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Original Manuscript

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Perceptual and Motor Skills
2024, Vol. 0(0) 1–23

DOI: 10.1177/00315125241239119
journals.sagepub.com/home/pms
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Abstract

Risk analysis is essential for promoting hiking-based tourism. Our objective in the present study was to map 395 mountain hikers' positions on risk judgment and risk taking, according to how they integrated three antecedent factors of confidence (environment, team, and self). For integrating information, people can develop an additive rule whereby they apply the same weight to all information or use interaction rules (i.e., conjunctive or disjunctive), to give different weights to information. In the questionnaire our participants completed, there were eight scenarios that combined the three confidence antecedent factors as information cues. We applied cluster analysis, repeated-measures analyses of variance, chi-square tests, and bivariate correlation analyses to the questionnaire results to identify three participant risk positions. In the first risk position (cluster 1), participants used a disjunctive integration rule for both risk judgment and risk taking. In the second risk position (Clusters 2 and 4), they used an additive integration rule for risk judgment while they used a disjunctive integration rule for risk taking. In the third risk position (cluster 3), they used an additive integration rule for both risk judgment and risk taking. In each risk position, confidence in the three antecedent factors (environment, team, and self) negatively affected risk judgment and positively affected risk taking. We found the compositions of the clusters to be related to the participants' sex, and we discuss various advantages of applying information integration for mountain hiking practitioners and promoters.

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Keywords
mapping, risk, information integration, confidence frame, mountain hiking

Introduction

Mountain Sports and Risk

Mountain hiking has become increasingly popular in France. This activity is defined as hiking on official trails, non-official trails, small paths, or general terrain in a mountainous area (Zürcher et al., 2020). This type of outdoor activity in mountain settings provides psychological and physical health benefits but also exposes participants to a risk of injury (Kortenkamp et al., 2017). Understanding this risk is essential for reducing the number of accidents and promoting hiking-based tourism (She et al., 2019). Faulhaber et al. (2017) reported an increasing number of hiking accidents over recent years, most of which occurred on a marked hiking trail or on small paths, and some of which were fatal (especially among males). Zürcher et al. (2020) investigated the circumstances and causes of death among fatally injured hikers in these accidents. They identified many objective risk factors that included the equipment (no hiking boots, no backpack, and no adequate clothing), the type of terrain, the season, the altitude, the weather, and the path's difficulty. In this study, we suspected that understanding the manner in which hikers perceive these objective risk factors (making them then subjective risk factors) would help prevent further accidents (Landrø et al., 2022). Thus, we sought to map how individuals mentally integrate various information cues when both judging and making decisions about engaging in risk situations while mountain hiking.

Given the complex nature of the mountain environment, risk activities in mountain sports may be conceptualized and perceived in different ways (Mannberg et al., 2018). Landrø et al. (2022) examined hikers' assessments and judgments about a selection of avalanche risk factors, since avalanche risk assessment requires knowledge of and ability to assess the relevant factors. Mannberg et al. (2018) investigated the perceived risk regarding a backcountry skiing accident (e.g., due to an avalanche or a fall) as a function of information about the terrain and snow conditions. The results from these studies suggested that both risk perception and risk taking attitudes were keys for deciding about ski runs in that individuals with avalanche training felt more confident in their decision to refuse to ski on terrain they judged to be too risky.

Relationship Between Risk Judgment and Risk Taking

To investigate risk, psychologists have examined the relationship between risk judgment (i.e., risk perception) and risk taking (Mills et al., 2008). In various domains, individuals' risk judgments were a key underlying factor in subsequent risk-taking behavior (Schürmann et al., 2019). A typical theoretical and empirical prediction has

been that risk judgment is inversely correlated with risk-taking such that the greater the judged risk, the less likely people are to take it (Reyna & Farley, 2006). However, some investigators have not found a significant correlation between risk judgment and risk taking (Brewer et al., 2007) or have found risk judgment positively correlated with risk taking (Reyna & Farley, 2006). These various findings reveal that different individuals may think about risk in different ways for unclear reasons. Therefore, we applied novel scientific approaches to better understand and explain this relationship (Mullet et al., 2004).

