Title: Citizens promote the conservation of flagship species more than ecosystem services in wetland restoration

Running title: Monetary values of flagship species

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Abstract

Assessing the non-market value of biodiversity conservation is crucial to justify it economically. Using a choice experiment on wetland restoration in Hokkaido, northern Japan, we assessed the willingness of citizens to pay for different ecological statuses of a flagship species (absence, occasional occupancy, permanent occupancy, and breeding) and other principal conservation targets (establishment of a birdwatching station and wetland sizes). The results showed that the fundraising potential of the flagship species surpassed those of other conservation targets, irrespective of its ecological status, highlighting the superior publicity generated by charismatic species. We also showed that upgrading ecological status from occupancy to breeding did not result in additional financial support. Our study emphasizes that, although publicizing ecologically important statuses such as breeding is critical for successful conservation efforts, focusing much effort on flagship species rather than other conservation targets may be important to increase the economic value of conservation practices if such species are available.

1. Introduction

Successful biodiversity conservation requires stable and reliable public support because all conservation practices inevitably need persistent budgets (Christie et al. 2006; Addison et al. 2016; Bennett et al. 2016). A promising approach to economically successful conservation is the assessment of non-market values of biodiversity conservation in monetary terms because unravelling these values can help to develop sustainable budget systems (White et al. 2001; Veríssimo et al. 2011; Di Minin et al. 2013; Yamaura et al. 2016a). However, most studies still evaluate the effectiveness of conservation practices primarily based on ecological aspects (Iftekhar et al. 2016).

Flagship species are species used to raise financial support and public awareness for conservation actions, and it is well appreciated that economic values of flagship species can enhance their conservation as well as broader biodiversity conservation (Caro & O'Doherty 1999; Caro 2010; Veríssimo et al. 2011). Although several studies have shown that the economic values of flagship species vary depending on the population size and public awareness of the species (e.g., Richardson & Loomis 2009; Jacobsen et al. 2012; Morse-Jones et al. 2012), the economic value of conservation practices for flagship species with different ecological statuses (e.g., occupancy or breeding) remains an open question. Unraveling this is critically

important to make conservation with flagship species both ecologically and economically sound, because the differences between the ecological statuses can be vital for species' long-term persistence (Donovan & Thompson 2001; Schlaepfer et al. 2002; Battin 2004), and loss of species might accelerate the estrangement of people from nature (Miller 2005).

Another longstanding issue is the relative value of flagship species compared with other key conservation targets, such as habitat metrics and ecosystem services (but see Kontoleon & Swanson 2003). Metrics such as habitat type and size can be reliable proxies for various components of biological communities, and the importance of ecosystem services has been recognized from both ecological and social aspects (Ferraro & Kiss 2002; Banks-Leite et al. 2011); however, the fundraising potential of these may be relatively poor compared with those of flagship species. This suggests that conservation practices based on these targets may lack sustainable financial support. Therefore, comparisons of monetary values among conservation targets are crucial to conduct economically efficient conservation practices.

The present study compared non-market values in monetary terms among conservation practices, focusing on different statuses of flagship species and other principal conservation targets. To achieve this, we conducted a choice experiment (CE)

on a wetland restoration project in Hokkaido, northern Japan, and evaluated the willingness to pay (WTP) of citizens for four different statuses (absence, occasional occupancy, permanent occupancy, and breeding) of a flagship species, as well as for restoration with a birdwatching station, varied wetland sizes, and an option to suspend flood-control measures. We used the red-crowned crane *Grus japonensis* as our focal flagship species for two reasons: 1) the name, appearance and habitat of the red-crowned crane are potentially well known by many national citizens, especially those in our study region, because this species is a symbol of good fortune and thus not only a variety of products including Japanese traditional crafts but also several local governments and organizations use it as their symbol (Harris 1994; Wild Bird Society of Japan 2011). This is an important feature for flagship species (Caro & O'Doherty 1999; Caro 2010; Veríssimo et al. 2011). 2) This species has been used to raise funding for conservation actions and environmental awareness for a long time (i.e., the species has been practically used as a flagship species). For example, Wild Bird Society of Japan has established 20 protected areas with the total of 2,516.9 ha in eastern Hokkaido for their habitat protection (Wild Bird Society of Japan 2011), all of which are purchased by donation from members of the society. Based on the results, we discuss how flagship species can be used to raise financial support to conserve ecologically important

components and ecosystem services.

