

Loss Aversion: A Narrative Review

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ABSTRACT

Loss aversion effects in the current literature include greater attention, longer evaluation time, heightened sensitivity to negative information, social conformity, smart phone addiction, short video addiction, further investment despite losses, and cigarette smoking. Risk factors for loss aversion include less sensitivity to loss, acute stress, cancer fear, material hardship, gambling disorder, and suicidality. Potential underlying biological mechanisms for loss aversion include prefrontal cortex involvement, amygdala connectivity with the prefrontal region, frontal medial connectivity, and insular cortex-temporoparietal connectivity. Methodological limitations of this literature include unequal sample sizes, the focus on single versus multiple effects and single versus multiple risk factors and cross-sectional versus longitudinal research design. Future research directions include comparing loss aversion with loss sensitivity, comparing different personality types that might be associated with loss aversion and gains such as pessimism and optimism respectively, and conducting multivariate studies that include several behaviors as well as physiological functions associated with loss aversion.

Keywords

Loss aversion, Decision-making, Behavioral biases, Risk-taking, Addiction, Stress, Neurobiology, Prefrontal cortex.

Loss aversion has been defined as a “tendency to value potential losses more than gains in situations that require decision – making” [1]. It has also been defined as a “stronger aversion to losses than an attraction toward equivalent gains” [2]. The latter research group has also shown greater sensitivity of the P3 wave (or P300) in reward-related brain regions or faster reaction (approximately 300 milliseconds) after thinking about losses versus gains. A specific example they gave is a greater P3 wave preceding acceptance versus rejection of gambling. Another example is the loss aversion noted for short video addiction [1]. Still another example is loss aversion in individuals who are currently smoking (N= 984) versus former smokers (N= 317) versus no smoking (N= 306) [2].

Effects of Loss Aversion

Several effects have been noted for loss aversion (see Table 1). They include greater attention, a longer evaluation process, heightened sensitivity to negative information, social conformity, smart phone addiction, short video addiction, further investment despite losses, and cigarette smoking.

Table 1: Effects of loss aversion (and first authors).

Effects	First Authors
Greater attention	Kim
Longer evaluation process	Nie
Increased sensitivity to negative information	Arioli
Social conformity	Li
Own payoff versus payoff of others	Arioli
Smartphone addiction	Wang
Short video addiction	Liu
Further investing despite losses	Khan
Cigarette smoking	Thrailkill

In a study entitled "Loss aversion in the control of attention", a visual search task was given with one color indicated for gain and another color indicated for loss [3]. In this visual search task, the participants **paid more attention** to the loss color and selected the loss color more frequently than the gain color.

In a study that assessed the neural dynamics of loss aversion, magnetoencephalography was used to track brain activity during the evaluation of loss and gain [4]. The **evaluation process of loss was longer** for participants with greater loss aversion. The authors suggested that the origin of loss aversion may lie in the neural

dynamics of loss processing.

In a comparison between loss aversion and loneliness, both were said to reflect **heightened sensitivity to negative information** [5]. Less emotion regulation and cognitive control were noted for loss aversion as well as less amygdala – prefrontal cortex connectivity. It’s not clear why these authors compared loss aversion and loneliness unless those with loss aversion were fearful of loneliness.

Connectivity between different brain regions has also been reported for loss aversion by a research group studying **social conformity** [6]. In this sample, loss aversion was accompanied by increased functional connectivity between the anterior insular cortex and the temporoparietal junction. Again, the pairing of two seemingly disparate experiences, loss aversion and social conformity, seems like an arbitrary selection of variables.

Still another brain region has been implicated for loss aversion. In this study, two groups who had or had not interacted with other players were compared for their loss aversion when choosing for themselves versus choosing for unknown or known others [7]. Greater loss aversion was reported for **one's own payoff versus the payoff of others**. This was noted to involve the dorsal medial prefrontal cortex and its inhibitory connectivity with the middle cingulate cortex. Being more concerned about one’s own payoff versus that of others was not surprising given the greater consequences for one’s own versus another’s loss. The connectivity effect is more difficult to interpret.

