BEING UNEMPATHIC WILL MAKE YOUR LOVED ONES FEEL LONELIER: LONELINESS IN AN EVOLUTIONARY PERSPECTIVE.

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Abstract

Loneliness has been conceptualized as an alarm against social isolation under an evolutionary theoretical framework. Loneliness, as an adaptive feature, would have to be linked to environmental conditions and not only to the subjective evaluation of our social network. This research investigates lack of received empathy as an environmental trigger of the loneliness alarm. Lack of received empathy could explain previously observed correlations between loneliness and low satisfaction with social relationships, attachment insecurity, and certain age groups like teenagers and the elderly. A well-defined evolutionary model opens up new possibilities for the development of more efficient strategies to reduce loneliness.

Keywords: loneliness; received empathy; evolutionary psychology; attachment.

1. Introduction

Loneliness has started to become a public health issue due to the number of people suffering from it and because of the life threatening health consequences chronic loneliness entails (Hawkley & Cacioppo, 2010; Heinrich & Gullone, 2006; Holwerda, et al., 2016). Recent studies have shown that loneliness is a complex phenomenon that has both environmental and genetic influences (Boomsma, Willemsen, Dolan, Hawkley, & Cacioppo, 2005; McGuire & Clifford, 2000). To account for the process by which loneliness arises and could be resolved, several theories have been proposed. Research conducted under an evolutionary framework considers loneliness to be a biological alarm that signals social isolation and motivates humans to re-establish or improve their social bonds (Cacioppo, Cacioppo, & Boomsma, 2014; Cacioppo, et al., 2006). Loneliness as an evolutionary trait needs both to be passed on as genetic information from one generation to the next and to provide improved fit to the environment. On the genetics of loneliness, studies have found links between loneliness feelings and the rs53576 variant of the oxytocin receptor gene (van Roekel, et al., 2013) and also the serotonin transporter gene 5-HTTLPR (Goossens, 2012) . These findings point to the mechanisms by which genes could affect an individual's susceptibility to the environment resulting in loneliness feelings. On the improved fitness to the environment, researchers have argued that variability in sensitivity to loneliness could have benefited both the formation of tight communities (those individuals more sensitive to loneliness) and more independent or resilient explorers or hunters (those individuals less sensitive to loneliness) (Cacioppo & Cacioppo, 2012). However, the cues of the environment that trigger loneliness feelings still need to be pin pointed in detail.

Objective social isolation has been found to be closely linked whilst remaining a clearly distinct phenomenon from perceived social isolation or loneliness (Holt-Lunstad, Smith, Harris, & Stephenson, 2015). Personality traits have also been associated with loneliness feelings. Some studies have found correlations between the latter and trait empathy, (Beadle, Brown, Keady, Tranel, & Paradiso, 2010), extraversion, self-confidence, neuroticism, and psychoticism (Cheng &

Furnham, 2002). What remains unresolved the specific environmental cue that puts all of these elements into play. Genes make us susceptible, but susceptible to what specifically? This research analyses the role of received empathy in loneliness. The empathy a person receives from their social relations could be an environmental cue for potential social help and/or support available when necessary, and hence increased survival possibilities. Given the increasing social complexity of human groups, the mere presence of conspecifics does not guarantee survival: conspecifics must be willing to aid the individual, which is by no means a given. Received empathy[1] could be a good proxy for potential help before it is needed. And some individual characteristics such as attachment style and mentalising competence could affect the perception of empathy in other people's actions.

There are some findings in the literature that support this theory in different ways. Empathy perception, for instance, has been found to reduce physical pain perception (Sambo, Howard, Kopelman, Williams, & Fotopoulou, 2010), which is interesting considering that loneliness, a form of social pain, is thought to be processed via the same neurological mechanisms that process physical pain (Eisenberger & Lieberman, 2004). Hombrados-Mendieta and colleagues found a negative correlation between emotional support, which is essentially the manifestation of emotional empathy demonstrated through behaviour, and loneliness in Spanish population (Hombrados-Mendieta, García-Martín, & Gómez-Jacinto, 2013). Moreover, Cramer and Jowett found a correlation between perceived empathy and satisfaction with relationships (Cramer & Jowett, 2010). And, to some extent, satisfaction with the most important or significant relationships (such as family) is related to lower loneliness scores (Perlman & Peplau, 1984). Moreover, in an experimental design, Sambo and colleagues found that perceived empathy reduces physical pain reporting with attachment style as the only mediating factor (Sambo, Howard, Kopelman, Williams, & Fotopoulou, 2010).

[1] The term "received empathy" in this paper makes reference to the empathy a person perceives others to have towards him/her. It could also be described as "empathy perception" or "perceived empathy", but in some cases that phrasing might be interpreted as referring to the empathy someone thinks they have for somebody else. We chose the term "received" instead to emphasize the fact that we speak of empathy from others to a self.

1.1 Empathy

In comprehensive terms, empathy is the ability to (a) be affected by and share the emotional state of another person, (b) assess the reasons of such emotional state on the other person, and (c) relate to him or her taking their perspective (de Waal, 2008). However, empathy has rarely been studied from the receiver's point of view. The study of the behavioural expression and perception of empathy has been generally developed around a different concept: social support. Studies have approached social support from the perspective of the provider (Dunn, Aknin, & Norton, 2008) and from the perspective of the receiver (Zimet, Dahlem, Zimet, & Farley, 1988; Procidano & Heller, 1983). But, ultimately, social support and empathy are related concepts —not equivalent ones. One of the most salient differences is that an empathic action involves concern for the other and social support does not need to. Besides, the provider of social support need not know nor understand the emotional state of the receiver. And finally, one can empathize with someone else without necessarily having a behavioural manifestation of that empathy; however, you cannot "feel" social support with no behavioural manifestation.

The same is true for other related constructs. For instance, Gruen & Mendelsohn (1986) found that sympathy —characterized as compassion or concern— and empathy —characterized as emotional tuning—, are discriminable both conceptually and empirically. However, the former does not require understanding or tuning in with the emotional state of another person (see also Eisenberg, 1988).