2. Materials and Methods

2.1 The flagship species

The red-crowned crane is a large crane species (body length: 140 cm, wingspan: 240 cm) distributed across the Korean peninsula, northeastern China, the Russian Far East, and Hokkaido, northern Japan. The population in Hokkaido experienced a drastic decline by the mid-20th century due to widespread replacement of wetlands with agricultural lands. Since then, its population has been increasing gradually due to intensive conservation activities, and its current population size is estimated to be over 1,000 individuals. They occur residentially in wetlands across Hokkaido, except for in its southern region. The red-crowned crane is considered an endangered species in Japan and is the prefectural bird species of Hokkaido. In addition, our previous study has shown that the species may act as an umbrella species for wetland birds due to its specialized habitat requirements and large home ranges (Higa et al. 2016).

2.2 The focal restoration project

To prevent severe damage to agriculture and residents by unpredictable floods, a flood

control project was conducted in central Hokkaido, northern Japan (42°55′12″N, 141°42′02″E). A total of 200 ha of agricultural land in this area was purchased by a national organization and replaced with a flood-control pond. As a consequence, wetland vegetation such as Manchurian wild rice *Zizania latifolia* has grown, and several wetland animals, such as waterfowl and dragonflies, have started to recolonize the pond. Therefore, the pond is expected to provide suitable habitats for diverse wetland organisms. Currently, no biodiversity maintenance is being conducted in the pond. However, future directions for this project to restore wetlands are under consideration.

2.3 The choice experiment to measure willingness to pay

The CE uses a stated preference methodology to estimate values of non-market goods and services (Adamowicz et al. 1998; Louviere et al. 2000). In the CE, we designed a scenario providing a hypothetical flood-control pond with additional features, including non-market values of wetland biodiversity and functions. The CE included the following four attributes (Table 1): 1) the red-crowned crane with four levels (occasional occupancy, permanent occupancy, breeding, and absence). We used these four levels because these statuses may be suitable to represent the habitat quality of a

species (Sergio & Newton 2003; Senzaki et al. 2015). 2) A birdwatching station with two levels (establishment and no establishment). The attribute was included to explain the recreational values of the pond with increasing bird abundance or species richness due to restoration plans. This attribute can also separate the value of increased bird abundance due to restoration from the value of the red-crowned crane itself. 3) Wetland sizes with five levels (25, 50, 75, 100, and 125 ha). This attribute was included because habitat area is a key landscape metric for biodiversity conservation, including species richness and abundance (Yamaura et al. 2016b). The levels of this attribute were decided based on the current sizes of natural wetlands around the study area (Senzaki & Yamaura 2016) and the largest wetland size (200 ha) that can realistically be restored in Japan. 4) Annual tax payments needed to introduce preferred plans. For this attribute, we used five levels [100, 500, 1,000, 2,000, or 5,000 JPY (Japanese yen; 100 JPY equals approximately one US dollar)].

During times of flooding, the habitat of red-crowned crane and bird-watching station are assumed to be underwater. The option to suspend the flood-control function allows managers to wait to open the floodgates until the last possible moment. This option appeals to beneficiaries of non-market goods and services, but places local residents at a greater risk of flooding. The political conflicts in which this kind of

facility becomes embroiled are often related to the fact that the groups who enjoy the benefits are not the same as those who bear the costs (Field 2008). Thus, to measure possibility of conflict between local residents and the general public with respect to tradeoffs between basic flood control services and additional non-market goods and services aforementioned above, the option to suspend the flood-control function with two levels (establishment and no establishment) was also included as an additional attribute.

