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Short title: Destination & emotion

High destination memory for emotionally-incongruent information

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This paper investigates the effect of emotion on destination memory. To this aim, participants were asked to tell neutral, positive, and negative information to neutral, positive, and negative faces. Afterward, participants were asked to remember to whom each piece of information was previously told. Results demonstrated high destination memory when the positive face was associated with negative information than with positive information. Results also demonstrated high destination memory when the negative face was associated with positive information than with negative information. These findings are attributed to the emotional incongruence between information and its destination. When telling positive or negative information, one may expect that the listener would experience the same emotional state. Violation of this expectancy seems to result in a high retention of the context in which the violation has occurred, and consequently, in a high destination memory.

Keywords: destination memory; emotion; emotional-congruence

There is a growing interest in destination memory, i.e., the study of the ability to remember the destination of previously relayed information (Earhart et al., 2021; El Haj et al., 2021; El Haj et al., 2020; El Haj & Ndobu, 2021; Lindner et al., 2015; Mugikura et al., 2016). The concept of destination memory can be related to the pioneer works by Koriat et al. (Koriat et al., 1991; Koriat et al., 1988), who have coined the term “output monitoring” to describe how individuals should keep track of their own responses when telling information to others. In a similar vein, Marsh and Hicks (2002) have considered the term “target memory” to account for the ability to remember to whom information was previously delivered. In addition, Brown et al. have proposed the term “target monitoring” to define the ability to monitor to whom one tells information to (Brown et al., 2006). In the present paper, we unify these different terminologies under the general heading of destination memory, as the previous terms have been used interchangeably to refer to the ability to remember the destination of previously relayed information.

Destination memory can be evaluated using procedures developed by Gopie et al. (Gopie et al., 2010; Gopie & Macleod, 2009). The authors have asked participants to tell facts to pictures of famous people, and in subsequent recognition tests, the participants had to decide whether they had previously told that fact to that face. Using similar procedures, other studies have revealed how destination memory can be influenced by affective and emotional factors. For instance, one study has demonstrated better memory for familiar than for unfamiliar destinations (El Haj, Omigie, et al., 2015). Similarly, another study has demonstrated better destination memory for attractive than for unattractive destinations (El Haj & Ndobu, 2020). Other studies have also demonstrated high destination memory in individuals with high ability to infer and predict the cognitive states, thoughts, or intentions of others (El Haj, Gely-Nargeot, et al., 2015; El Haj et al., 2016), as well as high destination memory in individuals with high ability to induce false beliefs

in others (El Haj et al., 2017; El Haj et al., 2018). This research has led to the Destination Memory Framework, according to which destination memory is intimately influenced by social processing, such as the familiarity of interlocutors, the stereotypes that are associated with them, and their perceived emotional states (El Haj & Miller, 2018).

The influence of emotion on destination memory was investigated in a study in which younger and older participants were asked to tell neutral facts to three types of faces: a neutral one, an emotionally positive one, and an emotionally negative one (El Haj, Fasotti, et al., 2015). On a later recognition test, participants had to associate each previously told fact with the face to whom it was told. Older participants demonstrated higher memory for facts told to negative destinations than to positive destinations, and the latter memory was better than for neutral destinations. However, no significant differences were observed for the younger participants. Using the same procedures, another study observed no emotional effect on destination memory in participants with Alzheimer's disease. These findings were attributed to the important impairment of destination recall in the disease (El Haj, Raffard, et al., 2015).

The relationship between emotion and destination memory, as investigated by previous research, has been solely assessed by asking participants to relay neutral information to neutral and emotional destinations. However, the relationship between emotion and destination memory can be better understood by asking participants to relay neutral and emotional information to neutral and emotional destinations. Such an assessment may be more sensitive to potential emotional effects because emotional valence will not only concern the destination-as this was the case in previous studies-but also the content of the message. Another interest of controlling the emotional valence of both information and its destination is the assessment of potential differences on destination recall according to emotional incongruence between information and its destination.

In other words, it is probable that destination recall may be higher for emotionally-incongruent than for emotionally-congruent information (i.e., higher memory for positive destination if associated with negative than with positive destination, and higher memory for negative destination if associated with positive than with negative destination).

Because the present paper expects for better destination memory for emotionally incongruent information than for emotionally congruent information, we have referred to studies with similar outcomes on source memory. In an experiment by Suzuki and Suga (2010), participants were required to borrow money from faces that looked trustworthy or untrustworthy. Participants were also trained to discriminate among good, neutral, and bad lenders, before trying to remember the lenders' faces on a later source memory test. Results showed better source memory for bad lenders when the lenders looked trustworthy than when they looked untrustworthy. In a similar vein, Bell et al. (2012) observed higher source memory for smiling cheater faces than for smiling cooperator faces. Overall, these studies have demonstrated better source memory for emotionally incongruent information than for emotionally-congruent information. Our study investigated emotional congruence and incongruence for destination memory.

