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Third-party decision-making under risk as a function of prior gains and losses

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ABSTRACT

Humans typically prefer risky options after incurring a financial loss, while generally preferring safer options after a monetary gain. Oftentimes we do not only make decisions for ourselves but also on behalf of others. In the present study we examine how decision-making on behalf of another person can alter risk preference for mixed gambles with moderate probabilities, as a function of prior monetary gains and losses. Furthermore, we test how the extent of accountability for choices and outcome further may impact these effects. To test this, participants performed a series of trials in which they could either gain or lose money depending on a separate, unrelated, task. Immediately following the respective gain or loss, they decided to either play or pass on a mixed gamble that could either double or eliminate their gain or loss. Importantly, participants decided either (1) for themselves, or (2) on behalf of another participant under outcome accountability, or (3) under full accountability (process and outcome). Results revealed increased risk-taking after incurring a loss as compared to a gain for both Self and Other choices. However, this effect was significantly *smaller* for choices on behalf of others, in particular when accountability was reduced. The reduced impact of gains and losses on risk behavior on behalf of others are discussed in terms of reduced saliency and subjective value for prior gain/loss contexts, and consequently reduced engagement of affective processes.

1. Introduction

Risky decisions are highly dependent on the specific context in which the choice is made. For example, foundational work by Kahneman and Tversky (1979, 1981) convincingly demonstrated that outcome valence (e.g. financial gains or losses) plays an important role in determining our choices. People are typically risk averse, that is, they avoid risky options framed as potential gains with moderate probabilities (i.e. gain context), but may conversely become markedly risk-seeking for options that involve potential losses with a moderate probability of occurrence (i.e. loss context) (Kahneman & Tversky, 1979; Weber, Blais, & Betz, 2002).

These results have been extended to show that gains and losses, even when they are not related to the decision at hand, can affect individual preference for risk (Barkan & Busemeyer, 1999; Kahneman & Tversky, 1979; Tversky & Kahneman, 1992; Weber & Camerer, 1998; Xue, Lu, Levin, & Bechara, 2011). For example, previous work (Losecaat Vermeer & Sanfey, 2015; Losecaat Vermeer,

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Boksem, & Sanfey, 2014) has explored situations when a risky choice was made in the context of either a prior loss or a prior gain, both of which were experienced via a separate, unrelated task, and thereby deemed to be earned or deserved. These studies showed that participants chose to play a mixed 50–50 gamble significantly more often after experiencing an unrelated monetary loss than after experiencing an unrelated gain. Hence, by varying the gain and loss outcomes separately from, and independent to, the decision, this allows for an exploration of how broader gain/loss contexts impact risky choice for identical gambles. This controls for potential confounds of presenting different magnitudes and probabilities for gain/loss decisions respectively.

This aforementioned behavioral effect, as indeed is the case for most studies of risky choice, was observed for individual choices, that is, where the participant is solely responsible for the choice and consequently the participant themselves solely benefits or loses. However, many everyday choices do not occur in isolation, but rather involve decisions on behalf of others. For instance, financial advisors make investment choices in the interests of their clients, medical specialists choose courses of treatment for their patients, and politicians decide on public policy affecting millions. Therefore, an important question of interest we address here is whether the differences previously observed in risky choice after experiencing unrelated gain or loss outcomes, are also evident, or are even exacerbated, when we make identical decisions on behalf of others. These types of decisions are both prevalent and important in daily-life. For example, a financial investor choosing a risky investment on behalf of their client may be influenced by whether prices in the stock-market had previously risen or fallen, and politicians deciding on specific risky policies (e.g. health screenings or funding for treatments) might need to decide immediately after being notified of a budget increase or budget cut. It is therefore crucial to understand how prior gain and loss contexts influence risky decisions taken on behalf of others.

A growing number of studies on self-other decision-making have shown that risky decisions for others can differ substantially to the same choices made for ourselves (e.g. Andersson, Holm, Tyran, & Wengström, 2016; Bolton & Ockenfels, 2010; Bolton, Ockenfels, & Stauf, 2015; Füllbrunn & Luhan, 2017; see for review Trautmann & Vieider, 2011; Vieider, Villegas-Palacio, Martinsson, & Mejía, 2016). For instance, decisions on behalf of another person become less biased by whether a choice is framed as a gain or loss (Ziegler & Tunney, 2015), an effect that seemed mostly driven by increased risk-preferences for choices framed as gains. A similar result was obtained for decisions about potential gains involving a wider range of outcome probabilities (Agranov & Bisin, 2011; Bolton et al., 2015; Chakravarty, Harrison, Haruvy, & Rutström, 2011; Hsee & Weber, 1997; Sun, Liu, Zhang, & Lu, 2017; Zhang, Liu, Chen, Shang, & Liu, 2017). In contrast, when choices involve potential losses risk-taking on behalf of others tends to decrease (Sun et al., 2017; Zhang et al., 2017). In line with these studies, research has found that individuals accepted more mixed gambles on behalf of others (as compared to oneself), due to reduced loss aversion –the tendency that we overweight losses as compared to equivalent sized gains (Kahneman & Tversky, 1979)– (Füllbrunn & Luhan, 2017; Mengarelli, Moretti, Faralla, Vindras, & Sirigu, 2014). It should be noted, however, that the opposite behavioral pattern has been shown for investment choices (Eriksen & Kvaloy, 2010), and that differences between self-other choices are not always observed (Bolton & Ockenfels, 2010; Stone, Yates, & Caruthers, 2002). Despite the somewhat mixed findings reported in the literature, which are likely a result of various design aspects (e.g. different choice domains and probabilities, hypothetical or real outcomes, outcomes impacting ourselves, another person or a group), they suggest that decisions on behalf of others are less impacted by the decision context, and become more risk neutral. That is, while individual choices reveal an increased preference for risk when dealing with losses (vs. gains) with moderate probabilities, this difference seems less pronounced when deciding for others.