The survey consisted of an introductory text explaining the purpose of the research and the background of the project, the CE scenario, and questions about personal socio-economic characteristics and ecological knowledge (Table 1). We included gender, age and income as the focal personal socio-economic characteristics because these may be related to respondent choices in the CE (Di Minin et al. 2013). In addition, we asked respondents whether they knew the words of “endangered species” and “umbrella species” and have observation experience with the red-crowned crane. These were included because ecological knowledge and natural experience of respondents might affect their willingness to pay (Turpie 2003). In the CE, each respondent evaluated three profiles (alternative management plans) with different levels of the five attributes. We included the status quo profile, which provides no

conservation actions (i.e., no crane, no birdwatching station, 25 ha wetlands, no suspension of flood-control function, no annual tax payment), in one of the three profiles. This kind of choice task was repeated seven times for each respondent (i.e., seven choice sets with different combinations of the levels were used for each respondent). In this study, the profiles were designed using a D-optimal design, which is frequently used in empirical studies (Zwerina et al. 1996). In November 2015, a research company sent invitation emails regarding our Internet questionnaire to its registerees in Hokkaido Prefecture, with taking into account the balance among socio-economic characteristics. Of these registereess, 1,206 (15.7 %) completed the questionnaire. Note that respondents who began the questionnaire but did not complete it were not included in the sample (i.e., there was no incomplete questionnaire in the sample). Thus, all completed questionnaires were used for the analysis. The CE was performed in accordance with relevant guidelines and regulations from the Japanese Ministry of the Environment and were conducted under the current Japanese laws.

2.4 Latent class modeling and willingness to pay estimates

Although we used a conditional logit model for the initial analysis (McFadden 1974), its goodness of fit was poor adjusted McFadden's pseudo R^2 = 0.031], suggesting that the

preferences of respondents were heterogeneous. Therefore, we used a latent class model (LCM) for the analysis because it can assess preferences of respondents for attributes in each of several homogeneous segments. An LCM postulates a random utility framework consisting of an observable deterministic component and unobservable random component. Utility for a profile *i* is described as equation:

$$U_{ni|k} = \beta_k' X_i + \varepsilon_{ni|k} \quad (1)$$

where $U_{ni|k}$ is the utility obtained by an individual *n* in segment *k*, β_k' is a vector of parameters of segment *k*, X_i is a vector of attributes of the *i*th alternatives, and $\varepsilon_{ni|k}$ is a vector of the random component assumed to have a type 1 extreme distribution. The probability that profile *i* is chosen among a choice set *C*, is the probability that $U_{ni|k}$ is larger than any other profile $U_{nj|k}$. The joint probability of a set of seven choices $(i_1, \cdots, i_7)$ from a series of choice sets conditional on belonging to segment *k* can be obtained as the following equation:

$$P_n(i_1, \cdots, i_7|k) = \sum_k P_{n|k} \cdot \prod_{l=1}^{l=7} P_{n|k}(i_l|k) = \sum_k \frac{\exp(\lambda \gamma_k' Z_n)}{\sum_k \exp(\lambda \gamma_k' Z_n)} \cdot \prod_{l=1}^{l=7} \left[\frac{\exp(\mu_k \beta_k' X_{i,l})}{\sum_{j \in C} \exp(\mu_k \beta_k' X_{j,l})} \right] \quad (2)$$

where μ_k is and a scale parameter for segment *k*, $\beta_k' X_{j,l}$ is a specific utility for in *l*th choice set for segment *k*, and $P_{n|k}$ is a probability that respondent *n* is classified in segment *k*. Following Swait (1994) and Boxall and Adamowicz (2002), we assumed a latent membership likelihood function represented by psychometric or socioeconomic characteristics of respondent *n*. The probability is described by a scale parameter (λ), psychometric or socio-economic characteristics of a respondent (Z_n) and their parameters (γ_k'), and a vector of the random component. In contrast to the conditional logit model, LCM assumes that an individual *n* belongs to a latent class *k* that is unobservable a priori. The model is estimated based on maximum likelihood estimation. We also estimated attribute-specific WTP using the parameters obtained by the LCM based on the following equation:

$$\text{WTPa} = -\frac{\beta_{ak}}{\beta_{taxk}} \quad (3)$$

where β_{ak} is a segment-specific parameter (non-monetary coefficient) of each attribute and β_{taxk} is the segment-specific parameter of additional tax payment.

3. Results

The LCM analysis required determining the number of segments. We initially sought the number of segments based on two major statistical criteria (AIC, BIC). However, these procedures required too many number of segments to interpret (i.e., more than four segments) and hence made a characteristic of each segment obscure. In such cases, a model selection can be conducted based on the use of theory and common sense (Agresti 2002). Thus, we have decided to use two segments because the two-segment LCM enabled us to discuss which socio-economic variables and ecological knowledge were related to WTP (see the following results and Table 2).

