowledge is just one (relatively less important) factor that predicts pollinator conservation behaviour—other socio-psychological factors provide potential pathways for increasing uptake, and structural and contextual limitations also need to be considered. In practice, this could be achieved by engaging, inspiring and empowering the public to help pollinators and to take responsibility for their local environment, for example through environmental education and community programmes facilitating public interest and involvement in the management of greenspace.

KEYWORDS

attitudes, bees, beliefs, online questionnaire, pollinator declines, pro-environmental behaviour, social psychology, theory of planned behaviour

1 | INTRODUCTION

Declines of some pollinator species have been recorded in several regions world-wide (Potts et al., 2016). This has been attributed to multiple interacting factors, including land-use change, the use of particular agrochemicals and the impacts of pathogens, invasive species and climate change (Potts et al., 2016). These anthropogenic drivers, and the implications for food security, make pollinator declines a complicated socio-ecological issue, involving diverse stakeholders. Yet research has focused almost exclusively on the ecological causes of, and solutions to, pollinator declines (IPBES, 2016), whilst largely ignoring how to get individuals and communities to implement these solutions (Hall & Martins, 2020; Marselle et al., 2020). Although numerous pollinator conservation strategies have been developed (e.g. in England, Ireland and Wales; Defra, 2014, Welsh Government, 2013, National Biodiversity Data Centre, 2015), and various policies have been proposed (Dicks et al., 2016) and adopted (Hall & Steiner, 2019), proposed solutions have largely been based on ecological evidence from natural scientists with limited appreciation of the social factors affecting implementation (Hulme, 2014; Maas et al., 2019; Marselle et al., 2020). As with most conservation problems, the challenge is fundamentally one of human behaviour (Schultz, 2011), so delivering impact requires an interdisciplinary approach (Hulme, 2014; Maas et al., 2019).

Whilst an individual's capacity to conserve pollinators is often small, their actions affect private land (e.g. gardens, allotments and spaces where they work or volunteer) and their perceptions drive the management of public spaces, which collectively span large and ubiquitous areas with a substantial capacity to support pollinators (Baldock et al., 2019). In recent years, there have been many public campaigns and newspaper articles about pollinators (see Appendix S1), and available evidence from Europe and North America suggests that people have reasonable levels of knowledge about, and generally positive attitudes towards, them (Schönfelder & Bogner, 2017; Sieg et al., 2018; Silva & Minor, 2017; Wignall et al., 2019). For example, a European public consultation with 67,000 responses showed that most respondents considered themselves to be well informed about pollinators, found pollinator declines alarming and felt significantly affected by pollinator declines (European Commission, 2018). Furthermore, studies show that attitudes towards pollinators are positively related to knowledge and benefit from education (Bhattacharyya et al., 2017; Penn et al., 2018; Schönfelder & Bogner, 2018; Sieg et al., 2018; Silva & Minor, 2017; Toomey & Domroese, 2013). There is some indication that this knowledge is matched by an intention to protect pollinators, for example participants in a UK study were willing to pay an average of £43/household/year (£842 million/year nationally) for a policy to protect bees (Mwebaze et al., 2018). However, it is unclear to what extent such knowledge and positive attitudes translate into actions to conserve pollinators, as it is well known that the provision of knowledge does not necessarily lead to the implementation of conservation actions (Hulme, 2014; Maas et al., 2019). If positive attitudes and adequate knowledge are not enough to predict conservation behaviour, what other drivers are involved? Understanding this is essential for predicting and improving the effectiveness of conservation programs (Rare and the Behavioural Insights Team, 2019; St. John et al., 2010).

Here, we use a socio-psychological approach to provide insights into the potential drivers of, and limitations to, pollinator conservation behaviour by the UK public. We deemed a behavioural perspective to be appropriate because many actions that can help pollinators are feasible on an individual level (e.g. planting wildflowers). However, behavioural perspectives, which emphasise individual responsibility, do not fully acknowledge the infrastructure and institutions in which individuals exist (Shove, 2010). We therefore take a pragmatic approach by considering multiple, different views of human action (Wilson & Chatterton, 2011). Specifically, we also interpret our findings using Social Practice Theory—a more collective-oriented approach that reframes and redefines behaviour change problems by considering how social practices (consisting of meanings, materials and competencies) emerge, persist, develop and disappear (Strengers & Maller, 2014).

Many socio-psychological theories have been used to predict behaviour including the Social Cognitive Theory (Bandura, 1986), Norm Activation Theory (Schwartz, 1968, 1974), Values-Beliefs-Norms Theory (Stern, 1999) and the Theory of Planned Behaviour (TPB; Ajzen, 1985, 1991). Of these, the TPB is a robust and

well-established behavioural framework (Armitage & Conner, 2001) that is the most widely adopted and empirically supported model of behaviour (Yuriev et al., 2020). The TPB posits that behaviour is preceded by intention, which is in turn shaped by: (i) *'behavioural beliefs'*: an individual's perceptions of the likely consequences of a behaviour, resulting in a favourable or unfavourable *'attitude'* towards the behaviour; (ii) *'normative beliefs'*: an individual's perceptions of the social normative expectations of others, resulting in perceived social pressure or *'subjective norm'*; (iii) *'control beliefs'*: an individual's perceptions of the presence of factors that may facilitate or impede performance of the behaviour, resulting in *'perceived behavioural control'*. In addition, whether intention leads to behaviour is also determined by (iv) *'actual behaviour control'*: the extent to which a person has the skills, resources and other prerequisites needed to perform the behaviour (Figure 1). The TPB has been used to explain a wide range of pro-environmental behaviours (most frequently recycling, travelling and energy saving; reviewed in Yuriev et al., 2020) and, in the context of nature conservation, has been applied to conservation agriculture (Lalani et al., 2016; Van Hulst & Posthumus, 2016; Wauters et al., 2010), forestry (Primmer & Karppinen, 2010), game management (Swan et al., 2020) and sea-turtle conservation (Hill et al., 2019). Whilst previous studies have explored the role of knowledge in pollinator conservation (Mwebaze et al., 2018; Wignall et al., 2019; Wollaeger et al., 2015), none has explored other socio-psychological factors that may predict pollinator conservation behaviour (or of specific 'actions' that collectively form behaviour).

The addition of variables to the TPB is a common practice to improve predictive power (Yuriev et al., 2020). In nature conservation, there has been much recent discussion about the diverse and plural values of nature that can be held by an individual and collectively by people in local communities across the world (e.g. the in progress IPBES values assessment). In particular, the concept of relational values goes beyond the traditional instrumental versus intrinsic values dichotomy by considering people's relationships with nature, and with others through nature (Chan et al., 2016, 2018). Pollinators are an interesting example because their instrumental values are widely appreciated (economic benefits arising from crop pollination), yet conserving pollinators may be underpinned by a diversity of other values (e.g. relating to stewardship, to responsibility to others, or to a moral necessity). For example, the European Union consultation found that a large majority of respondents considered pollinators to be indispensable for reasons relating to their instrumental (e.g. their importance for food security and for natural systems) and intrinsic value, though largely overlooked relational values (European Commission, 2018). As such, we considered additional factors relating to a person's identity (Stryker & Serpe, 1982; Terry et al., 1999), namely different dimensions of a person's nature-connectedness (Chawla, 2020; Whitburn et al., 2019) that can be broadly understood as types or expressions of relational values: *'self-perceived nature-connectedness'*, referring to degree of interest, engagement and personal relationship with nature, *'identity as an environmentalist'*, referring to possession of a pro-environmental self-identity (Carfora et al., 2017; Van der Werff et al., 2013) and *'nature exposure'* (Alcock et al., 2020), in terms of both the frequency and diversity of a person's interactions with nature (Figure 1).