Given the many situations in which individual decisions may also directly affect the outcome of others, accountability structures –where one must justify his or her decisions and outcomes to those others (Lerner & Tetlock, 1999)– are often put in place to both monitor and improve the behavior of the decision-maker. Interestingly, accountability[1] has been found to differentially influence risk-taking behavior for choices in various domains on behalf of others (e.g. Bolton et al., 2015; Füllbrunn & Luhan, 2015; Leonhardt, Keller, & Pechmann, 2011; see for review Trautmann & Vieider, 2011; Vieider et al., 2016). For example, accountability for another's outcome, or that of an entire group, increased risk aversion (Charness & Jackson, 2009; Reynolds, Joseph, & Sherwood, 2009). Thus, being evaluated by another, or having to justify your behavior, can additionally influence how much risk we are willing to take on behalf of a third-party.

Accountability can take different forms; people may need to justify the process leading up to the outcome of their decisions (i.e. *process* accountable), or they may only be evaluated based on the outcomes, regardless of how they came to their decisions (i.e. *outcome* accountable) (Lerner & Tetlock, 1999). These oft-employed accountability structures have been found to differentially influence risk-taking decisions on behalf of others. On the one hand, being evaluated based on the outcome and choices made for both oneself *and* another person increased risk aversion (Pahlke, Strasser, & Vieider, 2015; Pollmann, Potters, & Trautmann, 2014). On the other hand, being accountable for the process when deciding on behalf of another person (Pollmann et al., 2014) or a group including oneself (Lefebvre & Vieider, 2013) demonstrated reduced risk-taking for uncertain investments. In the latter study participants also held these investments longer, which was attributed to reduced loss aversion. In line with this, individuals who had to justify their choices in front of the beneficiary, as compared to merely being evaluated on their choices, showed increased risk-taking for mixed monetary gambles (Pahlke, Strasser, & Vieider, 2012). Taken together, these studies demonstrate that risk-taking on behalf of others is significantly impacted by the aspect of the decision process the participant is held accountable for. One open question is whether

[1] The term 'responsibility' is often used here also. Responsibility and accountability are related concepts and are often used interchangeably in the literature. Some of these studies infer a role for responsibility in their tasks, while other studies specifically manipulated responsibility by including a condition where the decision-maker decides for themselves *and* another person or a group, affecting pay-offs equally or unequally. One study by (Pahlke et al., 2012) compared risk-taking under responsibility and accountability. For the sake of clarity in this paper, we refer to 'accountability', and differentiate between outcome or process accountability.

being evaluated either based on the decision process or on the eventual outcome also modulate the salience of gain/loss contexts, and consequently modulate risk-taking.

Several psychological processes have been proposed to be specifically affected by accountability manipulations. Process accountability may increase cognitive effort and systematic, thorough processing of information relevant for making judgements, whereas outcome accountability may narrow attention with respect to the task at hand (de Langhe, Van Osselaer, & Wierenga, 2011; Lerner & Tetlock, 1999; Patil, Vieider, & Tetlock, 2014). This suggests that different forms of accountability may differentially influence how choices and decision contexts (i.e. prior gains and losses) are processed and valued, and consequently affect risky decision-making.

Despite the important situations in which individuals decide on behalf of others and are held accountable for their choices and the associated outcomes, it is nevertheless unclear how these two factors may interact in influencing risk-taking on behalf of others as a consequence of prior gains and losses. Here, we aimed to study this by examining self-other choices in the context of prior unrelated gains and losses, combined with an accountability manipulation. Specifically, we examined risk-taking behavior on behalf of another person in individuals who were only held accountable for the final payoff of another ("outcome accountability") as compared to individuals held accountable for both the others' final payoff as well as the decision-making process itself ("full (process + outcome) accountability"). Participants experienced prior monetary gains or losses for themselves (*Self*) or for another actual person (*Other - Outcome Accountable, or, Other - Full Accountable*) based on their performance on an unrelated task. Immediately after each monetary gain or loss, participants were presented with a choice to either accept or reject a mixed 50–50 gain-loss gamble. This design allowed us to i) compare directly how unrelated gain and loss contexts affect risk-taking for identical gambles within individuals, ii) disentangle the context from the decision itself and thereby examine the causal effects of prior context on choice, and iii) exclude potential confounds of magnitude and probability weighting.

2. Materials and methods

2.1. Participants

118 undergraduate students participated in the study. All gave written informed consent and received research credits for participation. Participants could earn a monetary bonus depending on either their own choices (*Self* condition, $N = 41$), or the choices of another player in the experiment (*Other* condition, $N = 77$), with this bonus being rounded to €0, €5, or €10, depending on their final balance. If participants' final balance was negative, they received €0 as bonus. Experimental exclusion criteria were self-reported history of psychiatric disorders, regular use of marijuana, or use of psychotropic drugs. Three participants in total were excluded. One male was excluded because of reported regular drug use, and the two remaining males were excluded to enable an analysis of a homogenous sample in terms of gender. Data is therefore reported from 115 participants (all female, $M = 19.76$ years, $SD = 1.64$). The study was approved by the local ethics committee.