The LCM with two segments greatly improved model fit (adjusted McFadden's pseudo R^2 = 0.302) over the conditional logit model (Table 2). The first segment constituted 41.9% of the sample and the socio-economic characteristics of this segment (i.e., age, gender and income) did not differ from those of the second segment (Table 2). Respondents in this segment did not know the words “endangered species” and “umbrella species”, had no observation experience with the red-crowned crane, and had no significant interest in the status of the red-crowned crane (Table 2). In addition, the alternative-specific constant for the status quo profile was positive and its absolute value was quite large compared with other parameters, indicating that they preferred the

current situation (Table 2). The WTP for the birdwatching station was estimated to be 76.12 JPY (−76.12 JPY is the baseline level that provides no birdwatching station),.

The second segment constituted 58.1% of the sample (Table 2). Compared to the first segment, respondents in this segment significantly knew the words “endangered species” and “umbrella species”, and had observation experience with the red-crowned crane (Table 2). In addition, all parameters except for the wetland size attribute were significantly different from zero at the 5% level (Table 2). The parameter for the status quo profile was negative, indicating that respondents expected a conservation plan. The crane attribute had its greatest increase in WTP from absence (as a baseline level of effects-coded dummy variables; −1,756.45 JPY) to occasional occupancy (381.73 JPY, a difference of 2,138.18 JPY; Fig 1). The differences in WTP among ecological statuses other than absence were relatively small (occasional to permanent occupancy: 251.80 JPY, permanent occupancy to breeding: 107.65 JPY; Fig. 1). WTP of other attributes were 390.11 JPY for a birdwatching station (−390.11 JPY is the baseline level that provides no birdwatching station), and 205.38 JPY for the option to suspend flood-control functions (−205.38 JPY is the baseline level that provides no such option). These results suggest that the economic values of these attributes would be considerably lower than those of the crane (Fig. 1).

4. Discussion

Currently, neither the fundraising potential of different ecological statuses (e.g., occupancy or breeding) of flagship species nor their economic values relative to other principal conservation targets have been quantified, despite their clear importance to conservation practices. In this study, 41.9% of respondents who had no ecological knowledge and observation experience relevant to a flagship species (the red-crowned crane) were less interested in implementation of any conservation practices. In contrast, the other 59.1 % respondents who had excellent ecological knowledge and observation experience relevant to the flagship species valued conservation practices with the flagship species more than those without such species (Fig. 1). These results suggest that facilitating knowledge and experience with flagship species, for people categorized to the former segment in particular, may be important for increasing financial support, although we cannot exclude the possibility that there are other superior attributes such as other species. Additionally, we showed that consideration for ecologically important statuses of the flagship species did not always improve the economic value of conservation practices.

The higher WTP for the red-crowned crane compared with other attributes

could be explained by the red-crowned crane's high-profile status and publicity, since it is considered an umbrella, symbolic and endangered bird species in Hokkaido (Higa et al. 2016). This explanation was also supported by lower WTP for a birdwatching station, as this suggests that people were less interested in other bird species in the wetland. Therefore, our results emphasize the strong potential of "charismatic species," regardless of ecological status, as financial drivers of conservation practices in at least our study region, which was consistent with previous studies (e.g., White et al. 1997; White et al. 2001; Di Minin et al. 2013).

The small differences in WTP among the ecological statuses other than absence of the flagship species suggest that ecological status does not foster additional financial support. This is unfortunate for two reasons. First, generally speaking, a status of permanent occupancy or breeding can be an excellent indicator of population persistence (Sergio & Newton 2003). Second, conservation of a single species based on their breeding status could be a shortcut to identify productive areas of many co-occurring species (Senzaki et al. 2015). Although future research should examine the reasons why people did not value ecologically important status, a potential reason for this result is that respondents might not recognize the differences among the ecological statuses. Therefore, our study indicates that marketing for raising the publicity of

ecologically important statuses may be important. To do so, enhancing interactions between ecologists and citizens through blogs, newsletters, or workshops may be promising solutions (Dicks et al. 2014; Matzek et al. 2014). It may also be critical to explore when, where, and how ecologists can better educate the public on the importance of ecological status, highlighting an urgent need for better collaboration between conservation and social sciences (Martín-López et al. 2008; Soga et al. 2016).