We used a large-scale online questionnaire, based around the TPB, as a tool for exploring the UK public's engagement in pollinator conservation and the socio-psychological predictors of, and limitations to, behaviour in order to identify opportunities for increasing uptake. We used the TPB as a lens through which to structure our study, and to interpret our findings, though we took a pragmatic approach, rather than strictly adhering to the framework. Chiefly, we considered a suite of different pollinator conservation actions rather than focusing on a single action, and therefore considered beliefs relating to pollinator conservation behaviour as a whole, rather than to a specific action. Furthermore, we did not measure intention, but rather measured self-reported past behaviour. Our main research question was: what are the socio-psychological factors influencing

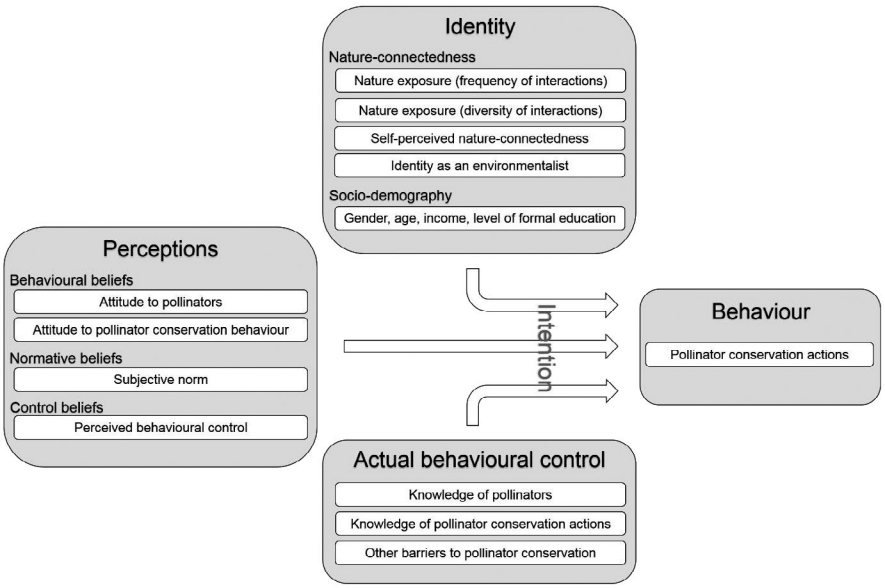

FIGURE 1 Conceptual framework for exploring drivers of people's pollinator conservation behaviour. The framework is broadly based around the Theory of Planned Behaviour (Ajzen, 1985, 1991). However, we did not attempt to measure behavioural intention (hence in grey), and we additionally considered several aspects of identity (Stryker & Serpe, 1982; Terry et al., 1999), principally different dimensions of a person's nature-connectedness (Whitburn et al., 2019). Grey boxes show the general areas that were assessed, the sub areas and the specific variables that we measured (white boxes)

people's pollinator conservation behaviour? We made the following hypotheses:

Hypothesis 1 *People with more positive perceptions and knowledge relating to pollinators engage in more pollinator conservation behaviour.*

Hypothesis 2 *The inclusion of a person's nature-connectedness improves the ability to predict pollinator conservation behaviour.*

Hypothesis 3 *The relative importance of each socio-psychological factor depends on the particular pollinator conservation action.*

Hypothesis 4 *In addition to socio-psychological factors, practical barriers inhibit people's pollinator conservation behaviour.*

We use the findings of the study to identify opportunities for increasing uptake of pollinator conservation behaviour, as well as to provide insights into public engagement in nature conservation and pro-environmental behaviour more broadly.

2 | MATERIALS AND METHODS

2.1 | Questionnaire

We created an online questionnaire (Appendix S2) to assess people's perceptions, knowledge and behaviour relating to pollinators. We broadly used the TPB as a framework around which to structure the questionnaire, and to interpret the findings, namely for predicting respondents' individual and total number of pollinator conservation actions (Table 1). The questionnaire consisted of 26 questions across four sections: (a) Perceptions: about the environment, nature, pollinators, pollinator declines and pollinator conservation behaviour, (b) Knowledge: of pollinators, pollinator declines and pollinator conservation actions, (c) Behaviour: specific actions for conserving the environment and pollinators, and barriers to implementing them, and (d) Identity: nature exposure (frequency and diversity of interactions) and socio-demography. Whilst we were primarily interested in conservation of wild pollinators, we purposely avoided specifying wild or managed pollinators in the questionnaire because we assumed that most people's knowledge of pollinators was limited and that distinguishing managed pollinators from wild pollinators would be unfamiliar and/or confusing.

We predominantly used closed questions (24 of 26 questions), consisting of yes/no, multiple choice and 7-point Likert items but, where appropriate, we provided open boxes to allow participants to elaborate. We included questions from the Monitor of Engagement with the Natural Environment (MENE; Natural England, 2018) to assess participants' nature exposure, self-perceived nature-connectedness and pro-environmental behaviour, adapted questions from the CN-12 (Hatty et al., 2020) to assess participants' identity as an environmentalist and used the Conservation Evidence website (https://www.conservationevidence.com/) to identify pollinator conservation actions (Table 1). The study received ethics approval from the University of Exeter's ethics board on 1 February 2019 (application eCORN001741). We pre-tested the survey on two individuals to ensure comprehension of the questions and made minor refinements in response. We then carried out a pilot study on 20 individuals, plotted and analysed the data and made further minor refinements.

2.2 | Distribution

The final questionnaire was launched on 27 March 2019 and responses were collected until 1 June 2019. We aimed for the questionnaire to be completed by any adult (age 16+), regardless of their interest in pollinators, and primarily in the UK. We distributed the questionnaire as widely as possible via email (social networks of the authors) and social media (Facebook and Twitter; Appendix S3), and made further efforts to recruit individuals from key stakeholder groups (gardeners, farmers, land owners, beekeepers, local government, conservationists) using personal contacts and their networks, and by targeting relevant people and groups on Facebook and Twitter (Appendix S3). Our distribution method may have resulted in a selection bias towards people with a pre-existing interest in pollinators and environmentalism, as well as a high digital fluency and/or reliable internet access. Given these limitations, we made further efforts to recruit individuals without a pre-existing affinity to nature or pollinators by distributing the questionnaire to non-nature-focused online groups, and by offering participants entry into a draw for a gift voucher (Appendix S3).