Several addictive behaviors have been associated with loss aversion. These include smart phone addiction, short video addiction, further investing despite previous losses and cigarette smoking.

Loss aversion has been negatively correlated with **smartphone addiction** [8]. Complex underlying neural mechanisms were noted for this association. **Short video addiction** has also been related to loss aversion in a study already described [1]. The individuals who were smartphone addicted were likely similar to those who were short video addicted.

Further investing in the stock market after losses has also been called loss aversion. In a paper entitled "Prior perceived losses and investment objectives after a stock market crisis", risk-tolerant investors continued to invest to earn a higher expected return even though they had experienced prior losses and loss aversion [9]. These risk-tolerant investors could be described as being investment addicted.

Cigarette smoking has been associated with less loss aversion. In one study, the title "Loss aversion predicts cigarette smoking" is misleading as it was less loss aversion that predicted cigarette smoking [10]. In another paper by the same authors the title "Loss aversion and risk for cigarette smoking and other substance use" was also misleading for the same reason that less loss aversion was

associated with smoking and substance abuse [11]. In this sample (N=181 smokers versus 237 non-smokers), less loss aversion was associated with the risk for cigarette smoking. As in several of these studies, this research has the methodological problem of unequal sample sizes limiting the statistical power to the smaller sample which has more variability.

Risk Factors for Loss Aversion

Several risk factors for loss aversion have appeared in this current literature (see Table 2). They include less sensitivity to loss, acute stress, cancer fear, material hardship, gambling disorder, and suicidality.

Table 2: Risk factors for loss aversion (and first authors).

Risk factors	First Authors
Less sensitivity to loss	Stigemune
Acute stress	Molins
Cancer fear	Lam
Material hardship	He
Faster diminishing loss sensitivity	Wei
Histories of mood disorders and suicide	Zerekidze

Less sensitivity to loss of options or less loss aversion has been reported for patients with Parkinson's (N= 27 patients) versus healthy controls (N=27) [12]. The authors suggested that the lesser sensitivity to the loss of options was due to decreased dopaminergic neurotransmission. This was not surprising given that dopamine is an activating neurotransmitter.

Although stress sensitivity is typically associated with loss aversion, the late phase of **acute stress** has been associated with less loss aversion [13]. These results were based on the participants (N=92) being given the Trier Social Stress Test. Loss aversion would be expected to decrease as acute stress decreased.

Loss aversion has also accompanied **cancer fear** prior to cancer screening (N= 379, 35–70-years -old) [14]. In this sample, cancer fear led to cancer screening which led to loss aversion and information avoidance. The association between cancer fear /screening and loss aversion and information avoidance was not surprising given the severity of a cancer diagnosis and the desire to ignore it.

Material hardship is also a risk for loss aversion. In a paper entitled "Material hardship predicts response bias and loss-adverse decisions", both response bias, also called risk avoidance, and evaluation bias, also labeled loss aversion, were prevalent [15].

Material hardship, indicating limited financial resources, would, not surprisingly, complicate loss-adverse decision-making.

Loss aversion has also been associated with **faster – diminishing loss sensitivity** in individuals with gambling disorder who are trying to make decisions (N= 100 with gambling disorder and 59 healthy controls) [16]. In this sample, those with gambling disorder had greater loss aversion, but also faster – diminishing

loss sensitivity which likely enabled their gambling. The authors suggested that diminishing loss sensitivity explained the deficits in risky decision-making. However, the diminished loss sensitivity was confounded by loss aversion.