Assessing destination memory for emotionally-incongruent information is of interest because in everyday life we constantly relay emotional information to friends, colleagues, family members, or even to strangers. Consider the example of a physician who may have to discuss a diagnosis with relatives of a patient. The physician may show high destination memory if the relatives demonstrate an incongruent emotional reaction. Such a memory bias may occur because the emotional reaction violates expectancies, leading to a strong emotional or attentional reaction in the physician. Consistent with this view, studies have demonstrated that negative and positive

events that violate expectancies are accompanied by strong emotional reactions (Bettencourt et al., 1997) and elicit more attention (Rothermund, 2011; Rothermund et al., 2008). In order to test the differences between destination memory for emotionally-congruent and emotionally-incongruent information, we asked participants to tell neutral, positive, and negative information to neutral, positive, and negative destinations, before asking them to decide/pinpoint, on a later recognition test, to whom information was previously told. We expected better destination memory for emotionally incongruent information than for emotionally congruent information.

Method

Participants

Forty-one graduate/undergraduate students at the University of Nantes participated in the study. They were native French speakers. Exclusion criteria were a history of psychiatric, neurological or learning disorders. Informed consent was also obtained in accordance with the principles laid down by the Helsinki Declaration. Their demographic and cognitive characteristics are summarized in Table 1. We defined sample size as the maximum number of participants willing to participate during January and February 2020 (we had to stop recruitment due to the COVID-related-crisis). The sample size was also based on that used by previous research on destination memory.

Cognitive assessment.

We assessed cognitive function to ensure that participants were free of cognitive decline. To assess working memory, participants repeated a string of numbers in the same order (i.e., forward spans) or in reverse order (i.e., backward spans). Episodic memory was assessed using the Grober and Buschke (1987) in which participants had to retain 16 words, each describing an item

belonging to a different semantic category; after a 20-sec distraction phase, they had to recall as many words as they could, the maximum score being 16 points. On the Stroop task, participants 1) read words printed in black ink, all words naming colors, 2) named the color of the ink, and 3) named the color of the color-word printed in incongruously colored ink. The inhibition score was the: completion time for the interference condition – average completion time for word reading and color naming conditions. The Plus-Minus task included three lists, each containing 20 numbers (the numbers ranged from 10–99 and were randomly chosen). On the first list, participants added one to each number, and on the second list, they subtracted one from each number. On the third list, they added and subtracted one alternately. The shifting score was the difference between the time for list three and the average of the times for lists one and two.

INSERT TABLE 1 HERE

Destination memory;

Material.

To assess destination memory, we used three colored face pictures and 72 facts. The pictures, each representing a face, were taken from the FACES database (Ebner et al., 2010) and represented three different young Caucasian men (age = 21 years). Thanks to the FACES database, the three faces were matched for overall luminosity and size, and were equally aligned on a gray background template. The emotional valence of the faces varied, one face was neutral, the other was happy and the third was angry. As for the 72 facts, they were accurate and gathered from encyclopedia, 24 were neutral (e.g., it takes about eight minutes to boil an egg), 24 were positive (e.g., employment is expected to increase significantly), and 24 were negative (e.g., the number of traffic victims is high). The emotional valence of the information was rated on a five-point scale

(-2 = negative, 0 = neutral, +2 = positive) by a separate sample of ten young adults (three women and seven men). These participants reported the neutral information as neutral ($M = .11$, $SD = .60$), the positive information as positive ($M = 1.78$, $SD = .39$), and the negative information as negative ($M = -1.69$, $SD = .49$).

A laptop computer with a 15-inch LCD display was used for testing. The software package Psychopy (Peirce, 2007) controlled stimuli presentation and response recording.

Procedures.

All participants were individually tested in a study phase and a test phase. The study phase consisted of 72 trials. Each began with a 1,000-ms white fixation cross in the center of a grey background followed by a fact presented in white Times New Roman 40-point font. After a five-sec time interval, during which participants read the fact silently, a 250-ms white fixation cross appeared, followed by a one face (12 x 12 cm). Participants had to tell the face the fact with no time limit. Afterward, they pressed the space bar again, eliciting another white fixation cross for one sec. This procedure was repeated until they had told each of the 72 facts to the corresponding face. All participants told eight neutral, eight positive, and eight negative facts to the neutral face; eight neutral, eight positive, and eight negative information to the positive face; and eight neutral, eight positive, and eight negative information to the negative face (total = 72 information). The correspondence between faces and information was predetermined, however, the order of the 72 (information-face) pairs was randomized. To ensure encoding, participants were informed about the purpose of the study, and that their memory for the association between facts and faces would be tested in a later session. However, in order not to influence their emotional performance, no mention about emotional valence was made.