2.3 | Analysis

All data representations and analyses were carried out using R 3.6.1 (R Core Team, 2019). We coded Likert items (designed to measure perceptions) across 7-points, from +3 (strongly agree) to −3 (strongly disagree). Likert scales were constructed by summing the relevant Likert items (Table 1). We coded true or false questions (designed to measure knowledge) with 1 for a correct response and 0 for an incorrect response, and summed them as a score of knowledge. We deemed answers as'correct' if they agreed with the available scientific evidence. For each variable (e.g. each element of the TPB), scores from relevant questions were summed to provide an overall score (Table 1; Figure 1). We distinguished between two different types of 'attitude' ('attitude to pollinators' and 'attitude to pollinator conservation behaviour'), between two different types of 'knowledge' ('knowledge of pollinators' and 'knowledge of pollinator conservation actions') and between four different types of 'nature connectedness' ('self-perceived nature-connectedness', 'identity as an environmentalist', 'nature exposure (frequency of interactions)' and 'nature exposure (diversity of interactions)'; Figure 1; Table 1). The internal consistencies of scores were calculated using Cronbach's α (Cronbach, 1951; Appendix S4). Following movement of one sub-question between variables (Appendix S4), variables showed reasonable internal consistency ($\alpha > 0.576$) given the low number of test items (Tavakol & Dennick, 2011), except for 'subjective norm' ($\alpha = 0.284$). In this case (and also for other variables) sub-questions measured different, but important, dimensions of the variable (see

TABLE 1 An outline of the parts of the questionnaire (Appendix S2) used in analyses, the purpose of each question and the socio-psychological aspect that it measured. The 'Results' column describes where the responses to each question are presented, with 'summed' indicating that the responses to sub-questions were added together to provide an overall score for the described socio-psychological aspect for each respondent, which was then used in the statistical analyses. Additional results are presented in Appendix S6

Aspect	Sub-aspect	Question (statement) number	Measure *component statement*	Results
Perceptions	Behavioural beliefs	4 (1–3) Likert	Attitude to pollinators *'Pollinators are very important to me'* *'I find pollinators very interesting'* *'I care about doing things for pollinators'*	Figure 2a; summed to create 'attitude to pollinators'
		4 (7–9) Likert	Attitude to pollinator conservation behaviour *'My actions at home can help pollinators'* *'My actions at work can help pollinators'* *'Nothing that I do for pollinators will make a difference'*	Figure 2a; summed to create 'attitude to pollinator conservation behaviour'
	Normative beliefs	4 (10–12) Likert	Subjective norm *'We must do more to protect pollinators'* *'People expect me to do things for pollinators'* *'None of my friends or family do things to help pollinators'*	Figure 2a; summed to create 'subjective norm'
	Control beliefs	4 (13–15) Likert	Perceived behavioural control *'I am confident that I can do things to help pollinators'* *'It is difficult for me to help pollinators at home'* *'It is difficult for me to help pollinators at work'*	Figure 2a; summed to create 'perceived behavioural control'
Knowledge	Actual behavioural control	6 True/false/not sure	Knowledge of pollinators *'Pollinators are an essential part of nature'* *'There are 2 species of bee'* *'Flies and beetles can be pollinators'* *'All of our food depends on animal pollination'* *'Some pollinator species are in decline'* *'Honey bees are at risk of extinction'*	Figure 3a; summed to create 'knowledge of pollinators'
		9 True/false/not sure	Knowledge of how to help pollinators *'Providing more wildflowers will help to reverse pollinator declines'* *'Keeping honey bees will help to reverse pollinator declines'* *'Mowing lawns and parks less often will help to reverse pollinator declines'* *'Giving sugar water to tired bees will help to reverse pollinator declines'* *'Reducing pesticide use will help to reverse pollinator declines'*	Figure 3a; summed to create 'knowledge of pollinator conservation actions'
Behaviour	Actions	15 (1–12) Multiple choice	Pollinator conservation actions Twelve actions (see Figure 4)	Figure 4; summed to create 'number of pollinator conservation actions'
Identity	Nature-connectedness	1 (1–3, 9) Likert	Self-perceived nature-connectedness *'Being in nature makes me very happy'* *'Spending time in nature is NOT important to me'* *'I feel part of nature'* *'I'm NOT the type of person who is interested in nature'*	Summed to create 'self-perceived nature-connectedness'
		1 (7–8) Likert	Identity as an environmentalist *'I think of myself as someone who looks after the natural world'* *'Protecting nature is an important part of who I am'*	Summed to create 'identity as an environmentalist'

(Continues)

TABLE 1 (Continued)

Aspect	Sub-aspect	Question (statement) number	Measure *component statement*	Results
		17 Multiple choice	Nature exposure (frequency of interactions) *'Thinking about the last 12 months, how often, on average, have you spent your leisure time outdoors, away from home?'*	Measure of 'nature exposure (frequency)'
		18 Multiple choice	Nature exposure (diversity of interactions) *'Which of the following activities involving the natural environment do you take part in?'*	Summed to create 'nature exposure (diversity)'
	Socio-demography	19–20,25–26 Multiple choice	Socio-demography (age, gender, income, education level)	Response used for each aspect

Table 1). Ultimately, we chose to retain the full question set because removing particular questions did not improve α, presenting a choice between using a single question to represent this construct, or to use the full question set with low internal consistency. We therefore felt that the full question set represented a more robust measure of these constructs (see further discussion in Appendix S4). Multiple choice questions (designed to measure behaviour) were summed to provide an overall score of each respondents' number of different pollinator conservation actions.

We used a generalised linear model (with Poisson error structure and square root link function) to explore how respondents' number of pollinator conservation actions (response variable, range: 0–12) was explained by the measured variables (Figure 1; Table 1). We used this approach rather than structural equation modelling because we were interested in the effect of variables directly on (self-reported, past) behaviour, rather than via intention (Hankins et al., 2000). Explanatory variables were attitude to pollinators, attitude to pollinator conservation actions, subjective norm, perceived behavioural control, knowledge of pollinators, knowledge of pollinator conservation actions, nature exposure (frequency of interactions), nature exposure (diversity of interactions), self-perceived nature-connectedness, identity as an environmentalist, gender, age, income and level of formal education (Table 1). Gender was a factor, whilst all other explanatory variables were numeric. We refined the full model using forwards and backwards stepwise selection to identify and remove any variables that did not significantly improve the fit of the model based on Akaike's information criterion (AIC; R package MASS; Venables & Ripley, 2002). We tested for multicollinearity using variance inflation factors, which were <2 in all cases. The relative importance of each explanatory variable was determined using standardised coefficients as a measure of effect size. We used a second analysis (without model selection) to explore which socio-psychological factors predicted whether respondents carried out each pollinator conservation action. For each of the 12 pollinator conservation actions, we used a generalised linear model (with binomial error structure and logit link function) with the action as a binary response variable, and the same explanatory variables listed above. All models were tested for over dispersion and were checked visually to ensure that residuals were normally distributed, and that the variance was homogenous. Likelihood-ratio based pseudo-R-squared was calculated following Bartón (2017). Finally, model fit was compared with and without the addition of nature exposure (frequency of interactions), nature exposure (diversity of interactions), self-perceived nature-connectedness and identity as an environmentalist for both analyses.

3 | RESULTS

We received a total of 1,275 responses, of which 96% were from the UK. Respondents were largely representative of UK demographics in terms of age, household income and employment status, though female respondents, people aged 55–64 and people with University-level of formal education were overrepresented, people aged 65+ and people with lower levels of formal education were underrepresented (Appendix S5). At least ninety percent of respondents had the capacity to implement pollinator conservation actions: 83% owned/managed a garden (consistent with an estimated 88% of households in the UK having access to a private or shared garden; ONS, 2020), 14% owned/managed an allotment, 8% owned/managed farmland, 2% managed amenity grassland, 1% owned/managed a private estate and 15% were beekeepers (Appendix S6: Figure S5). Most respondents self-identified as an 'environmentalist' (e.g. 85% agreed that 'Protecting nature is an important part of who I am') and had a high level of engagement with nature (70% spent leisure time outdoors, away from home, at least several times a week, and on average, people participated in six out of eight activities involving the natural environment; Appendix S6). In comparison to MENE (Natural England, 2018)—a more representative sample of the public—respondents to our survey spent a greater amount of time outdoors in their leisure time, were more involved in activities relating to the natural environment and were much more likely to carry out actions relating to nature and the environment (Appendix S5). Nonetheless, respondents were diverse in terms of occupation and socio-demography (Appendix S6), showing that people who are engaged with pollinators and pollinator conservation in the UK come from a wide range of backgrounds.