In a recent paper, Powell and Roberts (2017) distinguished three dimensions of empathy: cognitive, affective and "compassionate" empathy; the latter is characterized as "feelings of sympathy, concern, and compassion for another" (Powell & Roberts, 2017, p. 138). The behavioural manifestation of compassionate empathy is what would give rise to someone receiving empathy. Empathy's behavioural manifestation is associated to some extent with prosocial behaviour, although this relationship is just beginning to be documented and understood (Eisenberg

& Miller, 1987; Sánchez-Queija, Oliva, & Parra, 2006; Mestre Escrivá, Samper García, & Frías Navarro, 2002). Jolliffe & Farrington (2006) have argued that high levels of empathy increase the likelihood of prosocial behaviour because sharing other people's distress should motivate individuals to assist that person to reduce their own distress. For example, low levels of empathy (affective or emotional empathy in particular) have been linked with bullying (Joliffe & Farrington, 2011) and cyberbullying (Brewer & Kerslake, 2015). If empathy motivates prosocial behaviour, prosocial behaviour increases survival for humans, and loneliness is an alarm against life-threatening risks of social disconnection, then it would follow that lack of received empathy triggered loneliness because it would anticipate lack of prosocial behaviour.

Given that in this study the main interest are actions involving concern (or compassion) and shared affect, we decided to use the term "empathy" to emphasize the distinction with other related concepts. For the purposes of this investigation, received empathy is then defined as the demonstration that someone else understands and/or shares the affective state of an individual; and the demonstration that, as a result, they are willing to react in accordance with any of the individual's needs with the intention of improving his or her emotional state.

2. Research Questions and Hypothesis

The aim of this research was to study the effect of received empathy on loneliness feelings. We posed two research questions:

I. Is perceived empathy a trigger for loneliness as an evolutionary alarm?

   Lack of received empathy will signal low probabilities of receiving prosocial behaviour and would therefore trigger loneliness feelings. For Study 1 this meant that participants who did not receive empathy will report more loneliness than participants who are exposed to an empathic interaction. A physiological correlate (heart rate) was expected to mirror this behaviour. For Study 2 it meant that participants who score higher in the Multidimensional Empathy Scale will have lower loneliness scores.

II. Is the relationship between perceived empathy and loneliness affected by attachment style and mentalising competence?

Individual differences in attachment security and mentalising competence are hypothesized to result in differences in the effects of empathy on loneliness. People with higher levels of attachment insecurity and with lower levels of mentalising competence will require more perceived empathy than their peers with higher levels of attachment security and mentalising skills.

a. Higher levels of mentalising competence are hypothesized to result in higher levels of received empathy and lower levels of loneliness. Greater mentalising competence allows people to make more complete analysis of other's actions and intentions, which might allow them to perceive more empathy in their social interaction. Another possibility is that greater mentalising competence allows for a more efficient social interaction. This means that a competent individual might find it easier to adjust his/her behaviour in order to provide him/herself with the empathy they need, compared with someone less competent. Mentalising competence is thought to enable empathy (particularly cognitive empathy), as studies on autism reflect (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Roeyers, Buysse, Ponnet, & Pichal, 2001; Rueda, Fernández-Berrocal, & Baron-Cohen, 2015; Smith, 2009). Mentalising competence (theory of mind) is what allows us to read and speculate about other people's intentions beyond the direct effects or implications of their actions. It also allows us to work with false beliefs, both our own and others' (Baron-Cohen, Lombardo, & Tager-Flusberg, 2013; Gergely & Csibra, 2005; Tomasello, 2004). There is also evidence suggesting that mentalising competence is a predictor of the size of the social network (Stiller & Dunbar, 2007), that is the number of active relationships which a person can count on. Moreover, it has also been correlated with the empathy we feel for others, which has a cognitive component (Ibanez, et al., 2013; Perry & Shamay-Tsoory, 2013). In this research, mentalising competence is considered to play an important

role in the interpretation of social interaction and empathy perception, and consequently would affect the experience of loneliness.

b. Attachment style has been found to mediate the relationship between perceived empathy and physical pain (Sambo, Howard, Kopelman, Williams, & Fotopoulou, 2010) and has been correlated to loneliness a well (DiTommaso, Brannen-McNulty, Ross, & Burgess, 2003). Lack of empathic care is thought to result in insecure attachment and many negative psychosocial outcomes (Weil, 1992). Also, previous studies have found that secure attachment predicts lower loneliness (DiTommaso, Brannen-McNulty, Ross, & Burgess, 2003; Riggio, Throckmorton, & DePaola, 1990). Specifically, satisfying basic psychological needs has been found to mediate the relationship between attachment security and lower loneliness (Wei, Shaffer, Young, & Zakalik, 2005). Also Cacioppo and Hawkley (2003) have hypothesized attachment insecurity to explain increased stress observed in lonely people —compared to the non-lonely— via increased activation of the sympathetic nervous system and of the sympathetic adrenomedullary (SAM) and hypothalamic pituitary adrenocortical (HPA) neuroendocrine systems. Therefore, for this study higher levels of attachment security are hypothesized to result in less required empathy and less loneliness. More attachment security would entail less required empathy because securely-attached people are less emotionally dependent on other people's reactions; therefore, their emotional wellbeing is less dependent on their context compared with an insecurely-attached person.

c. Age, gender and income are variables that some studies have associated to differences in loneliness scores. Previous research has documented age differences in loneliness, with younger adults reporting less loneliness than older adults, although the difference is larger among those over 80 years old (Pinquart & Sörensen, 2003). Also, women have been found to report more loneliness than men when instruments make explicit reference to loneliness (Pinquart & Sörensen, 2003; Borys & Perlman, 1985) whereas no

differences are found (Pinquart & Sörensen, 2003) or men report more loneliness (Russell, 1996) when there is no explicit reference to loneliness in the employed measures. This is likely caused by either differences in socialization for men and women —which in turn cause differences in social dynamics and needs—, or by men under reporting their actual loneliness levels due to social expectations (de Jong Gierveld, van Tilburg, & Dykstra, 2016; Borys & Perlman, 1985). Low/inadequate income is related to increased loneliness (Lauder, Mummery, & Sharkey, 2006; Mullins, Sheppard, & Andersson, 1991) possibly because socioeconmic circumstances can affect people's ability to optimize and divesify social contacts (de Jong Gierveld, van Tilburg, & Dykstra, 2016), which makes them more vulnerable to loneliness. In accordance with this findings, age, gender and income will be included in the analysis under the hypothesis that older adults, men, and lower socioeconomic circumstances will relate to increased loneliness feelings.