2.2. Design

We used an existing paradigm (Losecaat Vermeer et al., 2014) in order to study risk-taking behavior in the context of prior gains and losses on behalf of either another participant or themselves. Each trial began with a simple time-estimation task in which participants either won or lost a fixed amount of money (€1.20) depending on their performance. The purpose of this task was to induce a gain or a loss context on that trial. Directly after either the gain or loss feedback from the time-estimation task, participants received a mixed (50–50 chance, gain-loss) gamble, which they could decide to either play or pass (i.e. binary choice, see Fig. 1). Playing the gamble led to two possible outcomes with equal probability: 1) A win outcome which added €1.00, €1.20 or €1.40 to their overall experimental balance depending on the exact gamble, or 2) a loss outcome which subtracted €1.00, €1.20 or €1.40 from this balance, depending on the exact gamble (Table 1). Each mixed gamble contained either a positive expected value ('+EV'), a negative expected value ('−EV'), or a zero expected value ('0EV'), constructed by varying the gain or loss outcomes (Table 1), and occurred randomly in both gain and loss contexts. Alternatively, deciding to pass on the gamble resulted in keeping the gain or loss (i.e. ± €1.20) from the time-estimation task. To allow causal inference about how prior gain and loss contexts affected risk-taking and increase statistical power, the gain/loss feedback from the time-estimation was manipulated within-subject and quasi-randomized to ensure a balanced number of observations (see 2.3 for further details). The three different gamble types were designed to assess whether participants were differentially sensitive to the expected value of the gamble. In addition, one-fourth of the total trials were "no-gamble" time-estimation trials. These trials were indicated by a specific visual cue (i.e. cubes instead of dice), and did not present a gamble after receiving feedback on the time-estimation task. These trials were employed to enhance engagement in the gamble trials and the task, but were not included in the analysis, as they did not contain a gamble.

Time–estimation performance on all trials and decisions to either gamble or not gamble was reflected in the experimental running balance. This overall running balance was controlled for to create phases of "neutral" (total balance range of €-5 to €5), "negative" (range €-5 to €-17), and "positive" experimental balances (range €5 to €17), and to test for any direct (*Self*) and indirect (*Other*) wealth effects on decisions to take risk. The order of these three running balance phases was counterbalanced across participants.

Our main question of interest was if risk-taking for mixed gambles differed as a function of prior gains and losses on behalf of another person. Therefore, our critical manipulation was as follows: participants either played the entire task for another anonymous participant in the study (*Other* condition) or they played the task for themselves (*Self* condition). Participants in the Self condition would receive the total earnings themselves, whereas for participants who played the task in the *Other* condition, a randomly

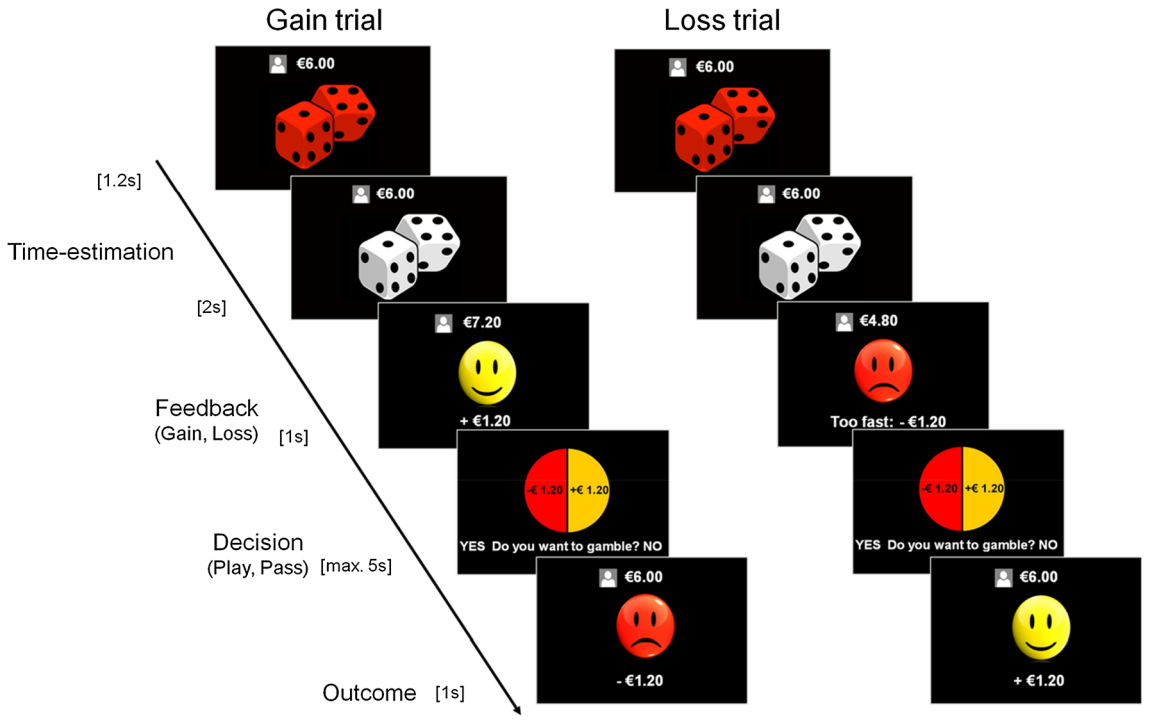

Fig. 1. An outline of two gamble trials are presented: an example of a gain trial and a loss trial. In this example the *Other* condition is shown. Each picture represents a screen in the experiment. The trial started with a time-estimation task, where participants were required to press a button exactly 1 s after the dice color changed to white. Feedback on performance was shown as a monetary gain of €1.20 if correct, or a loss of €1.20 if incorrect. Following this feedback, participants had the opportunity to choose to play or pass on a mixed gamble with a 50–50 chance to either gain or lose money. If participants decided to gamble, the gamble was resolved and the outcome then presented. Average duration of a trial is 9–13 s. The task was the same for the *Self* condition with the exception of the icon displayed at the top of the screen.

Table 1
Mixed gambles by expected value (EV) and EV type.

50|50 mixed gamble	Expected value (EV)	Gamble type
− €1.40 | + €1.20	−0.10	− EV
− €1.20 | + €1.00	−0.10	− EV
− €1.20 | + €1.20	0	0 EV
− €1.00 | + €1.20	0.10	+ EV
− €1.20 | + €1.40	0.10	+ EV

Note: All gambles contained of a 50–50 probability to lose-win money.

selected, anonymous, experimental participant would receive the total earnings. It was made clear to participants in the *Other* condition that another experimental participant, selected randomly at the end of the experiment, would also play for them. All participants were instructed at the start of the experiment that the earnings from the task would be paid out when the study was completed (see Appendix B).