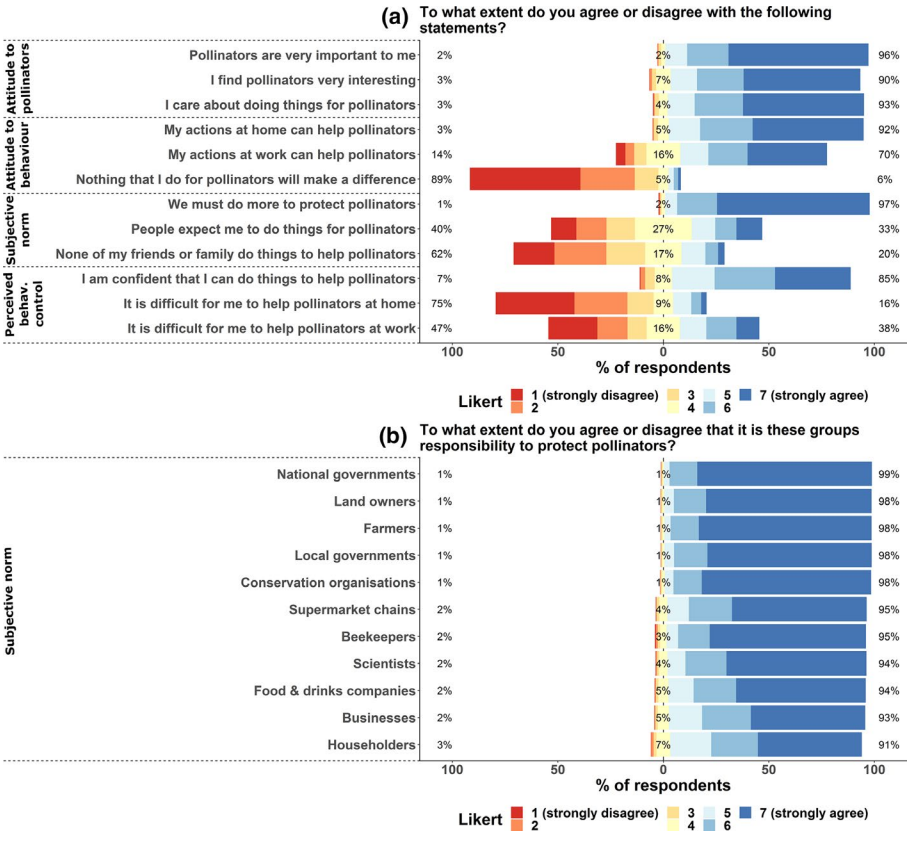

FIGURE 2 Survey respondents' (n = 1,275): (a) attitude to pollinators, attitude to pollinator conservation behaviour, subjective norm (perceived social pressure to help pollinators) and perceived behavioural control (perceived ability to help pollinators), and (b) perceived responsibility of different stakeholder groups for protecting pollinators (subjective norm). Percentages are the proportion of respondents that either disagreed (Likert scores 1–3), neither agreed nor disagreed (Likert score 4) and agreed (Likert scores 5–7)

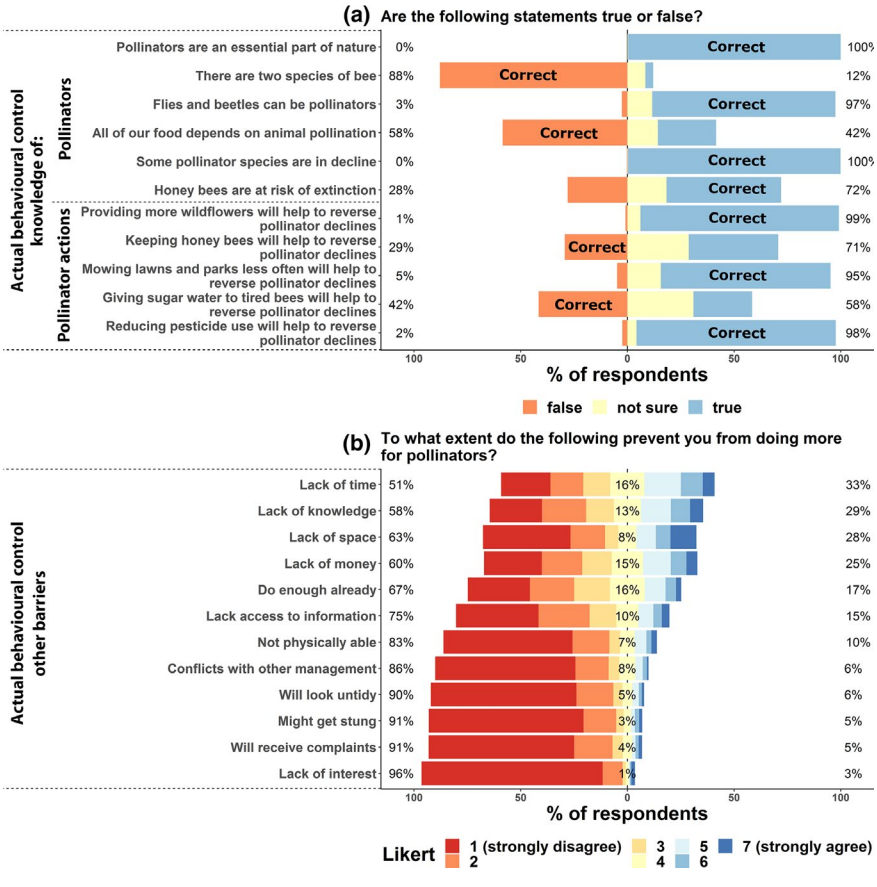

FIGURE 3 Survey respondents' (n = 1,275) capacity to implement pollinator conservation actions- 'actual behavioural control' - measured in terms of: (a) knowledge of pollinators and how to help (correct answers are shown; percentages are the proportion of respondents who responded with 'false', 'not sure' and 'true') and (b) reported barriers to pollinator conservation actions (paraphrased for clarity; Appendix S2; percentages are the proportion of respondents that disagreed [Likert scores 1–3], neither agreed nor disagreed [Likert score 4] and agreed [Likert scores 5–7])

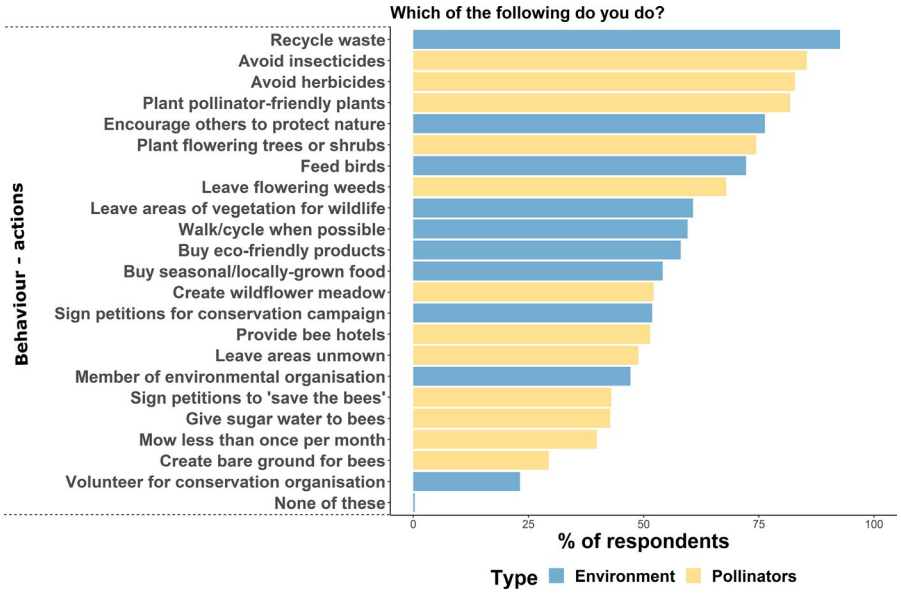

FIGURE 4 Survey respondents' (n = 1,275) actions for the environment and pollinators (paraphrased for clarity; Appendix S2)