In this research endeavour, the first obstacle is to measure received empathy. There are, to our knowledge, no dedicated instruments other than those designed for medical or psychological clinical settings (*e.g.* Barrett-Lennard, 1962; Hills & Knowles, 1983). Those measures do not allow to adequately exploring the empathy perceived in core relationships which typically involves several different people and varies in the kinds of interaction they entail (they are never a professional relationship). Therefore, two different strategies were used in each of the two studies reported here. The first one was exposing participants to an empathic interaction and exploring the different aspects of empathy that might contribute to reducing loneliness feelings. The second was to use an adaptation of an existing instrument designed to measure the empathy a person has for others.

The two studies were conducted using different methodological approaches. First, an experimental approach in Study 1 tested for the effects of empathic/unempathic interaction on

loneliness. In Study 1, empathy was operationalized as an interaction where participants were asked about their current affective state, received understanding and shared experience, and a standard helping behaviour (a glass of water). Following the results of that study, Study 2 analysed the relationship between received empathy and loneliness in a general population sample using a more comprehensive measure of empathy. In Study 2, received empathy was operationalized as the responses to the adapted version of the Multidimensional Empathy Scale (see Study 2's "Methods" section for additional information).

We found that, effectively, loneliness feelings are greater among the people who perceive their core relationships to be less empathetic towards them and that attachment, but not mentaliasing competence, has also important effects on loneliness. Understanding the mechanisms by which received empathy reduces loneliness might help find more efficient strategies targeting those segments of the population more vulnerable to loneliness.

3. Study 1 (experimental)

3.1 Methods

Participants. Participants were undergraduate students of the Science School of the National Autonomous University of Mexico (UNAM) who volunteered for the study in exchange for course credits. 67 participants were randomly assigned to two experimental (empathy, G1 / no empathy, G2) or a control group. Five participants were excluded from the final sample due to inconsistent heart rate readings, not following the instructions given, or failing to answer all items in the questionnaire. The final sample consisted of 62 volunteers (34 females), mean age 21.38 (SD 1.38) years.

This study was approved by UNAM's School of Psychology ethics committee and the participants gave informed consent before taking part in the study.

Procedure. All participants completed a questionnaire containing social network profiling, empathy and relationship satisfaction indicators and attachment style questionnaires gathered in section A. Section B was formed by loneliness and mentalising competence measures. Heart rate was measured throughout the experiment. Participants completed section A alone, and upon completion they were asked to wait for 5 minutes while the second section was brought to them. During those 5 minutes, G1 participants (empathy condition, 10 females and 11 males) interacted with the researcher who started a casual conversation with them asking about their emotional state and making every effort to create an empathetic environment (*e. g.* "How are you finding the session?", "Yes, I know it can be tiring sometimes"). G2 participants (no empathy condition, 11 females and 9 males) waited in the presence of a research assistant who did not speak to them and did not make eye contact. The G3, control group, waited alone (13 females and 8 males). After the 5 minute waiting period, all participants answered the second part of the questionnaire alone.

Measures. Loneliness was measured with the short version of the Multi-faceted Loneliness Inventory (IMSOL) (Montero López Lena, 1999) which consisted of three questions on subjective feelings of loneliness on a 1 (*never*) to 5 (*all the time*) frequency scale. A simple 1 to 10 scale was also included to measure intensity of loneliness feelings. Attachment style was measured with the Experiences in Close Relationships scale, Spanish version by Teresa Frías (2011), which obtained a Cronbach's alpha reliability coefficient of .81. Mentalising competence was measured with the shortened, revised version of a task-based instrument developed by Kinderman, Dunbar, & Bentall (1998) (Stiller & Dunbar, 2007) which consist of three short stories depicting social situations followed by a series of questions about the mental states of the characters in the story. It includes questions with different levels of inference that the participant has to make in order to answer correctly (*i.e.* "Helen deliberately tricked Sam" vs. "Pete expected Sam to understand that he thought Helen had wanted Sam to know where to find the post office").

Five questions targeting received empathy and relationship quality were also included. These were participant's self-rated satisfaction with, closeness to, understanding, support, and care/importance from close relationships (support clique and sympathy group of the social network) on a 1 (*very little*) to 5 (*a lot*) scale. The aim was to identify which elements involved in a relationship's "quality" are significantly correlated to loneliness feelings. Previous research conducted under a discrepancy perspective establishes dissatisfaction as the key variable for loneliness (Peplau, Miceli, & Morasch, 1982) since it indicates that obtained social interaction does not measure up to what is desired. However, we sought to identify and compare other factors that could cause both dissatisfaction and loneliness –particularly empathy, or lack of thereof. Understanding targets cognitive empathy, care targets empathic concern and support targets social support.

Social network data were collected for the support clique and sympathy group regarding different aspects such as frequency of contact, type of relationship (kin, partner or friend) and participant's perceived closeness to that person (Hill & Dunbar, 2003).

Heart rate (HR) was recorded throughout the length of the study using a Polar H7 chest band. HR was used as a physiological measure related to stress and social support. Lower satisfaction with social support has been associated with higher heart rate reactivity after a stressful task (Nausheen, Gidron, Gregg, Tissarchondou, & Peveler, 2009), increased HR has been reported when participants face a stressful condition with no social support (Allen, Blascovich, & Mendes, 2002) and decreased cardiovascular reactivity has been found amongst the lonely (Cacioppo, et al., 2000). The purpose of taking this physiological measure was to analyse if the experimental conditions had different effects on participant's HR during and in recovery after the condition with the aim of potentially observing non-conscious reactions to the experimental treatment that psychometric tools would not be able to record. As mentioned earlier, HR was hypothesised to mirror empathy-related hypothesis: participants in the empathy condition will show lower HR than participants in the other two groups (no-empathy and control).