In addition, to assess to what extent the degree of accountability influences risk-taking for monetary gambles on behalf of others, half of the participants ($N = 39$) from the *Other* condition were instructed that the beneficiary of the final balance would rate their personal satisfaction with the monetary outcome, which we refer to as the *Other-Outcome Accountable* group. The other half of the participants ($N = 38$) from the *Other* condition were informed that both the final balance *as well as* the actual behavioral performance during the task (i.e. their performance and the sequence of choices they made) would be evaluated by the beneficiary. This created a condition under which the participant was accountable for the process and outcome (henceforth called *Other-Full Accountable* group). This latter group is most similar to the self, where participants evaluate their own behavioral performance during the task and final outcome, with the only difference that they are not playing and affecting another person, but themselves. Overall therefore, we assigned participants to one of the three treatment groups: Self, Other-Outcome accountable or Other-Full accountable (Table 2). The assignment of participants was randomly pre-determined to create approximately equal-sized groups of participants.

Table 2
Treatment description.

Treatment condition	Description
Self (N = 38)	Participant makes decisions for themselves
Other-Outcome Accountable (N = 39)	Participant makes decisions on behalf of an anonymous participant, knowing that the other participant will judge the decision-maker's performance based on the final monetary outcome he/she receives
Other-Full Accountable (N = 38)	Participant makes decisions on behalf of an anonymous participant, knowing that the other participant will judge the decision-maker's performance based on the full decision history and the final monetary outcome he/she receives (i.e. process + outcome)

2.3. Procedure (task and payment)

Participants first performed two practice sessions of 5 min. In the first session participants practiced the time-estimation trials. Here, participants were required to estimate the required duration, by waiting exactly one second after a cue on the screen changed in color and then pressing a response button, with their precise response times recorded. Unbeknownst to the participants, we used the minimum and maximum of the recorded response times for each participant to determine an initial allowable response time-window, which was used in the main experiment to give feedback on whether their response on the time-estimation task was either correct or incorrect. The second practice session gave participants the opportunity to practice the gambling task and experience the different trial type conditions. After these practice sessions, the experiment began and lasted for approximately 60 min, with a short break halfway.

Before the task started, participants were instructed that their goal was to win as much money as possible, either for themselves (*Self* condition) or for another, random, participant in this study (*Other* condition). Participants were instructed that the final balance would be paid out to the respective beneficiary (with a minimum of €0, and a maximum of €10), in addition to their participation credit. In case of the two *Other* conditions, the total amount that the participant earned during the experiment was paid out to one of the other, randomly assigned, participants in the study, done at the end of the experiment. Similarly, earnings of one of the other participants in the study were randomly assigned to the decision-maker in the *Other* condition.

An additional small monetary bonus (€1) at the end of the study could be earned if there was a positive evaluation by the beneficiary. Participants were informed that the additional bonus in the *Other-Outcome Accountable* condition was determined by a positive satisfaction rate of the receiver for the total final outcome (a score of between 5-7 from a 1-7 satisfaction Likert scale). The bonus in the *Other-Full Accountable* condition was determined by a positive satisfaction rate of the receiver for both the choice process and the total final outcome. At the end of the experiment, all participants were invited to give their ratings online based on multiple possible hypothetical outcomes (Qualtrics software, 2013). The ratings were only completed by a subset of participants[2]. Participants from all conditions had to return to the laboratory to receive their payments (earnings + bonus), with the note that in the *Self*-condition participants already knew what they would earn.

At the start of each trial, participants saw a cue (i.e. a red pair of dice) that changed in color to white after 1.2 s (Fig. 1). Participants were then required to press the response button exactly one second after this color change. Responses to this time-estimation task were considered correct when they were within their allowable time-interval. For a correct response, participants won €1.20. When a response was not within this time-interval (i.e. either too fast or too slow) participants lost €1.20. Unbeknownst to the participant, the allowable response-interval was covertly adjusted as the task developed as a function of the variance in response time of the participant, in order to ensure a balanced number of gain and loss feedback on this task. Specifically, if participants responded within the allowable response-interval, this interval was subsequently shortened by 50 ms; if they responded either too quickly or too slowly, the interval was then lengthened by 50 ms. Importantly, although the amount of gain and loss feedback was experimentally controlled, the feedback and associated gains and losses was contingent upon participants' performance. Thus, the time-interval was adjusted individually based on the participant's actual response behavior (see for further details Boksem, Kostermans, & De Cremer, 2011).

The task contained a total of 180 "gamble" trials (indicated by a pair of dice) and 60 "no-gamble" trials (indicated by a pair of cubes). In the "gamble" trials, immediately following a gain or loss from the time-estimation task, participants had to decide within 5 s whether to accept or reject to play a mixed (50–50 gain-loss) gamble. If the participant decided to accept the gamble, the computer immediately resolved the gamble by randomly selecting either outcome with a 50–50 probability. Alternatively, if the participant decided to pass on the gamble, the next trial would begin and thus the participant accepted the gain or loss (i.e. ± €1.20) from the previous time-estimation task. The gamble outcomes were independent from the performance on the time-estimation task, which was also explained to the participants. All gains and losses received during the task were immediately updated the total running balance. This balance was shown on the screen at all times.

Participants were informed that the balance (if positive) would be paid out as a bonus at the end of the experiment. This made the task more engaging and realistic, as compared to other studies that use hypothetical scenarios or chose a random trial for payment. Participants experienced three phases of experimental balances, a "neutral", "negative" and "positive" balance. To allow the transition through these running balances, a similar procedure for the time-estimation interval was used. Specifically, to transition to a

[2] Participants were randomly matched to other participants that had given their ratings online.

Table 3
Structure of experimental trials (N_{trials} = 240).