In a paper entitled “Risk, reward, and suicide: how impulsivity and loss aversion influenced decision – making in individuals who attempted suicide”, depressed individuals with histories of mood disorders and suicide attempts were compared (N= 49) with patients who did not have those histories (N= 34) [17]. These participants engaged in the Iowa Gambling Task and the Go/No go Task. The participants with **histories of mood disorders and suicide** attempts, not surprisingly, showed less loss aversion and inferior performance on the gambling and go/no go tasks. In this sample, the multiple problems were confounding risk factors for inferior performance. In addition, the sample sizes were unequal raising the problem of loss of statistical power.

Potential Underlying Biological Mechanisms

Several potential underlying biological mechanisms for loss aversion have been recently reported (see Table 3). They include prefrontal cortex involvement, amygdala connectivity with the prefrontal region, frontal-medial connectivity, and insular cortex-temporoparietal connectivity.

Table 3: Potential underlying biological mechanisms (and first authors).

Mechanisms	First Authors
Dorsolateral prefrontal cortex	Hi
Amygdala connectivity	Arioli
Anterior insular cortex and temperoparietal junction	Li
Posterior fronto-medial region	Gianelli

Loss aversion has also been described as greater sensitivity to ambiguity loss than gain. Ambiguity loss has had a significant effect on the **dorsolateral prefrontal cortex**.

As already mentioned, the **amygdala has connectivity with the prefrontal cortex, the insular cortex and the temporoparietal junction** [5]. And as already described, **functional connectivity between the anterior insular cortex and the temperoparietal junction** has been associated with loss aversion [6]. Further, decreased loss aversion has been associated with atrophy in the **posterior fronto – medial region** in individuals with alcohol use disorder (N=22 with alcohol use disorder versus 19 healthy controls) [18]. Directionality of the loss aversion, alcohol use and atrophy in the posterior fronto-medial region cannot be determined from these cross-sectional data.

Methodological Limitations of this Literature

Several methodological limitations of this literature have been noted. These include the various definitions of loss aversion, the unequal sample sizes, the focus on single versus multiple effects and single versus multiple risk factors, the different brain regions affected and the cross-sectional versus the longitudinal design of most of the studies.

Loss aversion has been associated with risk aversion, as they have similar effects, although the similarity of these aversions has not been addressed in this literature. Loss aversion has been apparently defined/coined by the researchers who studied loss aversion. It is not clear why decision-making is required for loss aversion. Loss aversion could also be viewed as fearful thinking rather than requiring decision-making for its occurrence.

Low loss aversion rather than loss aversion per se is the independent variable in most of the studies (11 effects and 6 risks studies), suggesting that the titles of most of the studies called loss aversion are misleading. Loss aversion in most of the studies has been confounded by “faster diminishing loss sensitivity” which have not been compared for their risks or effects.

Other methodological limitations are the unequal sizes of the loss aversion and healthy control samples given that unequal sample sizes contribute to the loss of statistical power because power is derived from the small sample size and greater data variability occurs in smaller samples. Further, the samples have typically had clinical problems including smoking, alcohol use or substance disorder and Parkinson’s disease, suggesting that these baseline conditions may be confounded with the loss aversion factor.

Further, several variables that have been paired with loss aversion have been arbitrarily selected without theoretical bases, for example, loneliness and social conformity. Others have seemed like rational selections, for example, information avoidance, stress and addictions (smartphone, smart video, gambling and smoking addictions). Surprisingly, personality traits that might be associated with loss aversion have not been studied such as pessimism that could be associated with loss aversion and optimism that could be linked to gains.

Surprisingly, every study on potential underlying biological mechanisms has involved different brain regions and different connectivity between different brain regions, as if different researchers have different biases or different “pet” brain regions. In virtually all of the loss aversion studies, directionality or causality could not be determined given the cross-sectional versus longitudinal design of the studies.

Despite these methodological limitations, this literature has been informative. Future research directions include comparing loss aversion with loss sensitivity, comparing different personality types that might be associated with loss aversion and gains such as pessimism and optimism respectively, and conducting multivariate studies that include several behaviors as well as physiological functions associated with loss aversion.

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