Table 1. Descriptive statistics of the experimental sample

Variable	mean	max	min	range	SD
Age	21.39	26	19	7	1.38
Loneliness (IMSOL)	5.16	14	3	11	2.18
Loneliness intensity	3.65	10	1	9	2.77
Anxiety	2.58	4.17	1	3.17	0.80
Avoidance	2.13	4.5	1	3.5	0.73
Received empathy	23.36	25	17	8	2.02
ToM	99.71	120	72	48	11.65

Analysis. Two-way Analysis of Variance (ANOVA) was performed to examine the effects of the three conditions on loneliness scores, and on heart rate.

Multiple regression analysis was conducted to examine whether empathy-related items, attachment style and mentalising significantly predicted loneliness scores with gender and income also included in the regression and to compare those results with other objective and subjective variables that have previously been related to loneliness.

3.2 Results and Discussion

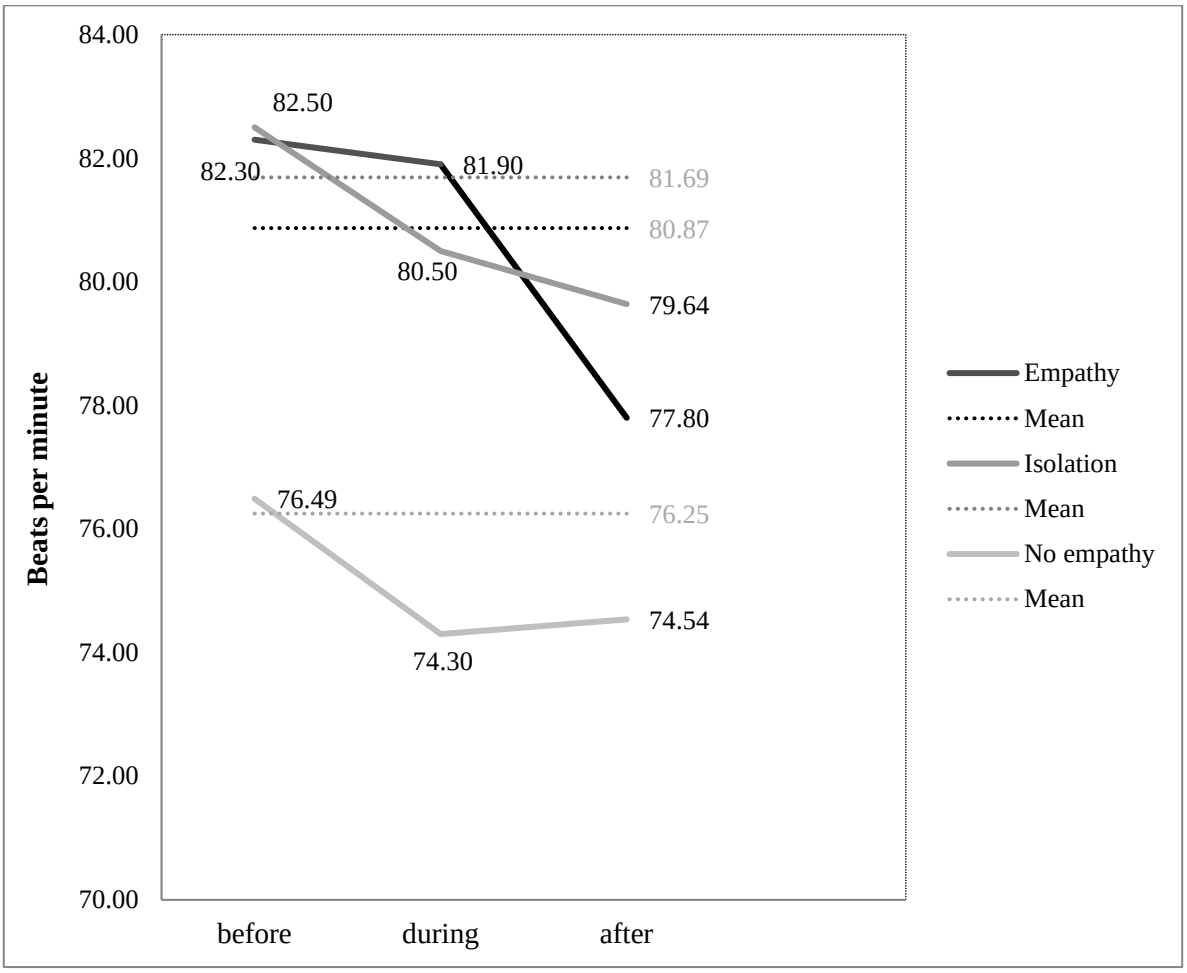
Results. There was a significant interaction between the effects of the experimental condition and gender on participants' levels of perceived loneliness feelings $F(2, 56)= 3.873$, $p= .027$. Simple main effects analysis showed that males perceive significantly more loneliness feelings than females when left alone in the control condition ($p=.013$) but not in the empathy ($p=.520$) or the no-empathy ($p=.915$) conditions.

Further analysis showed that there is a underlying significant interaction between the effects of the experimental condition and gender on participants' levels of perceived loneliness intensity (as opposed to frequency) $F(2, 56)=6.18$, $p= .004$. Simple main effects analysis showed that males

perceive significantly more intense loneliness feelings than females when left alone in the control condition (p=.003) but not in the empathy (p=.280) or the no-empathy (p=.173) conditions.

Regarding HR, the three conditions behaved in different patterns. It is worth noting that no significant differences were found between experimental groups in heart rate before the experiment, which allows to assume that the three groups were initially homogeneous in this regard. In the *empathy* condition, there are significant differences between before (hr1) and after (hr3) (p=.000), and between during (hr2) and after (hr3) (p=.000) the experimental treatment. Conversely, in the *no-empathy* condition there was a significant difference between before (hr1) and during (hr2) only (p=.022). Finally, in the *control* condition there were significant differences between before (hr1) and during (hr2) (p=.039), and between before (hr1) and after (hr3) (p=.024). This was true for males and females alike.