Running balance	Feedback context	Gamble trials (N)	No-gamble trials (N)
Positive	Gain	30	10
	Loss	30	10
Neutral	Gain	30	10
	Loss	30	10
Negative	Gain	30	10
	Loss	30	10

Note: The number of trials is an average and were slightly unbalanced between participants to ensure an equal number of gain and loss trials per participant. N = number of trials.

positive balance, the allowable response-interval was shortened by 10 ms after a correct response, and lengthened by 100 ms after an incorrect response (i.e. too quickly or too slowly). To transition to a negative balance, the same adjustment was made but in opposite direction. The transition trials consisted both of additional gamble-trials (33%) and no-gamble option trials (67%), and were excluded from the analysis. Only the trials during the three balance phases were included in the analyses (see Boksem, Kostermans, Milivojevic, & De Cremer, 2012). Participants were not aware of these adjustments to the response-interval, nor were they aware that they were transitioning through three phases of experimental running balance (see Fig. A1 in Appendix A, for an example of the trajectory of the experimental running balance of a participant).

Participants played on average a total of 240 experimental trials (including "gamble" and "no-gamble" trials), and another 60 trials used to transition participants through the different running balance phases. The design contained a nested structure, summarized in Table 3. The large amount of trials was employed to ensure adequate power to examine both play and pass decisions. Each trial varied in duration between 9 and 13 s, with an average task duration of 60 min. The task was presented in Presentation1 software (Version 14, www.neurobs.com).

2.4. Behavioral analysis

In order to assess the degree of risk-taking following gains and losses respectively, we assessed the number of gambles played/passed on as a binomial dependent measure. To this end, we had three within-subject factors: 'running balance' (three levels: Positive, Neutral, Negative), 'feedback context' (two levels: Loss, Gain), and 'gamble EV' (three levels: positive EV, equal EV, negative EV). The between-participants factor was the beneficiary of the final outcome and further split by level of accountability (three levels: *Self* (N = 38), *Other-Full Accountable* (N = 38), *Other-Outcome Accountable* (N = 39)). A generalized linear mixed effect model was performed, to avoid aggregation of the data, thereby maintaining intra-individual variance, and due to the data being slightly unbalanced in number of trials. For this, we used the mixed function of the package for Analysis of Factorial Experiments (afex, Singmann et al., 2018), running on lme4 (Bates, Mächler, Bolker, & Walker, 2015), using the R statistical package (version 3.4.3, R Core Team, 2017). The model contained the three within-participant factors and the between-participant variable as fixed effects to predict participant's decisions to play a 50–50 mixed gamble (binary variable). To account for the repeated-measures and nested nature of the data, we included random adjustments to the fixed intercept ("random intercept") for participant in the model (e.g. Baayen, Davidson, & Bates, 2008). Within-unit random slopes were not included, due to non-convergence of the model. P values were determined using Likelihood Ratio Tests. We computed all post-hoc pairwise multiple comparisons with the emmeans package (Lenth, Singmann, Love, Buerkner, & Herve, 2018). Reported means are estimated marginal means and confidence intervals (CI) are set at 95%, obtained using the emmeans package.

3. Results

Our main question of interest was how deciding on behalf of another affects risk-taking for mixed gambles as a function of prior unrelated gain/loss contexts. Firstly, replicating previous findings (Kahneman & Tversky, 1979; Losecaat Vermeer & Sanfey, 2015; Losecaat Vermeer et al., 2014; Tversky & Kahneman, 1992; Weber & Camerer, 1998), participants were more likely to accept a gamble when they previously experienced a loss (M = 56.8%), as compared to a gain (M = 42.4%; χ^2 (1) = 325.55, $p < 0.001$)[3]. Importantly, we found that the identity of the beneficiary of the decision outcomes significantly influenced risk-taking following gain and loss contexts (χ^2 (2) = 43.07, $p < 0.001$), such that a lesser degree of accountability on behalf of the other led to a reduced difference in risk-taking propensity following losses compared to gains (see Fig. 2, Table 4). Examining the means, this effect appears largely driven by the differences in decisions after gains, although pairwise comparisons of the gains were not statistically significant (Beneficiary for gains: χ^2 (2) = 3.21, p = 0.201)[4].

Collapsing across both the *Other-Full accountable* and *Other-Outcome accountable* condition the difference in risk-taking as a

[3] See model summary in Table A1 in Appendix

[4] Based on a separate model split by gain feedback context. Direct post-hoc comparisons on the main model between groups for gain feedback revealed similar results, with all three comparisons being non-significant ($p > .050$, Tukey corrected for multiple comparisons).

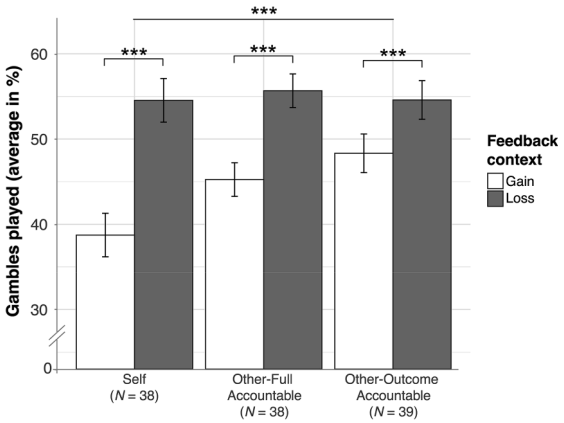

Fig. 2. Mean (raw) percentage of gambles chosen following gains and losses per beneficiary; playing for oneself (*Self*), playing for a third-party in which both the participants' choice behavior and total final outcome was disclosed to the other person (*Other-Full Accountable*), playing for a third-party in which only the participants' total final outcome of the task was disclosed to the other person (*Other-Outcome Accountable).* Error bars are standard error of the mean. *** $p < 0.001$.

Table 4
Estimated marginal means and 95% confidence intervals.