The birdwatching station had lower WTP and wetland sizes had no WTP, indicating that conservation practices using landscape metrics and ecosystem services as targets may be prone to lacking sustainable financial support. The absence of WTP for wetland size is important because habitat area is considered a key metric in many conservation practices, including restoration and setting of priority areas (e.g., Faith 2003). One potential solution to this is a hybrid approach that uses several non-mutually exclusive targets simultaneously. For example, even if management is focused primarily on recovering natural habitats or ecosystem functions, using a flagship species may raise its monetary value. This hybrid approach has great potential because flagship species with high fundraising potential can exist among even common species (Smith et al. 2012). In addition, specific attributes of flagship species related to individual preferences and financial support are also revealed (Martín-López et al. 2008; Veríssimo

et al. 2014a, b).

Finally, it must not be forgotten that the WTP for the option to suspend flood-control functions in the larger group was positive and significant. The results show that this wetland restoration project is generally favorable to the public. However, the operation of the flood-control pond may stoke conflicts between the general public and local residents. Both the amount of financial support and its distribution (e.g., compensation for local residents who bear a burden caused by additional services) require further discussion. In addition, although our results were based on respondents with diverse socio-economic characteristics throughout our study area and thus might be considered generalizable, the response rate (15.7 %) was not high. Thus, future studies should follow up the generality of our findings.

In conclusion, our study showed that the flagship species in this study, irrespective of their ecological status, was more valued than other important conservation concepts such as ecosystem services and habitat metrics. This suggests that a single flagship species can play an important role in raising the economic value of conservation practices. Although raising the public awareness of ecologically important statuses may be crucial to justify conservation practices both ecologically and economically, our results suggest that focusing much effort on flagship species rather

than other conservation targets may be important to increase the economic value of conservation practices if such species are available.

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Table 1. Attributes and corresponding levels used in the choice experiment and socio-economic and ecological knowledge questions. In the CE, we presented three profiles with different levels of the five attributes to each respondent and repeated this kind of choice task for seven times.

Attributes	Levels
Status of the red-crowned crane	Occasional occupancy/Permanent occupancy/Breeding/Absence
Wetland area	25ha/50ha/75ha/100ha/125ha
Bird-watching station	Yes/No
Option to enable suspension of flood-control function	Yes/No
Annual amount of tax payment for a restoration plan	100JPY/500JPY/1,000JPY/2,000JPY/5,000JPY
Observation experience of the red-crowned crane	Yes/No
Knowledge of endangered species	Yes/No
Knowledge of umbrella species	Yes/No
Gender	Male/Female
Age	10~19, 20~29, 30~39, 40~49, 50~59, 60~69, 70~
Income	~2,000,000JPY/~4,000,000JPY/~6,000,000JPY/~8,000,000JPY/~10,000,000JPY/~12,000,000JPY/~14,000,000JPY/~16,000,000JPY/~18,000,000JPY/~20,000,000JPY/~22,000,000JPY/22,000,000JPY~

Table 2. Results of latent class model parameters for each recognized segment.

		Segment_1			Segment_2		
Attributes	Levels	Coef	SE	*p*-value	Coef	SE	*p*-value
Status of the red-crowned crane†	Occasional occupancy	0.20	0.12	0.09	0.18	0.04	<0.001
	Permanent occupancy	0.02	0.12	0.87	0.30	0.04	<0.001
	Breeding	0.03	0.14	0.83	0.35	0.04	<0.001
	Absent	-0.25			-0.83		
Wetland area ($*10^{-2}$)		0.37	0.19	0.053	0.09	0.05	0.067
Bird-watching station†	Yes	0.19	0.09	0.038	0.19	0.02	<0.001
	No	-0.19			-0.19		
Option to enable suspension of flood-control function†	Yes	-0.10	0.08	0.22	0.10	0.02	<0.001
	No	-0.10			-0.10		
Annual amount of tax payment for a restoration plan ($*10^{-3}$)		-2.45	0.24	<0.001	-0.47	0.02	<0.001
Alternative-specific constant for status quo profile		1.91	0.30	<0.001	-0.76	0.09	<0.001
Constant term of membership function		0.18	0.15	0.21	0.00††	-	-
Crane experience		-0.36	0.13	0.006	0.00††	-	-
Knowledge of endangered species		-0.45	0.13	<0.001	0.00††	-	-
Knowledge of umbrella species		-1.22	0.40	0.002	0.00††	-	-