Overall, most respondents held strong, positive attitudes towards pollinators (Figure 2a), considered themselves to be knowledgeable about pollinators (Figure 3a) and agreed that all stakeholder groups had a responsibility to protect pollinators (though governments, landowners and conservation organisations were perceived as having the greatest responsibility, whilst householders were perceived as having the least responsibility; Figure 2b). For reference, the European Union's public consultation of 67,000 people, found respondents held similarly strong positive perceptions about pollinators, though respondents to our questionnaire more frequently used books and scientific literature to acquire information (54% compared to 30% of respondents). In our study, most respondents (88%) reported that they were taking actions to help pollinators, as well as for the environment more generally, with more than half of the listed actions being carried out by more than half of respondents (Figure 4). Recycling waste was the most popular action, followed by avoiding using pesticides and planting pollinator-friendly plants (Figure 4). Surprisingly, some of the less popular actions were those that are physically simple to implement such as mowing less, leaving areas unmown and creating patches of bare ground for ground-nesting bees (Figure 4).

3.1 | Hypothesis 1: People with more positive perceptions and knowledge relating to pollinators engage in more pollinator conservation behaviour

Attitude to pollinator conservation behaviour, frequency of nature interactions and self-perceived nature-connectedness did not significantly improve the model for respondents' number of different pollinator conservation actions so were removed during model refinement. All other measured socio-psychological factors (except level of formal education) were significant, positively correlated predictors of respondent's number of pollinator conservation actions, explaining 45% of the variation; these were (in order of importance, based on effect size): diversity of nature interactions, perceived behavioural control (perceived ability to help pollinators), attitude to pollinators, knowledge of pollinators and knowledge of pollinator conservation actions (actual behavioural control), subjective norm (perceived social pressure to help pollinators) and identity as an environmentalist (Table 2; Figure 5).

3.2 | Hypothesis 2: The inclusion of a person's nature-connectedness improves the ability to predict pollinator conservation behaviour

The addition of variables measuring different dimensions of respondents' nature-connectedness significantly improved the explanatory power of the model predicting the total number of pollinator conservation actions (original framework R^2 = 0.36, expanded framework R^2 = 0.45) and of models predicting individual pollinator actions (Appendix S7). However, this was predominantly driven by the predictive power of variables describing respondents' diversity of nature interactions, and to a lesser extent respondents' identity as an environmentalist, whilst respondents' frequency of nature interactions and self-perceived nature-connectedness variables had poor predictive power (Tables 2 and 3).

3.3 | Hypothesis 3: The relative importance of each socio-psychological factor depends on the particular pollinator conservation action

When pollinator conservation actions were analysed separately, diversity of nature interactions was a significant predictor of all 12 actions and one of the most important predictors (based on effect size) for 11 of these (Table 3). Similarly, perceived behavioural control was a significant predictor of 10 of 12 actions, and was one of the most important predictors for nine of these (Table 3). Attitude

TABLE 2 Analysis of social factors as predictors of respondents' ($n = 1,275$) number of different pollinator conservation actions. Results show standardised coefficient estimates (a measure of effect size, sorted from highest to lowest), unstandardised coeffient estimates, confidence intervals (CI; from unstandarised estimates), test statistic values (z) and significance values (p) from the best-fitting model. 'Attitude to pollinator conservation behaviour', 'nature exposure (frequency)' and 'self-perceived nature-connectedness' were removed during model refinement. Gender is for male and female only due to insufficient responses from other genders. See Section 2 and Table 1 for the scoring of each variable

Explanatory variable	Standardised estimate ± *SE*	Unstandardised estimate ± *SE*	2.5% CI	97.5% CI	*z*	*p*
Nature exposure (diversity)	0.182 ± 0.016	0.110 ± 0.009	0.045	0.071	11.613	<0.0001
Perceived behavioural control	0.144 ± 0.016	0.037 ± 0.004	0.029	0.046	8.775	<0.0001
Age	0.085 ± 0.015	0.057 ± 0.010	0.036	0.074	5.805	<0.0001
Attitude to pollinators	0.084 ± 0.018	0.030 ± 0.006	0.022	0.047	4.671	<0.0001
Gender male-female	0.062 ± 0.015	0.127 ± 0.031	0.077	0.198	4.128	<0.0001
Income	0.046 ± 0.015	0.021 ± 0.007	0.008	0.034	3.155	0.0016
Knowledge of pollinator conservation actions	0.045 ± 0.016	0.044 ± 0.016	0.017	0.079	2.802	0.0051
Knowledge of pollinators	0.040 ± 0.016	0.037 ± 0.015	0.017	0.079	2.483	0.0130
Subjective norm	0.037 ± 0.017	0.013 ± 0.006	0.002	0.024	2.242	0.0250
Identity as an environmentalist	0.037 ± 0.017	0.017 ± 0.008	0.004	0.029	2.131	0.0331
Level of formal education	−0.029 ± 0.015	−0.030 ± 0.016	−0.059	0.002	−1.913	0.0557

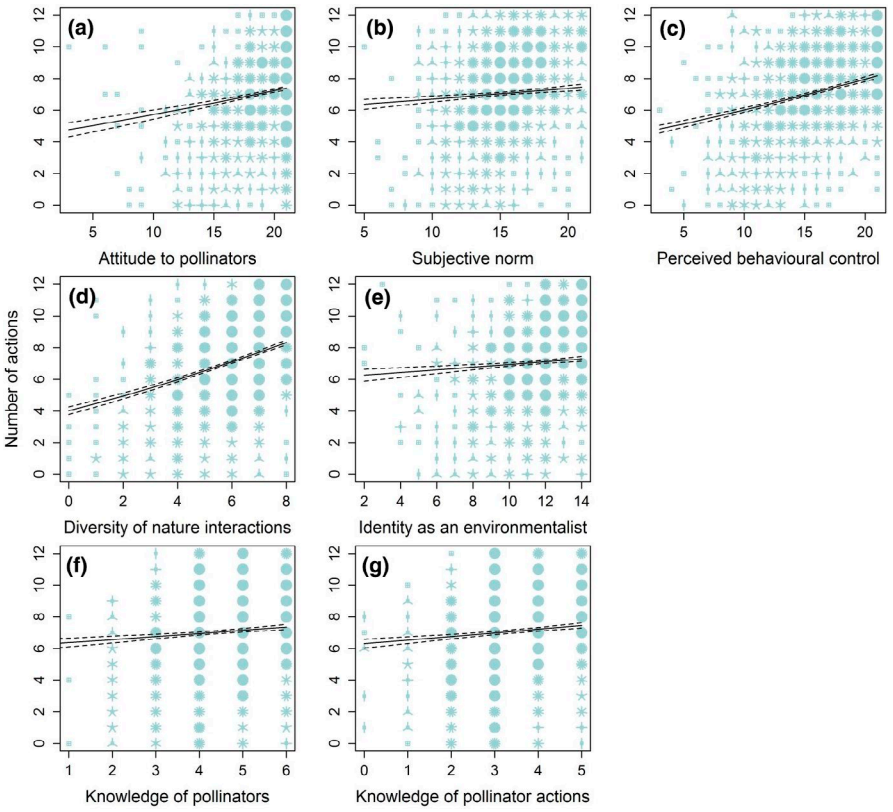

FIGURE 5 Predictors of respondents' number of different pollinator conservation actions: (a) attitude to pollinators, (b) subjective norm (perceived social pressure to help pollinators), (c) perceived behavioural control (perceived ability to help pollinators), (d) nature exposure (diversity of interactions), (e) identity as an environmentalist, (f) knowledge of pollinators, and (g) knowledge of pollinator conservation actions. Plotted lines are model predictions (mean ± *SE*). Sunflower plots have been used to show overlapping data, whereby each petal of the sunflower represents a data point. See Section 2 and Table 1 for the scoring of each variable