Figure 1. Average beats per minute during each period of the experiment



On the other hand, regression analysis showed that empathy-related relationship quality indicators are significantly correlated to loneliness (IMSOL) but they behave quite differently in the first and second layers of the social network. This comparison is shown in Table 2, which also shows that feeling understood is the variable most consistently correlated to loneliness, while feeling important in a close relationship is the most significant predictor of (decreased) loneliness and feeling close to a loved one is the strongest predictor.

Table 2. Relationship quality indicators regression analysis

Loneliness (IMSOL)	**First layer**	**Second layer**
Closeness	-3.220* [1.682]	-.004 [.411]

Satisfaction	.414 [.465]	.177 [.378]
Understanding	-.683** [.318]	-.996*** [.330]
Support	.226 [.686]	.405 [.401]
Importance	-1.697*** [.631]	-.755 [.642]
Constant	28.979** [6.791]	9.153** [1.719]
R^2	0.4175	0.2670
N	62	62

*p<0.1; **p<0.05; ***p<0.01
All models are OLS and robust standard errors.

The first layer was thus selected for further analysis with the hypothesised model that includes attachment and ToM. Here, loneliness IMSOL measure (frequency-based) was compared to the simple intensity scale[2]. Results showed that they behave considerably different. Particularly in the case of the intensity scale, understanding is the most significantly correlated variable with loneliness.

Table 3. Regression analysis with empathy, attachment and ToM as independent varaibles

Loneliness	**Frequency**	**Intensity**
Closeness (first layer)	-2.912* [1.700]	-4.306** [1.775]
Satisfaction (first layer)	.386 [.453]	1.212* [.713]
Understanding (first layer)	-.351 [.322]	-1.655*** [.596]
Support (first layer)	.121 [.729]	1.201* [.648]
Importance (first layer)	-1.350** [.626]	-.963 [.554]
Attachment anxiety	.741** [.278]	.435 [.413]
Attachment avoidance	.525 [.374]	.268 [.567]
Theory of Mind	.020	.017

[2] The frequency and intensity measures of loneliness were correlated (r=0.5358, p=0.000)

	[.021]	[.026]
Gender (dummy, m=0)	-.217 [.499]	-.967 [.704]
Income	.000 [.000]	.000 [.000]
Constant	20.218** [7.754]	22.193** [8.281]
R^2	0.5397	0.3818
N	62	62

*p<0.1; **p<0.05; ***p<0.01
All models are OLS and robust standard errors.

Finally, we compared a model based on the hypothesis of this investigation with a model based on previous theoretical approaches. Table 4 shows the results and it is clear that the former fits data better than the latter. **Model 1** comprises objective and subjective independent variables for loneliness which gather both satisfaction and interaction with the first two layers of the social network. The only significant variables (p<.1) were participants' reported satisfaction with their support clique and sympathy group, which is consistent with the cognitive approach to loneliness. **Model 2** is the model hypothesized for this research and includes empathy-related items, attachment anxiety and aversion and ToM variables. This model attained over twice as much of explained variance (R^2=0.5351) than Model 1.

Table 4. Regression analysis comparing objective and subjective variables *versus* this study's hypothesized model

Loneliness	**Model 1**	**Model 2**
Satisfaction (first layer)	-1.114* [.634]	
Satisfaction (second layer)	-.493* [.280]	
First layer size	-.052 [.069]	
Second layer size	.008 [.064]	
Frequency of face-to-face contact (first layer)	.034 [.373]	
Frequency of face-to-face contact (second layer)	-.148 [.298]	

Fortnightly social interaction (amount of people they actually interacted face-to-face with)	.038 [.069]	
Closeness (first layer)		-2.430** [1.175]
Understanding (first layer)		-.228 [.234]
Importance (first layer)		-1.273** [.577]
Attachment anxiety		.745** [.277]
Attachment avoidance		.485 [.343]
Theory of Mind		.022 [.018]
Gender (dummy, m=0)	-.677 [.649]	-.284 [.473]
Income	.000 [.000]	-.000 [.000]
Constant	12.959** [2.801]	19.215*** [6.688]
R^2	0.2112	0.5351
N	62	62

*p<0.1; **p<0.05; ***p<0.01
All models are OLS and robust standard errors.

These results lent support to further analyse the hypothesized relationship between loneliness and empathy and attachment. A specialized measure and a larger sample would be necessary for this endeavour.

Discussion. Experimental results show that men reported significantly more intense loneliness feelings in the control (isolation) condition. This can be interpreted in two ways. Other studies have found that men are generally more vulnerable to loneliness than women (Holwerda, et al., 2016; Borys & Perlman, 1985). In that light, our results could indicate that the presence of a person of the opposite sex has a protective effect against loneliness on males, given that both researcher and research assistant were female. It could be the case that males naturally score higher in loneliness and the experimental conditions reduced perceived loneliness intensity due to the company or

presence of a female regardless of the level of social interaction. The fact that men seem to respond to the presence of a female by feeling less lonely could be liked to a mechanism that promotes pair-bonding. Another possibility is that, at least in our sample, loneliness scores of males and females are not significantly different but males are in fact significantly more sensitive to isolation. This would seem inconsistent with the evolutionary argument where lower loneliness sensitivity (gene-related higher tolerance threshold for loneliness feelings) could be adaptive for primitive hunters and explorers who might need to isolate themselves from their group (or core network relationships) for some length of time in order to provide for them. However, it could also be true that precisely the people who get more lonely when isolated would be more motivated to return to their group to share their findings and food, and hence make better explorers than those who do not feel such a strong urge. Practical survival needs might motivate them to leave the group but higher sensitivity to loneliness when isolated might drive them back. Still, the observed difference between males and females should be further studied to identify its causes.