A possible explanation for prior contradictory results regarding the relationship between risk judgment and risk taking is the influence of person-specific factors (Mills et al., 2008). Such inter-individual differences might be explained by the person's sex or level of experience. Sex and experience have been investigated separately for either risk judgment or risk taking. Regarding sex, females have generally been prone toward less risk-taking in various mountain sports, such as hiking, orienteering, mountain biking, rowing, surfing, sailing, nordic skiing, tour skiing, snowboarding, parachuting, and cliff jumping (Demirhan, 2005; She et al., 2019), and male recreational skiers and snowboarders were found to take more risks than females (Willick et al., 2019). However, in a study of experienced professional mountain guides, Walker and Latosuo (2016) found no gender effect on risk tolerance. When the guides were asked to rank potential factors that might influence their decision-making while guiding, male and female guides did not differ significantly in their responses.

Furthermore, level of experience was found to positively influence risk judgment when considering various avalanche factors, with increased precision ratings when respondents had more avalanche education (Landro et al., 2022). Similarly, greater experience among mountain hikers was associated with greater risk-taking (Kortenkamp et al., 2017), and non-experienced individuals judged activities to be riskier than did experienced individuals (Demirhan, 2005). However, in a contrary finding, She et al. (2019) found that more experienced hikers judged activities to be riskier than less experienced hikers did. Unfortunately, sex and experience have been investigated separately for either risk judgments or risk taking, but investigators have not simultaneously addressed both risk judgments and risk taking.

Another possible explanation for disparate findings on the relationship between risk judgment and risk taking relates to varied research methods across separate studies. Mullet et al. (2004) highlighted the limitations of correlational techniques for modelling these two risk dimensions. While identifying a correlation between risk judgment and risk taking was an effective early investigative tool, such correlations provided no insights into the underlying causal factors in individual judgments or behaviors (Mullet et al., 2004).

An Information Integration Approach

Cognitive processes can be further probed by applying information integration theory (Anderson, 2008). This approach focuses on the way in which people may integrate

multiple stimuli into a judgment or a decision (i.e., how people combine various information cues and use a type of cognitive algebra to process information in different situations). Cognitive algebra refers to the subjective values (or psychological considerations) that people give to specific stimuli. Cognitive algebra includes three information integration rules (additive, conjunctive, or disjunctive).

Statistical analysis (mainly repeated-measures analyses of variance (ANOVA)) and graphical analysis (based on the response pattern; i.e. the shape of the lines) can be used to identify the three integration rules in the interactions of various factors. Using ANOVAs, an additive rule is characterized by a non-significant interaction effect on judgment, while the interaction rules (i.e., conjunctive and disjunctive) are characterized by a significant interaction effect on judgment. From the perspective of graphical analysis, an additive rule is characterized by two parallel lines, while a conjunctive rule is characterized by a fan that is open to the right, and a disjunctive rule is characterised by a fan that is open to the left (Anderson, 2008). This dual analysis is an informative method for understanding the weight respondents give to information in their integration process (Anderson, 2008).

To illustrate these varied means of integrating information, Fruchart (2021) explored the cognitive processes by which trail runners combined relatedness and mental vitality when judging the degree of happiness derived from pleasure, engagement, and meaning. Participants in this study used the three different information integration rules differently, depending on the pathway to happiness being probed (see Figure 1 from Fruchart (2021)). They used an additive integration rule for judgments of engagement and gave equal weight or importance to underlying constructs of relatedness and mental vitality. The two lines or judgment pathways from these information sources were parallel and rose from left to right. An ANOVA of the raw data showed no significant interaction effect from relatedness by mental vitality on *happiness* judgments. In contrast, participants developed a conjunctive integration rule for judgments of *pleasure* in which pathway lines from relatedness and mental vitality formed a fan that was open to the right, and an ANOVA showed a statistically significant interaction effect between relatedness and mental vitality. Lastly, participants developed a disjunctive integration rule for judgments of *meaning* in which the pathway lines formed a fan that was open to the left, and the ANOVAs also showed a statistically significant interaction effect of relatedness by mental vitality. With these disjunctive or conjunctive integration rules, for judgments of *meaning* or *pleasure*, relatedness had more weight or less weight, respectively, than mental vitality.