to pollinators and knowledge of pollinator conservation actions were consistently significant predictors, and occasionally one of the most important predictors (Table 3). Identity as an environmentalist, knowledge of pollinators and subjective norm were consistently significant predictors, but were never the most important predictors. Attitude to pollinator conservation behaviour, frequency of nature interactions and self-perceived nature-connectedness were rarely or never significant predictors, and never the most important predictors (Table 3). Knowledge of pollinators and pollinator conservation were more important for actions that are likely more difficult and/or less well known (e.g. creating bare ground, providing bee hotels, leaving flowering weeds and mowing less), and unimportant for

TABLE 3 Analyses of predictors of whether respondents ($n = 1,275$) carried out each pollinator conservation action. Actions are paraphrased for clarity (Appendix S2) and are ordered by the proportion of respondents that carried out each action (Figure 4). Standardised coefficients are provided as a measure of effect size, with the two largest effect estimates for each action in bold. See Section 2 and Table 1 for the scoring of each variable. 'Attitude to pollinator conservation behaviour' was non-significant in all models, and 'self-perceived nature-connectedness' and 'nature exposure (frequency)' were significant for only two actions each (with small, negative effects) so, for clarity, these variables are not presented. Socio-demographic factors (age, gender, income and level of formal education) were included in all models. Levels of significance are indicated by symbols (Ns, not significant, $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$)

	Standardised estimate ± *SE*							
Action (% of respondents)	**Attitude to pollinators**	**Subjective norm**	**Perceived behavioural control**	**Identity as an environmentalist**	**Nature exposure (diversity)**	**Knowledge of pollinators**	**Knowledge of pollinator conservation actions**	**Pseudo R^2**
Avoid insecticides (85%)	Ns	0.285 ± 0.111*	**0.423 ± 0.111*** **	Ns	**0.606 ± 0.092*** **	Ns	Ns	0.16
Avoid herbicides (83%)	0.185 ± 0.098+	0.194 ± 0.103+	**0.358 ± 0.105*** **	Ns	**0.588 ± 0.087*** **	Ns	0.285 ± 0.091**	0.16
Plant pollinator-friendly plants (82%)	0.285 ± 0.102**	Ns	**0.745 ± 0.110*** **	Ns	**0.731 ± 0.091*** **	Ns	Ns	0.23
Plant flowering trees or shrubs (74%)	Ns	Ns	**0.503 ± 0.093*** **	Ns	**0.465 ± 0.081*** **	0.276 ± 0.085**	Ns	0.23
Leave flowering weeds (68%)	0.233 ± 0.084**	0.149 ± 0.081+	**0.420 ± 0.085*** **	0.196 ± 0.089*	**0.387 ± 0.073*** **	0.164 ± 0.075*	0.223 ± 0.075**	0.18
Create wildflower meadow (52%)	Ns	Ns	**0.459 ± 0.079*** **	0.176 ± 0.083*	**0.240 ± 0.070*** **	0.203 ± 0.072**	Ns	0.15
Provide bee hotels (51%)	0.303 ± 0.086***	Ns	**0.341 ± 0.079*** **	Ns	**0.449 ± 0.073*** **	0.183 ± 0.073*	0.187 ± 0.070**	0.17
Leave areas unmown (49%)	0.160 ± 0.082+	Ns	**0.278 ± 0.073*** **	0.179 ± 0.084*	**0.360 ± 0.072*** **	0.174 ± 0.072*	0.117 ± 0.070+	0.15
Sign petition to 'save the bees' (43%)	**0.270 ± 0.087****	0.124 ± 0.072+	Ns	0.156 ± 0.084+	**0.338 ± 0.073*** **	Ns	Ns	0.12
Give sugar water to bees (43%)	**0.207 ± 0.086****	0.121 ± 0.073+	Ns	0.178 ± 0.085*	**0.328 ± 0.073*** **	Ns	−0.215 ± 0.070**	0.14
Mow less than once per month (40%)	Ns	Ns	**0.315 ± 0.079*** **	0.207 ± 0.085*	0.239 ± 0.071***	Ns	**0.264 ± 0.071*** **	0.11
Create bare ground (29%)	**0.332 ± 0.106****	Ns	0.244 ± 0.087**	0.194 ± 0.095*	**0.372 ± 0.084*** **	0.261 ± 0.083**	0.155 ± 0.078*	0.15

obvious actions (e.g. signing a petition, planting 'pollinator-friendly' plants and avoiding insecticides; Table 3). Identity as an environmentalist was generally more important for less commonly carried out actions (e.g. signing a petition and giving sugar water to bees), whilst perceived behavioural control was less important for these actions (Table 3). The measured variables explained between 11% and 23% of variation in whether or not respondents carried out a particular pollinator conservation action (Table 3).

3.4 | Hypothesis 4: In addition to socio-psychological factors, practical barriers inhibit people's pollinator conservation behaviour

The main reported factors preventing respondents from doing more to help pollinators were a lack of time, knowledge, space and money, though only a minority of respondents agreed that that these factors prevented them from doing more (Figure 3b).

4 | DISCUSSION

Leveraging public support and action for pollinator conservation has major potential to benefit pollinators due to the large areas of land that people collectively own (e.g. gardens), manage (e.g. places of work) and influence management of (e.g. public spaces). However, this potential is not currently realised (Baldock, 2020) and approaches for increasing public uptake of pollinator conservation have largely been ignored by existing research (Hall & Martins, 2020) and government policy (Marselle et al., 2020; e.g. Defra, 2014; National Biodiversity Data Centre, 2015; Welsh Government, 2013). We used a socio-psychological approach to identify the factors affecting pollinator conservation behaviour by the UK public. Our findings show that respondents' perceptions, knowledge and nature-connectedness are all important predictors of pollinator conservation behaviour, but that the relative importance of each factor depends on the particular conservation action. However, there were still significant gaps in explaining people's behaviour, which we explore by considering the required materials, meanings and competencies for different actions, using Social Practice Theory. We discuss the findings of the study in light of existing research to provide insights into the interdisciplinary social sciences literature on human action. We then use the findings to identify practical opportunities for increasing uptake of pollinator conservation, with implications for conservation and pro-environmental behaviour more broadly.

4.1 | What influences people's pollinator conservation behaviour?