Heart rate patterns are also revealing. In the three conditions, HR showed a tendency to decrease but it did so in different ways. The control condition showed a steady HR decrease trend in the before-during-after sequence of the experiment. The no-empathy condition showed a significant decrease between before and during but no significant differences after that –although, the tendency was to a slight increase in beats per minute. And the empathy condition showed no significant changes in the before-during lapse but it had the largest significant drop in the during-after comparison. The fact that the empathy condition is the only one that showed no significant decrease in HR in the before-during comparison could be explained in two ways. If taken as an indicator of stress, these HR pattern could show that the social interaction involved in the empathy condition was more stressful than the no-empathy and the control conditions. Or it is also possible that the physical effort of speaking counter-balanced the decreasing trend. However, the temporary stress or effort of the social interaction involved in the empathy condition was followed by the largest decrease in HR in the “after” period (hr3), which rules out the possibility of attributing the observed

differences to the fact that the empathy condition involved speaking whereas the other two conditions did not, given that it is very unlikely that speaking could affect the HR average after speaking without affecting in-the-moment HR. On the contrary, during the no-empathy condition there was no such decrease after the experimental condition, which was indeed observed in the control group but even more so in the empathy condition. Heart rate tendency to decrease flats-out after being in presence of someone who shows no empathy, whereas it decreases significantly more after interacting with an empathetic counterpart. Social interaction seems to be temporarily stressful but protective in the long run. No-empathy or lack of interaction with a potentially available person might not be stressful in the moment but it impairs HR decreasing trend.

In sum, empathic interaction was found to have positive physiological effects while lack of empathy showed comparatively negative effects. And isolation was found to have negative effects on loneliness scores for males.

Regression analysis results showed firstly that closeness, understanding, and feeling important are better predictors of loneliness than satisfaction or support. The first layer of the social network was found to be crucial whereas the sympathy group seems to play a secondary role. Attachment anxiety was found to be significantly correlated with loneliness, while avoidance was not. These results opened the way for a second study where a comprehensive measure of received empathy and a larger sample could potentially provide stronger evidence in support of the hypothesised model.

4. Study 2 (Cross-sectional)

Study 1 results partially supported the hypothesized relationship between empathy and loneliness and showed evidence of a significant correlation of anxious attachment with loneliness. To examine this further a larger survey sample with a more comprehensive measure of received empathy was conducted. The aim was to analyse in more detail the observed effect of received empathy on loneliness and to document whether those results are found not only on a small experimental sample

but also in a general population sample. Previous research on empathy has characterized it as a multidimensional phenomenon that includes emotional empathy and cognitive empathy, but also emotional contagion and personal distress in some studies (Batson, 2009; Diaz-Loving, Andrade-Palos, & Nadelsticher-Mitrani, 1986; Fernández Pinto, López Pérez, & Márquez, 2008) among other vicarious experiences. However, the effect that any of these have on the person who receives the empathetic gesture has seldom been addressed and never with regards to its effects on loneliness feelings. For this purpose, dedicated measure of empathy was included.

4.1 Methods

Measures. Study 2 was survey-based. Participants answered an adapted version of the Multidimensional Empathy Scale (Diaz-Loving, Andrade-Palos, & Nadelsticher-Mitrani, 1986) to measure received empathy. The adaptation consisted in reversing the questions that were originally designed to measure the empathy a person shows for others. Question content was preserved, but the questions were presented as an enquiry into how much the person's loved ones show empathy for her/him (*e.g.* "I take into account other people's feelings" was presented as "Your loved ones take your feelings into account"). Four questions were added to measure received empathy precision (*e.g.* "They make you feel like they are there for you"). Received empathy was rated on a 1 (*never*) to 4 (*always*) frequency scale and the instrument obtained a 0.8618 Cronbach's alpha reliability coefficient. It includes four empathy dimensions: cognitive empathy (perception of other people's affective and emotional state), empathic concern (feelings of sympathy and compassion towards others), indifference (lack of concern and calmness in face of other people's problems), personal distress (negative affect caused by other people's situation); precision (accurate response to other people's situation) is the one we added for this study. To verify that the adjustments did not affect the scale's structure, confirmatory factor analysis (CFA) was performed and it showed good results for the hypothesized five dimensions: x^2=317.973***, CFI=0.943, RMSEA=0.072. One item from the empathic concern was removed due to low factor loading (<0.4).

Participants also answered the IMSOL questionnaire to measure loneliness (α= 0.7961) and attachment was measured with the Experiences in Close Relationships scale, Spanish version by Teresa Frías (2011) (α= .7324). Social network structure and usual social interaction data were also collected for the support clique.

Procedure. Volunteers were recruited through invitation on social media and on campus. A total of 288 responses were obtained, of which 212 were complete and selected for analysis, 138 females and 74 males, mean age 34.6 (SD 12.4) years.

Table 5. Descriptive statistics of the survey sample

Variable	mean	max	min	range	SD
Age	34.66	65	17	48	12.42
Loneliness frequency	6.10	15	3	12	2.40
Loneliness intensity	3.81	10	1	9	2.66
Anxiety	15.58	29	6	23	4.65
Avoidance	13.90	29	6	23	4.72
Received empathy*	3.16	3.76	2.07	1.69	0.31
Received empathy precision	3.20	4	1.4	2.6	0.45
ToM	89.24	120	22	98	20.57

**Average of the empathy scale.*

Analysis. Multiple regression analysis was conducted to examine whether received empathy, attachment style and mentalising significantly predicted loneliness scores controlling for participant's gender, age and income.

4.2 Results and Discussion

Results. Linear regression analysis (Table 6) showed a significant relation between loneliness and different empathy dimensions, with attachment anxiety, attachment aversion, gender, age, and income also included in the regression $F(11,181)=7.32$, $p=.000$, $R^2=0.2544$. This regression represents the hypothesis proposed for this study. However, it could be argued that precision was

added to the original instrument and therefore is not as reliable as the original instrument. For this reason, the same regression was run again including only the original dimensions (*i.e.* without precision). Results show that cognitive empathy is then the most significantly correlated variable with loneliness and that the model holds relatively well with a slight decrease in explained variance: $F(10,182)=6.73$, $p=.000$, $R^2=0.2337$.