	Self (N = 38)		Other - Full Accountable (N = 39)		Other – Outcome Accountable (N = 38)		Collapsed (N = 115)	
	M	95% CI	*M*	95% CI	*M*	95% CI	*M*	95% CI
Overall	45.35	(36.2; 54.8)	50.33	(40.9; 59.7)	53.15	(43.8; 62.3)		
Feedback								
Gain	35.19	(27.0; 44.4)	43.33	(34.2; 52.9)	49.03	(39.7; 58.4)	42.41	(37.1; 47.9)
Loss	55.91	(46.3; 65.1)	57.33	(47.8; 66.3)	57.24	(47.8; 66.2)	56.83	(51.4; 62.1)
Running balance								
Positive	43.70	(34.5; 53.4)	48.19	(38.7; 57.8)	49.38	(39.9; 58.9)	47.08	(41.6; 52.7)
Neutral	44.01	(34.8; 53.7)	51.89	(42.3; 61.4)	53.39	(43.8; 62.7)	49.76	(44.2; 55.3)
Negative	48.36	(38.9; 58.0)	50.92	(41.3; 60.5)	56.66	(47.1; 65.7)	51.99	(46.4; 57.5)
EV gamble								
Positive	65.37	(56.1; 73.6)	75.82	(68.0; 82.2)	71.86	(63.5; 78.9)	71.20	(66.4; 75.6)
Neutral	44.39	(35.1; 54.0)	53.92	(44.3; 63.3)	53.13	(43.6; 62.4)	50.47	(44.9; 56.0)
Negative	27.50	(20.4; 35.9)	22.10	(16.1; 29.5)	33.55	(25.6; 42.6)	27.47	(23.2; 32.1)

function of the feedback context was significantly reduced ($M_{\text{Loss-Gain}} = 11.0\%$) as compared to participants playing for themselves ($M_{\text{Loss-Gain}} = 20.7\%$; Feedback × Beneficiary (Self, Other): χ^2 (1) = 34.49, $p < 0.001$). Nevertheless, the degree of accountability impacted differences in risk-taking; participants' decisions in the Other-Outcome accountable group were significantly less susceptible to the feedback context (i.e. a smaller difference between risk-taking following gains and losses; $M_{\text{Loss-Gain}} = 8.2\%$) as compared to participants' decisions of the Other-Full accountable group ($M_{\text{Loss-Gain}} = 14.0\%$; χ^2 (1) = 8.74, $p = 0.003$).

Results show that when deciding on behalf of another person, participants are less susceptible to the decision context than when participants make ostensibly the same decisions for themselves. When the participant knows that the beneficiary will explicitly rate the decisions (*Other-Full Accountable*), choices are more similar to those made for oneself than to those made when only the outcome, but not the decisions, would be rated (*Other-Outcome Accountable.*). Overall, across both gain and loss contexts, risk-taking between the groups did not significantly differ ($M_{Self} = 45.4\%$, $M_{Other\text{-}Full\ Accountable} = 50.3\%$, $M_{Other\text{-}Outcome\ Accountable} = 53.2\%$; χ^2 (2) = 1.34, $p = 0.512$).

In the task, gambles with three different expected values were used (Table 1). Participants were sensitive to the expected values of the gambles, with a higher likelihood of playing the positive EV gamble and a lower likelihood of playing the negative EV gamble (χ^2 (2) = 2253.32, $p < 0.001$). This effect was also observed within all three groups (EV gamble × beneficiary: χ^2 (4) = 90.09, $p < 0.001$), with the Other-Full Accountability group showing a larger difference in choice proportion to gamble between the different expected values as compared to the other groups (see Table 4).

Furthermore, trials played while having an overall positive, neutral and negative running balance were included in the model to test for wealth effects. The proportion of gambles played across these different phases of overall balance significantly impacted risk preferences for all groups equally (χ^2 (4) = 7.95, $p = 0.094$), with higher risk-taking when in a negative running balance and lowest risk-taking in the positive running balance (χ^2 (2) = 24.98, $p < 0.001$).

Due to the length of the task, we ran another model including time as a predictor, to test whether the effect of beneficiary by feedback on risk-taking was time-dependent. We distributed all trials over 3 time-bins of 60 gamble trials each. Our effect of

Beneficiary by Feedback on risk-taking was not moderated by Time (χ^2 (2) = 2.50, p = 0.287). Importantly, our main interaction of Beneficiary × Feedback remained significant (χ^2 (2) = 42.54, p < 0.001). We found a Beneficiary × Time effect (χ^2 (2) = 9.23, p = 0.010), showing that over the course of the experiment, the Self group significantly decreased risk-taking (B = −0.181, SE = 0.04) compared with the Other-Full Accountable group (B = −0.036, SE = 0.03, z = −2.86, p = 0.012), and the Other-Outcome Accountable group marginally decreased risk-taking (B = −0.150, SE = 0.03) as compared with the Other-Full Accountable group (z = −2.31, p = 0.055).

4. Discussion

In the present study, the aim was to examine decision-making under risk after experiencing monetary gains or losses for both self and on behalf of others under different degrees of accountability. Replicating earlier work (Losecaat Vermeer & Sanfey, 2015; Losecaat Vermeer et al., 2014), participants were sensitive to the prior gains and losses, choosing significantly more gambles when they had just incurred a small loss as compared to when they received a small gain. This demonstrates the reliable effect of the decision context – we observe changes in individual risk-taking for identical sets of mixed gambles with moderate probability as a function of a small preceding monetary gain or loss. Importantly, we found that when deciding for others compared to deciding for self, participants' decisions to take risk were significantly less susceptible to this gain/loss context, demonstrated by a significant interaction effect between the gain/loss choice context and the beneficiary. In other words, participants still exhibited greater risk-taking after a loss than after a gain, but this difference was smaller when individuals were deciding for another participant. In addition, when the degree of accountability for the other was at its smallest (i.e. outcome accountability condition, whose exact trial-by-trial decisions were *not* revealed and evaluated), we found that participants were most consistent in their risk-taking across gain and loss contexts. Conversely, when individuals chose for themselves the impact of choice context on risk-taking was most in evidence.