This approach to understanding information integration has been applied to various topical domains, including participants' perceptions of health risks (Muñoz Sastre et al., 1999), mountain sport generally (Fruchart & Rulence-Pâques, 2019), and risks in mountain sport specifically (Chamarro et al., 2019). Muñoz Sastre et al. (1999) studied how smokers integrated risk information about their daily cigarette consumption and the cigarette's nicotine concentration to judge the relationship between cigarette exposure and risk of lung cancer. These researchers' main finding was that the judgment of cancer risk increased as the level of smoking increased, with the number of cigarettes

smoked interacting with the nicotine concentration in type of tobacco. The pathway lines formed a fan open to the right; the integration rule was conjunctive. Fruchart and Rulence-Pâques (2019) investigated the way in which non-athletes, mountain athletes, and non-mountain athletes combined five different informational cues (relatedness, autonomy, competence, risk taking, and weather conditions) in judgments of the degrees of arousal and satisfaction they experienced during mountain hiking. There were no differences between the three groups. In all three groups, the influence of relatedness and risk taking on judgments of arousal differed from the influence of satisfaction judgments. In the relatedness by risk taking interaction, pathway lines were parallel, and the integration rule was additive. Chamarro et al. (2019) examined how climbers combined available information on environmental conditions and personal resources when judging the risk to their safety. They found that all the information factors had a highly significant influence on risk judgment, and participants applied different integration rules to different combinations of factors. For example, in applying the interactive influence of task difficulty by confidence i, the pathway lines were parallel; and the integration rule was additive. In applying both the interactive influence of task difficulty by meteorological conditions and the interactive influence of task difficulty by carrying appropriate tools, the pathway lines formed a fan open to the right; and the integration rule was conjunctive.

The information integration approach has also been used to map research participants' judgment positions (i.e., to identify qualitative, personal differences in views regarding judgment). By means of cluster analysis, this approach can describe potential radically different positions within raw data (in contrast to the use of an individual design) and reveal individual differences in information integration processes. Recent applications of this technique can be found in sport psychology (e.g., Fruchart & Rulence-Pâques, 2020) and health (e.g., Muñoz Marco et al., 2017). Fruchart and Rulence-Pâques (2020) mapped how adolescents, young adults, and middle-aged adults cognitively combined five elements when estimating their level of well-being in sport. All five elements had a significant impact on judgments of well-being, and two well-being judgment positions were identified, with each characterized by different cognitive processes (an additive rule in the moderate well-being position and a disjunctive rule in the high well-being position), and with both associated with the participants' age. Muñoz Marco et al. (2017) mapped how children and adolescents judged the risk of catching a disease from sick friends. They estimated this risk transmission in scenarios that were constituted from information about type of contact, type of disease, and number of contacts, and they identified six risk judgment positions.

The Present Study

Our objective in this study was to map participants' positions on mountain hiking according to two risk dimensions (risk judgment and risk taking), by identifying how people cognitively integrated these three information factors that have often been

described in the literature on risk in mountain sports that correspond to antecedents of personal confidence in this context (Males et al., 2015). During mountain activities, individuals may be aware of immediate danger, and they may develop a confidence frame or "psychological bubble" from within which they cope with risk or enjoy the sports situation (e.g., Houge Mackenzie & Kerr, 2014). This "bubble" might be a primary psychological construct affecting their subjective judgment of risk. This confidence frame provides feelings of safety from risk, and it is often operationalized as an individual's confidence in their equipment, their own knowledge and skills, and/or their knowledge and skills of others in their activity group (Apter, 2001). The development of this confidence frame may generate different levels of risk in these activities (Kerr & Houge Mackenzie, 2012). Within a confidence frame, risk taking can be experienced as exciting, and without it, people may feel particularly anxious and scared. Thus, Males et al. (2015) proposed three antecedent factors of the confidence frame in the sports domain: self, team, and environment. Self may refer to previous experience and accomplishments in the activity considered. Team may concern the support provided by social relationships. Environment may reflect equipment and other circumstances that ensure a favorable situation. We then mapped participants' positions on risk judgment and risk taking in mountain hiking by identifying the ways in which they cognitively combined these three antecedents of the confidence frame (environment, team, and self). First, we hypothesized that we would find several different positions on risk judgment and risk taking (e.g., Fruchart & Rulence-Pâques, 2020). Depending on their cluster position, participants might combine or integrate the three antecedents of the confidence frame in different ways. They might develop different (additive, disjunctive, and conjunctive) rules of integration. Risk judgment and risk taking would be differently correlated across the sample, with no correlation (Brewer et al., 2007), a positive correlation, or a negative correlation (Reyna & Farley, 2006). Second, we hypothesized that the participants' position would be linked to their individual characteristics (i.e., how often they went mountain hiking, and their sex) (e.g., Fruchart & Rulence-Pâques, 2019) such that a risk position characterized by high risk judgment and low risk taking would be linked to being females and inexperienced, while a risk position characterized by low risk judgment and high risk taking would be linked to being male and experienced.