Table 6. Regression analysis of the hypothesized model

Loneliness (IMSOL)	**Full adjusted scale**	**Original scale**
Precision	-1.326** [.556]	
Cognitive empathy	-.292 [.456]	-.847** [.390]
Empathic compassion	.829 [.536]	.399 [.544]
Indifference+	-.700 [.438]	-.770 [.426]
Personal distress	.186 [.538]	.095 [.530]
Attachment anxiety	.575** [.243]	.642*** [.243]
Attachment avoidance	.810*** [.275]	.808*** [.279]
Theory of Mind	-.002 [.011]	.001 [.011]
Gender (dummy, m=0)	.425 [.342]	.431 [.349]
Age	-.020* [.012]	-.020 [.012]
Income	-0.000 [.000]	-0.000 [.000]
Constant	6.276*** [2.215]	5.5156** [2.183]
R^2	0.2544	0.2337
N	193	193

*$p<0.1$; **$p<0.05$; ***$p<0.01$
All models are OLS and robust standard errors.
+Reverse coded.

The full model, was then compared to a second regression model representing objective social isolation (p=0.299 for face-to-face interaction and p=647 for distance communication), closeness to nuclear family (p=0.000) and being in a romantic relationship (p=0.020, dummy coded) ($F(7,193)$= 3.95, p=0.0005, R^2 =0.1386), which previous research has identified as important predictors of loneliness (see de Jong Gierveld, van Tilburg, & Dykstra, 2016 for a review).

Table 7. Regression analysis comparing objective and subjective variables *versus* this study's hypothesized model

Loneliness (IMSOL)	**Model 1**	**Model 2**
Precision	-1.326** [.556]	
Cognitive empathy	-.292 [.456]	
Empathic compassion	.829 [.536]	
Indifference+	-.700 [.438]	
Personal distress	.186 [.538]	
Attachment anxiety	.575** [.243]	
Attachment avoidance	.810*** [.275]	
Theory of Mind	-.002 [.011]	
Face-to-face interaction frequency (with core relationships)		-.185 [.149]
Communication frequency (with core relationships)		.053 [.247]
Nuclear family relationship quality		-.966*** [.282]
In a romantic relationship (dummy, no=0)		-.663** [.361]
Gender (dummy, m=0)	.425 [.342]	.505 [.356]
Age	-.020* [.012]	-.031** [.012]
Income	-0.000 [.000]	-0.000 [.000]

Constant	6.276*** [2.215]	12.171*** [1.643]
R^2	0.2544	0.1386
N	193	201

*p<0.1; **p<0.05; ***p<0.01
All models are OLS and robust standard errors.
+Reverse coded.

The hypothesized model shows better overall results. Both models had good significance levels but the proportion of explained variance is considerably different: 25.44% *versus* 13.86%.

Discussion. These results provide evidence for the importance of received empathy and attachment insecurity to explain loneliness variance. In Study 2 we confirmed that a modified version of an empathy scale has a slight advantage over the original although both significantly predicted loneliness.

Both anxiety (p=0.019) and avoidance (p=0.004) were significantly correlated to loneliness feelings, which means that attachment insecurity in general increases loneliness. This finding is interesting for two reasons. Firstly, seems that a pattern that we establish during childhood strongly affect our future social interaction outcomes. Positive early experiences with attachment figures seem to mean less loneliness during adulthood. The fact that we did not find an attachment-empathy significant interaction effects suggests different pathways by which these variables impact loneliness. However, attachment style is determined by main-caregiver's responsiveness and accurate handling of the infant's needs. This is a prototypical empathic interaction. Thus, it is possible that received empathy drives loneliness from childhood and into adulthood through several different mechanisms.

ToM proved not to have a significant effect on loneliness which could be due to the fact that this variable and the measure employed in this study are based on cognitive processing whereas loneliness and received empathy are affective phenomena. The cognitive skill that allows us to

make sense of the non-explicit side of every human interaction (mental states, intentions, goals, etc.) did not significantly affect empathy perception or loneliness in this study.

Finally, the hypothesized model for this study had better results than a model based on variables that other studies have found to predict loneliness. Significance, β coefficients and explained variance were stronger in Model 1 (see Table 7). Thus, including received empathy in the development of the evolutionary model on loneliness is relevant. Further research is necessary to disentangle the connexion between empathy, attachment and loneliness, which is likely to be cyclic. Other studies might consider to test a mediation model to explain the effects of empathy and attachment.

5. General Discussion and Conclusions

As mentioned before, previous research has studied the relationship between loneliness and several internal factors, ranging from personality traits (Beadle, Brown, Keady, Tranel, & Paradiso, 2010; Cheng & Furnham, 2002), to genetics (Boomsma, Willemsen, Dolan, Hawkley, & Cacioppo, 2005; Goossens, 2012; McGuire & Clifford, 2000), to physiological and biochemical processes (Cacioppo, et al., 2000; Eisenberger & Lieberman, 2004; Hawkley & Cacioppo, 2010; Nausheen, Gidron, Gregg, Tissarchondou, & Peveler, 2009). Nonetheless, there are few data on the environmental cues to which those internal factors respond, other than objective social isolation which does not fully account for loneliness variance (de Jong Gierveld, van Tilburg, & Dykstra, 2016; Holt-Lunstad, Smith, Harris, & Stephenson, 2015). Under an evolutionary perspective, the link between loneliness and environment is crucial, and for that reason this investigation opens up a potentially fertile line of research.

The main contribution of the research reported here is to identify a specific element of social interaction (received empathy) that affects loneliness feelings. The hypothesised relationship between lack of received empathy and increased loneliness feelings was confirmed. However, the empathy from or relationship quality with sympathy group (social network second layer) does not

affect loneliness feelings if empathy received from support clique (inner-most layer) is controlled. This means that it is the core of a person's social network what makes the difference and it is not replaceable. This finding is in accord with other research on the effects of social support on loneliness feelings associated with the loss of a partner (Stroebe, Stroebe, Abakoumkin, & Schut, 1996), where the distress of losing an attachment figure cannot be compensated by social support from other relationships. It is also in accord with the previously identified protective effects against loneliness that the four closest relationships have which are larger than those of other social ties (Van Tilburg, 1990).