In line with prior findings on behalf of others using pure gain and pure loss choices (Sun et al., 2017; Zhang et al., 2017; Ziegler & Tunney, 2015), our findings show that choosing on behalf of others makes individuals more risk neutral for mixed gambles following unrelated prior gain and loss contexts as compared to deciding for themselves. One explanation for the reduced susceptibility to gain/loss context is that of reduced loss aversion (Andersson et al., 2016; Füllbrunn & Luhan, 2017; Mengarelli et al., 2014; Polman, 2012). That is, while people are generally risk-averse for mixed gambles due to loss aversion, this behavioral tendency makes people become markedly risk-seeking for the same gamble after experiencing an unrelated loss outcome, in an attempt to break even and recover the loss. However, choosing on behalf of another individual reduces this gain/loss difference in risk-taking for mixed gambles.

The difference in risk-taking in the present study appears to be mostly driven by the gain context, albeit that this is not statistically significant. A possible explanation for why this difference seems to be largest following gains is because gains for others might not be integrated in the decision-maker's own mental account, but rather treated as the other's money. This is consistent with the "house money effect", observed when people gamble after winning money in a casino (Thaler & Johnson, 1990), and suggests that not integrating these prior wins as their "own" could have made participants less risk averse for subsequent mixed monetary gambles. A similar finding was also observed when people choose riskier investments with other peoples' money (Agranov & Bisin, 2011; Andersson, Holm, Tyran, & Wengström, 2013), and choosing between risky gains for others (Bolton et al., 2015; Chakravarty et al., 2011). Alternatively, others' gains might not weigh as heavily as one's own gains, and therefore have less impact on individuals' risk preferences for mixed gambles. In fact, previous studies have reported that negative and positive outcomes are processed less strongly when deciding on behalf of others (Beisswanger, Stone, Hupp, & Allgaier, 2003; Kray & Gonzalez, 1999). Further evidence from neuroimaging work has found increased activity in reward-related brain regions (e.g., ventral striatum, medial prefrontal cortex) when choosing between immediate over delayed rewards for the self, but not when choosing for others (Albrecht, Volz, Sutter, Laibson, & von Cramon, 2011). Taken together, these studies suggest that gains for another person are less salient and rewarding than gains for one's self, and as a result have lessened impact on subsequent risk-taking for mixed gambles.

In slight contrast to earlier findings of reduced loss aversion on behalf of others for pure loss or mixed gambles with moderate probabilities (Andersson et al., 2016; Mengarelli et al., 2014; Pahlke et al., 2012), we found that following a small loss the willingness to take risk on behalf of another was almost identical to the risk taken for one's self. As losses generally loom larger than gains, experiencing losses for others may in fact be as salient as for ourselves, and therefore affect risk preferences for 50–50 mixed gambles equally. Moreover, incurring a loss as a result of performance on the time-estimation task may be negatively evaluated by the beneficiary and therefore encourage choosing the gamble in order to compensate for this. However, in contrast to the previous studies reviewed here, participants in the current study always had to choose to either play or reject an identical mixed gain-loss gamble with equal probability, which may have made the loss more salient. Interpreting null-results should be done with caution, and our design differs in several other ways to previous studies, as we separate gain and loss contexts from the choice in order to examine effects of unrelated gain/loss contexts on risk-taking.

Several previous studies have shown a role for accountability in decision-making under risk (Bolton et al., 2015; Lefebvre & Vieider, 2013; Pahlke et al., 2012; Pollmann et al., 2014). Our findings of the full accountability treatment closely resembled situations in which individuals choose for themselves – who are also accountable for both their own choices and outcomes. These findings are consistent with observations from an investment task where participants under both outcome and process accountability behaved more similarly to participants deciding for themselves than participants who are only accountability for the process (Pollmann et al., 2014). One plausible explanation for this phenomenon is that of an increased saliency of, and subjective value for, the gain/loss outcomes that preceded a risky choice. Previous research reported that individuals under process accountability, as compared with outcome accountability alone, attribute more analytical processing and attention to available information before

making judgements (de Langhe et al., 2011; Patil et al., 2014), which could increase the weight of the available information in the decision process. Although not directly measured here, this suggests that holding a person accountable both for the process *and* outcome may increase attention and subjective value for the immediate gains and losses, and thereby having a greater impact on their decisions to accept/reject a subsequent mixed gamble. Conversely, those who were accountable only for the final outcome may shift their focus from the details of the decision process to the overall aim (i.e. final outcome), resulting in reduced salience of immediate small gain/loss outcomes on subsequent risk-taking. Further support for this is reported by Sokol-Hessner et al. (2009), who showed that participants were less loss averse and showed reduced physiological response to loss-gain outcomes when instructed to think about the greater context and observe each small individual outcome as part of a larger portfolio, rather than observing each outcome in isolation. Together, our results suggest that the more the decision-maker was held accountable (process + outcome), the higher the relevance and salience of immediate outcomes, and the stronger their impact on subsequent choice.

The majority of studies investigating risk-taking on behalf of others have mostly examined whether risk-taking overall differs for different gambles (i.e. for pure gain, pure loss, and mixed gambles with various or fixed probabilities). Consistent with some previous research (Bolton & Ockenfels, 2010; Stone et al., 2002), when collapsing the data across gain and loss contexts, we do not find differences in risk-taking between decisions for the self and decisions on behalf of the other, nor for different degrees of accountability. In other words, the differences we observed between self-other choices were specifically impacted by the prior gain and loss contexts. Other studies found an accentuated risk pattern on behalf of others for gambles with small probability gains or losses, that is, increased risk aversion for gains and risk-seeking for losses (Pahlke et al., 2015; Vieider et al., 2016). These results highlight the importance of different decision variables that can further contribute to self-other decision-making under risk.