Respondents who did more for pollinators were characterised by (in order of importance) having a greater diversity of interactions with nature, feeling better able to help pollinators (perceived behavioural control), having more positive attitudes towards pollinators, having greater knowledge of pollinators and how to help them (aspects of behavioural control), perceiving a greater social pressure to help pollinators (subjective norm) and identifying more strongly as an environmentalist (Hypothesis 1). These findings, including subjective norm being a relatively weaker predictor, are in-line with reviews of factors predicting pro-environmental behaviour in the TPB (Armitage & Conner, 2001) and other socio-psychological models (Bergquist et al., 2019; Klöckner, 2013). Notably, knowledge was far less important than people's perceptions and other socio-psychological factors, and many people did not carry out pollinator conservation actions which they knew would help. This highlights a knowledge-action gap (Kollmuss & Agyeman, 2002), a well-known phenomenon in conservation (Habel et al., 2013; Hulme, 2014; Knight et al., 2008) and environmental research (e.g. Chung & Leung, 2007; Whitmarsh et al., 2011; Young et al., 2010). A knowledge-action gap can result from knowledge being too theoretical or too general (i.e. difficult to apply), for example non-collaborative research creating knowledge that inadequately addresses the needs of the target audience (i.e. does not account for their perceived barriers; Hulme, 2014). In this case, implementation of pollinator conservation knowledge by the public is clearly limited by socio-psychological factors. However, these only account for up to 45% of the variation in people's pollinator conservation behaviour, suggesting that further explanation is needed.

Critics of behavioural perspectives (focusing on attitudes, choices and actions of individuals) argue that knowledge-action and value-action gaps are inevitable because human action is to a large extent determined by structural and contextual factors—including, in a very broad sense, the 'practical barriers' that we identified (Hypothesis 4)—rather than by human agency (Shove, 2010). Social Practice Theory reframes and redefines behaviour change problems by considering how social practices (consisting of meanings, materials and competencies) emerge, persist, develop and disappear (Strengers & Maller, 2014). We provide two examples of how this perspective can provide further insights into creating environments that favour the adoption of pollinator conservation behaviour. First, adoption of practices relating to 'doing less' (e.g. not using pesticides, mowing less) do not require new materials and competencies, but are heavily inhibited by social norms around tidiness (Sisser et al., 2016). These social norms are deeply embedded in northern European culture (Ignatieva et al., 2017) and are maintained in public and commercial areas by long-established institutions (e.g. infrastructure and jobs associated with regular mowing of grass in public spaces). Second, adoption of practices relating to habitat creation (e.g. planting wildflowers) is strongly related to existing practices of gardening, which depend on the same materials (e.g. space and tools). As such, planting flowers is often carried out for reasons unrelated to caring for pollinators. For gardeners, adoption of practices that focus on 'pollinator-friendly' plants should be relatively frictionless in terms of materials but requires new competencies (e.g. knowledge of which plants to buy, or of how to establish wildflower meadows), and new

meanings to motivate doing so. For those not already involved in gardening, it is necessary to provide adequate space, tools and knowledge, to enable them to help pollinators. Otherwise, adoption of practices that benefit pollinators have relatively little structural complexity in most cases, but depend on development of new meanings that explain, justify and reinforce these practices (e.g. relational values such as stewardship and care for nature) and override existing meanings that maintain inertia (e.g. social norms around tidiness—regularly mown lawns, removal of weeds). We discuss the practical application of these insights in the following section.

The addition of nature-connectedness variables significantly improved predictions of respondents' pollinator conservation behaviour (Hypothesis 2). In particular, respondents' diversity of nature interactions was an important, significant predictor for all pollinator conservation actions. This is broadly supportive of recent research and syntheses showing the positive association between nature exposure and nature-connectedness with diverse pro-environmental (including pro-nature) behaviours (Alcock et al., 2020; Chawla, 2020; Mackay & Schmitt, 2019; Richardson et al., 2020; Whitburn et al., 2019). As in our study, Richardson et al. (2020) found that engagement in simple nature activities (such as watching wildlife) was a strong predictor of pro-nature conservation behaviour, whilst time spent in nature was a poor predictor (but see Alcock et al., 2020). This emphasises the importance of *how*, rather than *how much*, time is spent engaging with nature.

Different aspects of nature-connectedness can be broadly understood as types or expressions of relational values (Chan et al., 2016, 2018), further to the instrumental values that respondents hold relating to crop pollination and food security (Breeze et al., 2019; Hanes et al., 2015; Park et al., 2020) and intrinsic values demonstrated previously (European Commission, 2018). However, our nature-connectedness measures barely scratch the surface of the diversity of other relational values that may directly or indirectly influence a person's actions, such as attachments, commitments, responsibility and admiration, towards nature (Chan et al., 2016, 2018). Take, for example, caring for nature: care is a central element of human wellbeing and agency and fosters trust, social cohesion and responsibility (Jax et al., 2018). In the case of pollinators, giving sugar water to tired bees is a very interesting example of an action that is likely to have minimal benefits for pollinator populations, but may strengthen feelings of care that could indirectly increase a person's propensity to carry out other pollinator conservation actions. Future research should further disentangle the diverse and plural values that people hold about pollinators and pollinator conservation, and their relative abilities to inspire action, and to be developed via environmental education (Britto dos Santos & Gould, 2018). These might then be leveraged by conservation programs to increase public engagement in pollinator conservation.

In agreement with a range of studies (see Yuriev et al., 2020), the relative importance of different socio-psychological factors depended on the behavioural action being analysed (Hypothesis 3). In particular, knowledge of pollinators and knowledge of pollinator conservation actions were more important for actions that are generally less well known (e.g. creating bare ground, providing bee hotels, leaving flowering weeds, and mowing less), whilst unimportant for many obvious actions (e.g. signing a petition, planting 'pollinator-friendly' plants and avoiding insecticides). This could be due to our measures of knowledge only quantifying 'explicit' knowledge rather than 'tacit' knowledge, a more intuitive and experience based knowledge that can be difficult to quantify (Hulme, 2014). However, knowledge may also encourage people to carry out actions that conflict with dominant social norms, such as reduced mowing of lawns.

4.2 | Opportunities for increasing uptake of pollinator conservation

Our findings reveal three main practical insights, which provide opportunities and potential pathways by which to increase engagement in pollinator conservation by the public.

First, respondents largely had the capacity to perform pollinator conservation actions (e.g. most owned or managed a garden) but identified a number of common barriers to doing more (e.g. lack of time, money, space and knowledge of how to help; Hypothesis 4). Strategies should aim to overcome these barriers, for example by providing free resources (e.g. seeds of pollen- and nectar-rich plants) and communicating simple beneficial actions that can be carried out with limited time, space and money (see below). This is supported by respondents' most common (environmental) action being recycling—a heavily facilitated and free action in the UK.

Second, although most respondents carried out pollinator conservation actions, several relatively simple, low-cost actions had comparably low uptake, namely mowing less, leaving areas unmown and creating areas of bare ground for ground-nesting bees. In particular, reduced mowing of lawns is a simple action that can benefit pollinators by increasing the availability of floral and larval food sources (Watson et al., 2020). Whilst reduced mowing is perceived as untidy by some portions of the public, a recent Europe-wide study found that most people were favourable about such management when within well-defined areas, for example by regularly mowing edges (Fischer et al., 2020). These simple but under-utilised actions should be prioritised by pollinator conservation programmes, namely by communicating the benefits, and developing narratives that overcome social norms around tidiness (e.g. associating mowing less with caring for nature, rather than as neglect).