The relationship between attachment and loneliness was found to be stronger than initially anticipated. While other studies have also found attachment to significantly predict loneliness (DiTommaso, Brannen-McNulty, Ross, & Burgess, 2003; Riggio, Throckmorton, & DePaola, 1990; de Jong Gierveld, van Tilburg, & Dykstra, 2016) it is not yet clear which mechanisms underpin this relationship. Cacioppo and Hawkley have hypothesized that the increased activation of the sympathetic nervous system and of the sympathetic adrenomedullary (SAM) and hypothalamic pituitary adrenocortical (HPA) neuroendocrine systems could be the mechanisms by which insecure infant attachment and anxious or ambivalent attachment during adulthood relate to increased loneliness feelings (Cacioppo & Hawkley, 2003). However there are yet no clear results or theories to explain this relationship. Under an evolutionary theoretical framework it could be possible that attachment security increases tolerance to lack of empathy because secure people are less emotionally dependent on others. This is a potentially fertile line of research for future studies.

The observed differences in the effects that first and second layer of the social network have on loneliness highlight the importance of taking into account the structure of a person's social network and the importance of controlling for closeness in a relationship to observe the effects of other variables, particularly when dealing with attachment style. Different personal preferences or external constraints (such as time, distance, etc.) on network structuring need to be further studied to disentangle their contribution to empathy perception and loneliness.

Also, as Vanhalst and colleagues (2014) point out, considering the interplay of external factors with internal characteristics on loneliness is of importance. This study contributes to that endeavour which proved to be fruitful. Comprehensive models integrating internal and external factors will help gain insight into complex social phenomena such as loneliness.

Results of both studies reported here evidenced that loneliness frequency and loneliness intensity behave in very different ways, although the two dimensions were correlated (r= 0.6319, p=.000). Yet, the most common measures of loneliness, such as the UCLA loneliness scale (Russell, 1996), and the IMSOL scale (Montero López Lena, 1999) used in this research are frequency-based. This could indicate the importance of analysing loneliness as a two-dimensional phenomenon in order to gain a more comprehensive understanding of and to improve strategies to tackle loneliness.

5.1 Limitations and conclusions

This research has limitations. Firstly, Study 1 did not provide enough evidence to distinguish the effects of experimentally manipulated empathy on loneliness given that loneliness scores only showed differences by gender in the control *versus* treatment comparison, although physiological correlates (*i.e.* HR) did followed the proposed hypothesis. However, regression analysis in Study 1 evidenced that empathy from the core of the social network is key. Following on this finding, future studies could provide evidence on whether manipulating empathy from the first layer of a person's network can in fact reduce a person's loneliness feelings, and if so, this could prove to be a very important element to consider in the design of strategies to tackle loneliness.

Also, in this research's samples, mentalising competence had no effect on loneliness or received empathy, which was surprising considering that perceiving empathy in other people's actions would logically require engaging a person's ability to "read" other minds. For instance, knowing that an interlocutor understands someone's feelings was hypothesized to be mediated by that person's ability to "read" the interlocutor's mental state. However, data did not support this

hypothesis, which could be explained by either two possibilities. It could be the case that there is a different process involved, such as “reading” emotion, which could be measured by instruments like the Reading the Mind in the Eyes Test (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). However, DiTommaso and colleagues (2003) found no correlation between emotional sensitivity (the ability to decode others' emotions, beliefs, or attitudes, and cues of status-dominance) and loneliness. Alternatively, processing empathy perception could be a very general and fundamental skill that shows not enough variance in a “normal” population. A general population sample could be compared to a non-normal population sample (such as people with different levels of autism spectrum disorder) to possibly identify the effects of “mind reading” skills on the relationship between loneliness feelings and received empathy.

On the other hand, an up-to-date received empathy instrument is necessary. This research’s findings are limited by the characteristics of the available psychometric tools. In particular with regard to the employed empathy scale, the definition of empathy upon which it was originally developed distinguishes different empathy dimensions than other more recent scales (*e.g.* Powell & Roberts, 2017), although key dimensions such as cognitive empathy and empathic compassion are included. As a result, the principal weakness of this study is the lack of a purposely designed received or perceived empathy instrument. It can be argued that results would be more complete if a theoretically updated scale was employed. It can also be argued that there is uncertainty about the effect that reversing the questions of the original empathy questionnaire has on the instrument’s reliability. However, both confirmatory factor analysis and reliability coefficients proved to be within acceptable ranges, thus allowing us to consider that the scale performs as intended. Nonetheless, this possible objection points to the need to investigate empathy perception, which has been largely overlooked in psychology research in favour of social support. Sympathy, empathy and social support are different phenomena (Eisenberg, 1988; Gruen & Mendelsohn, 1986) that are very likely distinguishable to the person they are targeting. The analysis of the potentially different effect each of them has should not be dismissed. Secondly, purposely developed instruments and reliable

indicators are not readily available as a consequence of the lack of research conducted on empathy perception (and related phenomena). This is an exciting opportunity to produce interesting discoveries that contribute to understanding the highly complex and nuanced human social interaction, specifically loneliness which is an increasingly relevant issue in modern industrialized societies.

Despite these limitations, the present research was the first to investigate empathy from the perspective of the receiver with regards to perceived social isolation or loneliness. Our results suggest that lack of received empathy is a trigger for loneliness and open new questions for further analysis. It is likely that, in order to avoid or mitigate loneliness, people require empathy from different types of relationships in different stages of life. From a social and an evolutionary perspective, young children probably require empathy from parents more than they do from peers, teenagers might require more empathy from peers than from kin, and adults could require more empathy from a partner than from other family members. Also, empathy requirements and sources are likely to be determined by the same cultural norms and expectations that regulate close social relationships and that define which actions are appropriate ways to transmit meaning, emotion, and intention, highlighting the need for cross-cultural research on this topic.

As new research on empathy from the receiver's point of view develops, the effects of received empathy could prove to be of importance for emotional wellbeing beyond loneliness with potential physiological benefits as well, perhaps related to social anxiety, stress, or depression. It should therefore not be overlooked in future studies on empathy or on social pain.

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Conflict of interest

The authors have no conflicts of interest to declare.

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