The study phase was followed by a filled delay phase. In this phase, implemented to prevent reliance on immediate memory, participants were required to read aloud strings of three-digit numbers for one minute.

Immediately after the filled delay phase, participants proceeded to the recognition test. In this test, they were presented the 72 pairs of information-face previously seen, however, half of the original pairs were reorganized into new pairs. Pairs were presented one at a time. For each pair, participants had to decide, in a forced-choice fashion, whether they had previously told the information to the face. Information-face pairs correspondence was identical for all participants, however, the order of the 72 pairs was randomized.

As recommended for analyzing recognition memory (Snodgrass & Corwin, 1988), performance on the destination memory task referred to the proportion of hits minus the proportion of false alarms (incorrect “yes” responses). Hits were calculated as the average of correct “yes” responses for congruent and incongruent matched-pairs. False alarms were calculated as the average of incorrect “yes” responses for congruent and incongruent new-pairs (e.g., for positive-happy information-face pairs, false-alarms referred to the proportion of all new information-face pairs that were falsely classified as old). Regardless of the emotional modality, a score of 1 means that the participant correctly recognized all the pairs, without any false alarms.

Results

Table 2 depicts performances on memory for the three destinations (i.e., neutral, positive, and negative destination) vs. the three emotional modalities of information (i.e., neutral, positive, and negative destination). Because non-normal distribution for destination performances was observed with the Shapiro-Wilk test, differences were compared using non-parametric tests. Level

of significance was set as $p \leq 0.05$, p values between 0.051 and 0.10 were considered as trends, if any. Effect size was calculated using Cohen's d criterion (Cohen, 1992) (0.20 = small, 0.50 = medium, 0.80 = large).

High memory for positive and negative information.

We first compared differences between mean memory for information associated with the neutral destination (i.e., mean memory for neutral, positive, and negative information that were associated with the neutral destination), mean memory for information associated with the positive destination, and mean memory for information associated with the negative destination. The Friedman test showed no significant differences between the three means, respectively, $M = .64$ ($SD = .16$), $M = .69$ ($SD = .12$), and $M = .64$ ($SD = .19$), $\chi^2(2) = .66$, $p = .72$. We then compared differences between mean destination memory associated with neutral information (i.e., mean memory for the neutral, positive, and negative destination that were associated with neutral information), mean destination memory associated with positive information, and mean destination memory associated with negative information. The Friedman test showed significant differences between the three means, respectively, $M = .60$ ($SD = .14$), $M = .70$ ($SD = .14$), and $M = .68$ ($SD = .13$), $\chi^2(2) = 7.03$, $p = .029$. Wilcoxon tests showed no significant differences between mean destination memory for positive information and mean destination memory for negative information ($Z = -.77$, $p = .44$), however, mean destination memory for positive information was higher than that for neutral information ($Z = -2.73$, $p = .006$, Cohen's $d = .59$), and mean destination memory for negative information was higher than that for neutral information ($Z = -2.98$, $p = .003$, Cohen's $d = .71$).

High destination memory for emotionally-incongruent information.

The Friedman test showed no significant differences between memory for the neutral destination regardless of whether information was neutral, positive, or negative, $\chi^2(2) = .72, p = .41$. However, a significant difference was observed when comparing memory for the positive destination when associated with neutral, positive, or negative information, $\chi^2(2) = 7.03, p = .041$. The Wilcoxon tests showed higher memory for the positive destination when associated with negative than with positive information ($Z = -2.73, p = .006$, Cohen's $d = .65$), when associated with negative than with neutral information ($Z = -2.98, p = .003$, Cohen's $d = .80$), but no significant differences between neutral and positive information ($Z = -.77, p = .44$). The Friedman test showed significant difference when comparing memory for the negative destination when associated with neutral, positive, or negative information, $\chi^2(2) = 22.33, p = .002$. The Wilcoxon tests showed higher memory for the negative destination when associated with positive than with negative information ($Z = -2.39, p = .02$, Cohen's $d = .65$), when associated with positive than with neutral information ($Z = -3.94, p < .001$, Cohen's $d = .83$), but no significant differences between neutral and negative information ($Z = -.94, p = .35$).