Sex	0.13	0.12	0.31	0.00††	-	-
Age	-0.07	0.12	0.60	0.00††	-	-
Income	-0.002	0.001	0.24	0.00††	-	-
Class probability		0.42			0.58	
Log likelihood			-6460.37			
Adjusted McFadden's Pseudo R^2			0.302			
No. of observations			8442			

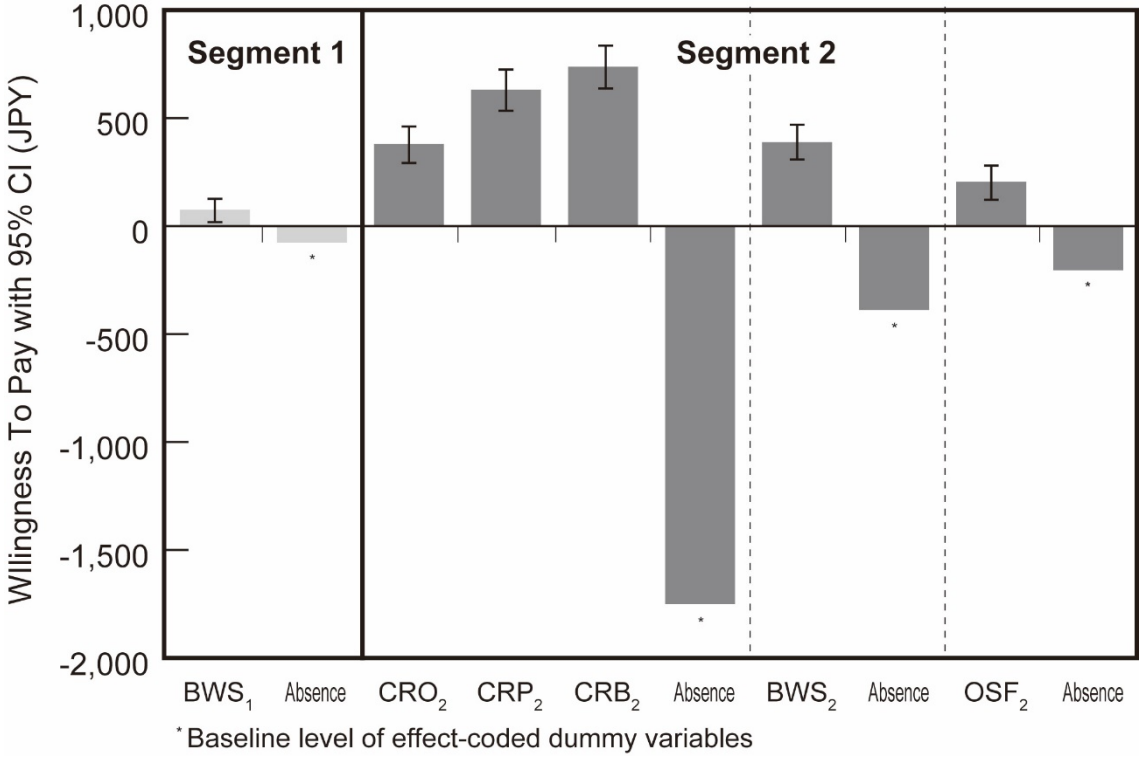
† These attributes are included in the model as dummy variables with effects coding (Louviere et al., 2000).

†† These are fixed parameters.

Figure legends:

Figure 1 Willingness to pay (WTP) for choice experiment attributes derived from the latent class model. Error bars in the upper panel are 95% confidence intervals calculated from the coefficients and variance terms of the latent class model. “CRO,” “CRP,” “CRB,” “BWS,” and “OSF” indicate “occasional occupancy of the crane”, “persistent occupancy of the crane”, “breeding of the crane”, “bird-watching station”, and “option to suspend the flood control function,” respectively.

Figure 1


Segment 1
Segment 2
Willingness To Pay with 95% CI (JPY)
1,000
500
0
-500
-1,000
-1,500
-2,000
BWS1
Absence
CRO2
CRP2
CRB2
Absence
BWS2
Absence
OSF2
Absence
*Baseline level of effect-coded dummy variables