Third, the consistent importance of nature-connectedness and perceived behavioural control strongly suggest that they can be leveraged to increase uptake of pollinator conservation. Similarly, the identified knowledge–action gap highlights that education that only increases people's knowledge probably has a limited capacity to change behaviour, compared to education that transforms

people's perceptions and beliefs (Schultz, 2011). It is also necessary to overcome structural and contextual factors (such as the barriers mentioned above) that limit the abilities of individuals to carry out pollinator conservation actions (Strengers & Maller, 2014). In practice, this might be achieved by engaging, inspiring and empowering the public, particularly children (Chawla, 2020), to help pollinators and to take responsibility for their local environment. This could involve community programmes that facilitate public interest and involvement in the management of greenspace (Shwartz et al., 2012). Furthermore, promoting engagement with, and care for, nature can reciprocally benefit people's nature-connectedness, knowledge and attitudes towards nature (Soga & Gaston, 2016) and their engagement in other pro-environmental behaviours (Alcock et al., 2020), whilst also benefiting their health and wellbeing (Bell et al., 2020; Chawla, 2020; Twohig-Bennett & Jones, 2018). Recent research suggests that even promoting simple nature-related activities (e.g. watching wildlife, smelling wild flowers, listening to bird song) can provide such benefits (Richardson et al., 2016).

4.3 | Limitations and future directions

Our study took a broad, exploratory approach, based around socio-psychological theory, to scope a novel research area, so there is much potential for further work. First, correlations between social factors and respondents' pollinator conservation actions do not necessarily equate to causation because behaviour is, conversely, likely to affect a person's perceptions (Kroesen et al., 2017; Whitburn et al., 2019), but could be validated through experimentation. Second, we used the TPB as a broad framework, but considered beliefs at a very coarse level, relating to pollinator conservation as a whole rather than to specific actions. Third, many additional socio-psychological factors might be important (Klöckner, 2013; Yuriev et al., 2020), as well as other relational values (Chan et al., 2016, 2018) and aspects of social positioning and vulnerability (McLaughlin & Dietz, 2008). Also, perspectives of human action beyond social psychology, such as Social Practice Theory (Strengers & Maller, 2014), could help further to explain patterns that are not well captured by behavioural perspectives. More generally, it would be beneficial to assess perceptions and behaviour around pollinators for a more representative sample of the public, as well as across different countries and continents (Morren & Grinstein, 2016). Finally, the relative importance of each factor might have been different if we had assessed the extent or effectiveness of respondents' pollinator conservation actions. For example, the effectiveness of planting pollinator-friendly plants depends on the species of plants (Garbuzov & Ratnieks, 2014), and actions carried out by some individuals (e.g. those owning large areas of land) have a disproportionate capacity to benefit pollinators. In this regard, we propose the following three steps. (a) Stakeholder mapping to identify individuals with high influence (but potentially low interest) in pollinator conservation and assess whether their motivations and actions are similar to our findings, or otherwise explore how to motivate their action. (b) Considering the ecological outcomes of people's actions (Ardoin et al., 2020), e.g. in terms of increases in pollinator populations. (c) Further identifying and overcoming the institutional and structural settings which may constrain engagement in pollinator conservation by individuals and organisations.

5 | CONCLUSIONS

Pollinator conservation has received much societal and scientific interest in recent years, yet despite abundant ecological research on the topic and widespread appraisal for taking an interdisciplinary approach when addressing nature conservation issues (Maas et al., 2019; Mattison & Norris, 2005), social research around pollinator conservation is in its infancy (Hall & Martins, 2020). This study explored potential drivers of people's involvement in pollinator conservation. From a theoretical perspective, we have shown that consideration of a person's nature-connectedness can improve predictability of their pro-conservation behaviour, and that the relative importance of different socio-psychological factors depends on the particular conservation action. From a practical perspective, our findings suggest that: (a) Several simple, low-cost pollinator conservation actions (reduced mowing, leaving areas unmown and creating patches of bare ground for ground-nesting bees) are currently under-utilised so should be priorities for pollinator conservation programmes. (b) Strategies are needed to overcome reported practical barriers, for example by providing free resources (e.g. seeds of pollen- and nectar-rich plants) and communicating simple beneficial actions that can be carried out with limited time, space and money. (c) Knowledge is just one (relatively less important) factor that predicts pollinator conservation behaviour, whilst other socio-psychological factors provide potential pathways for increasing uptake, and structural and contextual factors also need to be considered.

The identified knowledge–action gap highlights an important point of reflection for scientists working on pollinator conservation, who have tended to focus on improving the ecological evidence base as the primary means of promoting pollinator conservation (Hall & Martins, 2020; Marselle et al., 2020). Our results show that, as with other conservation challenges, taking action does not necessarily depend on ecological knowledge alone (Hulme, 2014). Ecologists need to work closely with social science experts, practitioners and other stakeholders to deliver a much more holistic, transdisciplinary approach to pollinator conservation—an '*inclusive conservation*' approach as described by Maas et al. (2019). Likewise, if local and national government strategies to protect pollinators are to work effectively and deliver real impact, they need to be designed to engage, inspire and empower the public to help pollinators and to take responsibility for their local environment, rather than simply communicate what works based on ecological evidence. In part, this could be achieved by improving access and opportunities to engage and connect with nature.

Whilst the study has focused on pollinator conservation, the findings are also relevant to other conservation challenges where public action could have a strong impact, in particular the conservation of other wildlife in urban spaces. Mobilising public interest and engagement in nature conservation can benefit biodiversity threefold: by enhancing the large areas of private land that people collectively own and manage (e.g. gardens), by influencing the management of public spaces and by affecting policy around land-use and the environment. Doing so is also likely to have wider societal benefits by improving access to nature, with associated benefits for people's health and wellbeing.

ACKNOWLEDGEMENTS

We would like to thank Sarah Crowley, Beth Roberts, Grace Twiston-Davies, Alice Lord and Adam Bates for commenting on the questionnaire, everyone who participated and helped to share it and Ben Wheeler and Jane Wills for commenting on the manuscript. J.L.K. was funded by The Halpin Trust and the Natural Environment Research Council (NE/P011217/1). BP was funded by a NERC GW4 + Doctoral Training Partnership studentship from the Natural Environment Research Council [NE/L002434/1], with additional funding from the Cornwall Area of Outstanding Natural Beauty unit. J.C. was funded by an SWDTP/SWBIO studentship from the Economic and Social Research Council and the Biotechnology and Biological Sciences Research Council [ES/P000630/1, BB/M009122/1]. J.L.O. and R.F.S. were part funded by the European Regional Development Fund as part of Cornwall Council's Green Infrastructure for Growth Project. The manuscript was much improved by the thoughtful and constructive feedback of the Editor, Kai Chan, the Associate Editor, Carla Morsello, and three anonymous reviewers.

CONFLICT OF INTEREST

There are no conflicts of interest to declare.

AUTHORS' CONTRIBUTIONS

J.L.K. and B.B.P. jointly conceived the project, designed and distributed the questionnaire, analysed the data and wrote the manuscript; J.C. and R.F.S. contributed to the methodology and questionnaire; J.L.O. led the projects that funded the work and provided guidance throughout. All authors contributed to the manuscript and gave final approval for publication.

DATA AVAILABILITY STATEMENT

Data available from the University of Exeter's institutional repository https://doi.org/10.24378/exe.2783.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Knapp JL, Phillips BB, Clements J, Shaw RF, Osborne JL. Socio-psychological factors, beyond knowledge, predict people's engagement in pollinator conservation. *People Nat*. 2020;00:1–17. https://doi.org/10.1002/pan3.10168