Complementary analysis.

For convenience, we briefly report analysis regarding hits and false alarms. Regarding hits, analyses showed no significant differences between mean hits for positive information and mean hits for negative information ($Z = -.71, p = .48$), however, mean hits for positive information was higher than that for neutral information ($Z = -2.67, p = .007$), and mean hits for negative information was higher than that for neutral information ($Z = -2.98, p = .003$). Analysis also demonstrated higher hits for the positive destination when associated with negative than with

positive information ($Z = -2.66, p = .008$), when associated with negative than with neutral information ($Z = -3.21, p = .001$), but no significant differences between neutral and positive information ($Z = -.24, p = .81$). Analysis also showed higher hits for the negative destination when associated with positive than with negative information ($Z = -2.03, p = .042$), when associated with positive than with neutral information ($Z = -3.72, p < .001$), but no significant differences between neutral and negative information ($Z = -.35, p = .73$).

Regarding false alarms, analyses showed no significant differences between mean false alarms for positive information and mean false alarms for negative information ($Z = -.66, p = .51$), however, mean false alarms for neutral information was higher than that for positive information ($Z = -3.01, p = .003$), and mean false alarms for neutral information was higher than that for negative information ($Z = -3.11, p = .002$). Analysis also demonstrated higher false alarms for the positive destination when associated with positive than with negative information ($Z = -2.22, p = .026$), when associated with neutral than with negative information ($Z = -2.98, p = .003$), but no significant differences between neutral and positive information ($Z = -.24, p = .81$). Analysis also showed higher false alarms for the negative destination when associated with negative than with positive information ($Z = -2.29, p = .022$), when associated with neutral than with positive information ($Z = -3.06, p = .002$), but no significant differences between neutral and negative information ($Z = -.29, p = .78$).

For convenience, we also report the Friedman test for 1) the differences between memory for neutral information associated with neutral, positive, or negative destination, $\chi^2(2) = .65, p = .72$, 2) the differences between memory for positive information associated with neutral, positive, and negative destination, $\chi^2(2) = 3.71, p = .16$, and 3) the differences between memory for negative information associated with neutral, positive, or negative destination, $\chi^2(2) = 11.02, p = .004$. The

Wilcoxon tests showed higher memory for negative information when associated with the positive than with the neutral destination ($Z = -2.96, p = .003$, Cohen's $d = .77$), with the positive than with the negative destination ($Z = -2.92, p = .003$, Cohen's $d = .87$), but no significant differences between the neutral and negative destinations ($Z = -.33, p = .74$).

INSERT TABLE 2 HERE

Discussion

This paper assessed the effect of neutral, positive, and negative information on neutral, positive, and negative destinations. Our results revealed higher memory for positive destination when associated with negative than with positive information. Our results also revealed higher memory for negative destination when associated with positive than with negative information.

Previous research has shown no significant differences between neutral, positive, and negative destination memory in younger adults (El Haj, Fasotti, et al., 2015). However, this research has assessed destination memory solely with regard to neutral destination. By controlling the emotional valence of both the information and destination, the present paper has replicated the previous research by demonstrating no significant differences between neutral, positive, and negative destination memory for neutral information. However, our paper revealed an effect of emotional information on destination memory. The latter effect referred to a high memory for positive destination when associated with negative than with positive information, as well as a high memory for negative destination when associated with positive than with negative information. These findings can be attributed to the emotional incongruence between information and its destination. When outputting positive or negative information, one may expect that the listener would experience the same emotional state, an expectation that can be linked to the basic

empathy by which we expect that others will recognize and understand the emotional value of the outputted message (Davis, 1994). This expectation can also be linked to the “emotional contagion”, that is, the tendency to convert emotionally to each other, especially by mimicking and synchronizing with the facial, postural and instrumental expressions of the other party (Hatfield et al., 1994). Hence, any violation of our basic expectancy about the emotional state of interlocutors may result in a high retention of the context in which this violation has occurred. In other words, it is likely that our participants showed high memory for the positive destination when the associated information was negative, and high memory for negative destination when the associated information was positive because this emotional-incongruence has violated the usual expectation on emotional-congruence, as the latter may be expected in everyday life. It is also noteworthy that previous studies have demonstrated that negative and positive events that violate expectancies are accompanied by strong emotional reactions (Bettencourt et al., 1997) and elicit more attention (Rothermund, 2011; Rothermund et al., 2008). Together, emotional incongruence between information and its destination is likely to violate basic expectancies about similarity between emotional valence of the relayed information and emotional state of the receiver, a violation that results in high memory for this emotional incongruence.