The current findings provide several interesting avenues for future research. Decreasing one's personal economic involvement (i.e. self vs. other) and the level of accountability for the decision may function as a form of regulating one's responses to monetary rewards and monetary punishments that might otherwise affect decision-making. Additionally, deciding on behalf of another person may trigger taking a third-person perspective that functions to shift attention to the broader, more abstract, goal, thereby reducing context-dependent risk taking. This effect has been observed to reduce loss aversion when individuals were instructed to "think like a trader" (Sokol-Hessner et al., 2009). Future studies could test if perspective-taking influences risk preferences in a similar way and if brain networks associated with theory-of-mind correlate with context-dependent risk-taking on behalf of others under accountability. Furthermore, accountability is closely linked to self-referential emotions, such as the anticipation of guilt (Berndsen, van der Pligt, Doosje, & Manstead, 2004; Chang, Smith, Dufwenberg, & Sanfey, 2011) and regret (Camille et al., 2004, 2010; Coricelli, Dolan, & Sirigu, 2007) during decision processes, which may increase people's tendency to avoid such accountability or blame when choosing for others (Beisswanger et al., 2003; Bolton et al., 2015; Leonhardt et al., 2011). One open question is whether increasing the degree of accountability triggers these additional affective processes and enhances the impact of the immediate prior context on choice. Based on this, one hypothesis is that full accountability (process + outcome) for others will increase self-referential processing and the anticipation of guilt resulting in choices more similar to the self. Conversely, when only accountable for the final outcome, irrespective of the process that led to it, we hypothesize that self-referential processing will be reduced and result in more risk neutral decisions. Future examination is required to isolate potentially different underlying psychological and neural mechanisms for self-other risk preferences under different degrees of accountability.

A limitation of the current study is that we only included women. Although gender differences in risk and accountability have been reported (see e.g. Brandts & Garofalo, 2012), recent studies show no clear and universal gender differences (see Filippin & Crosetto, 2016 for a recent *meta*-analysis; Lefebvre & Vieider, 2013). Future research is necessary to test whether our results also extend to men in order to be able to generalize these findings on a broader level.

To conclude, in the current study we demonstrate that deciding for a third-party diminishes inconsistency in risky choice following gains and losses. Furthermore, full accountability towards a third-party increases inconsistency in risk preferences, which we hypothesize is due to enhancing the salience and subjective value of decision variables and emotional involvement in the choice process. Conversely, being held accountable for only the final payoff of the other reduces the impact of immediate gains and losses on subsequent choices, presumably by shifting away focus from small outcomes. The current study provides additional insight into self-other decision-making under risk, by revealing differential effects of both context (prior gains or losses) and extent of accountability on risky choice. These findings provide awareness as to how decisions made on behalf of others influence risk-taking in different contexts that may be important on a broader level such as when third-parties decide on risky policies (e.g. health screenings) affecting millions.

5. Data availability statement

Data and analyses scripts are available at the open science foundation website (https://osf.io/vjz93/).

Declaration of Competing Interest

None declared.

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Appendix A

See Table A1.

Table A1
Model summary.

	Model 1 (main model)			Model 2 (incl. Timebin)		
	Chi-square	Df	P-value	Chi-square	Df	P-value
Feedback	325.55	1	< 0.001	326.32	1	< 0.001
Beneficiary	1.34	2	0.512	1.30	2	0.522
EV gamble	2253.32	2	< 0.001	2256.61	2	< 0.001
Running balance	24.98	2	< 0.001	19.96	2	< 0.001
Feedback × Beneficiary	43.07	2	< 0.001	42.54	2	< 0.001
EV gamble × Beneficiary	90.09	4	< 0.001	89.88	4	< 0.001
Running balance × Beneficiary	7.95	4	0.094	14.20	4	0.007
Timebin (continuous)				35.87	1	< 0.001
Timebin × Feedback				0.77	1	0.379
Timebin × Beneficiary				9.23	2	0.010
Timebin × Feedback × Beneficiary				2.50	2	0.287

Note: Generalized linear mixed effect models. Model 1: choice ~ Intercept + Feedback + Beneficiary + EV gamble + Running balance + Feedback * Beneficiary + EV gamble * Beneficiary + Running balance * Beneficiary, random intercept for participant. Model 2: choice ~ Intercept + Feedback + Beneficiary + EV gamble + Running balance + Feedback * Beneficiary + EV gamble * Beneficiary + Running balance * Beneficiary + Timbin * Feedback * Beneficiary, random intercept for participant. Fixed effects are set to contrast sum, and Timebin was centered.

See Fig. A1.

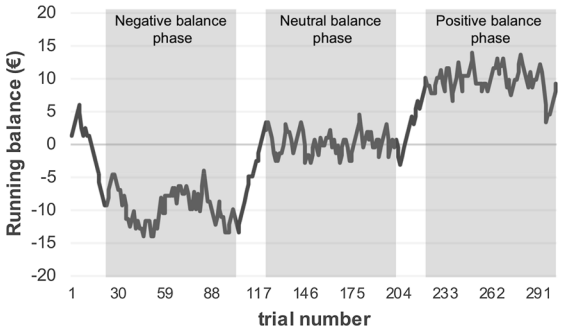

Fig. A1. An example of the trajectory of a participant in the task. This trajectory illustrates the running balance over the course of the experiment. The running balance was determined by the feedback on the time-estimation task (€1.20 for a gain, €-1.20 for a loss) and the outcomes of gambles that the participant chose to play. In total, participants played on average 300 trials of which 180 experimental gamble trials divided over the three balance phases. Moreover, participants played another 60 no-gamble trials randomly intermixed in the 180 trials, and another 60 transition trials that were used to move the subject between running balance phases.

Appendix B. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.joep.2019.102206.

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