When comparing mean neutral destination memory (i.e., mean memory for neutral, positive, and negative information associated with the neutral destination), mean positive destination memory, and mean negative destination memory, our analysis showed no significant differences between these three means. However, when comparing mean destination memory for positive information (i.e., mean memory for the neutral, positive, and negative destination as associated with positive information), mean destination memory for neutral information, and mean destination memory for negative information, significant differences were observed between these

means. Furthermore, mean destination memory for positive information and mean destination memory for negative information were higher than mean destination memory for neutral information. It is likely that positive and negative information may trigger more attentional resources than neutral information may do, which may explain why better mean destination memory was observed for emotional than for neutral information. These findings are of interest as they highlight the impact of the emotional valence of outputted information on destination memory, when telling emotional information, a particular focus is likely to be given to the emotional content of the relayed message.

Regardless of their social facet, our findings can be incorporated into a body of research assessing the effect of emotion on context memory. The research on the effects of emotion on memory for contextual information shows mixed results (Chiu et al., 2013). Studies have found enhanced memory for context memory, for instance, better memory for color information associated with emotional words or scenes (D'Argembeau & Van der Linden, 2005; Doerksen & Shimamura, 2001; MacKay & Ahmetzanov, 2005), better temporal order of emotional items within a list (Schmidt et al., 2011), and better location memory of negative arousing scenes (Mather & Nesmith, 2008). By contrast, other studies have found impaired memory for contextual information, for instance, low memory for scene contexts that form the background for centrally presented emotional items (Kensinger et al., 2007), low memory for relations of objects superimposed on emotional scenes (Rimmele et al., 2011; Touryan et al., 2007), and low memory for relational bindings between item pairs (Mather & Knight, 2008; Nashiro & Mather, 2010; Pierce & Kensinger, 2011). Finally, other studies have not found any difference in context memory for emotional vs. neutral information (Mather et al., 2009; Sharot & Phelps, 2004). According to Chiu et al. (2013), these controversial outcomes can be attributed to the fact that studies on the

effect of emotion on context memory critically involve different types of relational content and, consequently, differences in the memory systems tested.

The present paper has investigated relationship between emotion and destination memory by assessing the effect of neutral and emotional information on neutral and destination memories. However, the relationship between emotion and destination memory can be widened to include the emotional states of the transmitter. There is a wealth of clinical and experimental research showing that information is often processed in a mood-congruent manner, for instance, depression and anxiety have been associated with high memory for negative words (Bradley et al., 1995), while people in a positive mood are more likely to recall positive memories (Bower, 1981; Mayer et al., 1995). Interestingly, this mood congruency effect has been also observed for emotion perception in faces, for instance, a study has demonstrated that low positive affect (i.e., anhedonia) decreased the identification of happy expressions, while negative affect increased the identification of disgust (Coupland et al., 2004) ((see also (Voelkle et al., 2014)). Hence, it would be of interest to investigate whether subjects with low positive affect (i.e., anhedonia or even depression) would demonstrate a memory bias for negative destinations.

Overall, destination memory is a cognitive ability that is primarily oriented toward our environment. Converging with this view, destination memory has been found to be influenced by familiarity, by the ability to infer and predict intentions of others, and by the ability to induce false beliefs in others. By demonstrating how destination memory can be influenced by emotion, the present paper contributes to a growing and important area of research on destination memory, which may reveal a more prominent role for affective factors on memory.

Conflict of interest statement

The authors declare no conflict of interest

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Table 1

Demographic and cognitive characteristics of participants

Females/males	16/25
Age in years	22.85 (5.27)
Years of education	14.73 (5.54)
Working memory forward span	7.51 (1.36)
backward span	5.17 (1.16)
Episodic memory	11.14 (2.63)
Stroop	13.73 (5.23)
Plus-Minus	4.38 (1.79)

Note. Standard deviations are given between brackets; performances on the forward and backward spans refer to number of correctly repeated digits; the maximum score on the episodic memory task was 16 points; performances on the Stroop and Plus-minus tasks refer to reaction time in seconds.

Table 2

Means and (standard deviations) for destination memory performances

	Neutral destination	Positive destination	Negative destination
Neutral information	.62 (.26)	.61 (.26)	.56 (.25)
Positive information	.67 (.25)	.66 (.22)	.76 (.23)
Negative information	.63 (.23)	.80 (.21)	.61 (.23)

Note. Performance was calculated as proportion of hits minus proportion of false alarms