Method

Participants

The participants were 395 students attending a sport university located in a mountain environment in France (Males = 220, M_{age} = 21.35, SD = 2.25; Females = 175, M_{age} = 21.86, SD = 3.04). We only included people who reported prior experience hiking in a mountain environment. Participation was voluntary and not remunerated.

After obtaining the Dean's approval of the research protocol, we contacted students, explained the study's objectives and procedures, and invited students to

participate. When a student provided informed written consent to participate, a study appointment was arranged. Each participant had to state the frequency with which they went hiking in the mountains: very rarely ($n = 89$), sometimes ($n = 179$), and often ($n = 127$).

Materials

The materials were comprised of two questionnaires we designed (one on risk judgment and the other on risk taking). Each included a set of cards bearing a scenario, a question, and a rating scale. Each scenario was designed to have three within-subject factors: (a) Environment (with vs. without appropriate equipment), (b) Team (participation with inexperienced people vs. experienced people), and (c) Self Experience (No experience or knowledge vs. prior experience or knowledge). Hence, a 2 x 2 x 2 factorial design yielded 8 scenarios.

One typical scenario was as follows: "Jean Dubeut is on holiday in the mountains and is thinking about going for a mountain hike: this would involve more than six hours of walking, 1200 m of climbing, steep slopes, sometimes loose terrain, and some narrow paths with a sheer drop on both sides. Jean is in good physical condition. He is not very well equipped for this hike (no hiking boots, no hiking clothing, and no walking sticks). He will be hiking with people with experience at mountain hiking. Jean has already done difficult hikes in the mountains."

In the first questionnaire (risk judgment), the question below each scenario was: "If you were Jean Dubeut, how risky would you perceive the planned mountain hike to be?" Beneath each question was an 11-point response scale, with "Not at all risky" indicated on the left and "Extremely risky" indicated on the right. In the second questionnaire (risk taking), the question below each scenario was: "If you were Jean Dubeut, to what extent would you take the risk of going on the mountain hike?" Again, beneath each question was an 11-point response scale with "Not at all" indicated on the left and "Absolutely" indicated on the right.

Procedure

We performed the study in accordance with the ethical tenets of the Declaration of Helsinki and the ethical standards of our local institutional review board with the university's ethical standards. Participants were tested individually in a room at the university after they gave their written consent.

In line with Anderson (2008), we used a familiarization phase and an experimental phase. In the familiarization phase, the experimenter explained the procedure to each participant by informing the participant that their task was to read scenarios on a person's planned mountain hike and then indicate the degree of perceived risk (questionnaire 1) or willingness to take the risk of going on a planned hike (questionnaire 2). During this familiarization phase, each participant was presented with three scenarios that were selected to expose them to the full range of

informational stimuli related to their confidence frame. At the end of this phase, the participants could review their three answers and change them if they wished. In the second (experimental) phase, all eight factorial design scenarios were presented to the participants. In contrast to the familiarization phase, the participants were not allowed to review or change their answers during the experimental phase. Half of the participants were presented with the risk judgment questionnaire first and the risk-taking questionnaire second. The other half were presented with the questionnaires in the reverse order.

Data Analysis

Each participant's assessments of risk judgment and risk taking during the experimental phase were converted into numerical values corresponding to the distance between the point checked by the participant on the response scale and the left anchor (i.e., the point of origin). These numerical values were then entered into graphical and statistical analyses.

To test our first hypothesis, we used a two-step cluster analysis (hierarchical and then non-hierarchical cluster analysis) to obtain a robust solution (e.g., Martinent et al., 2013). First, we used a hierarchical cluster analysis based on Ward's linkage method with a squared Euclidian distance (Randriamihamison et al., 2021) measure to determine the number of clusters in the data from the agglomeration schedule coefficients and the dendrogram. A fully repeated-measure ANOVA with cluster membership as a between-subject factor, the three factors as independent variables (Environment, Team, and Self Experience), and we then estimated means as the dependent variables to check whether the cluster solution was valid (Aldenderfer & Blashfield, 1984). Second, we performed a *k*-means non-hierarchical cluster analysis by specifying the cluster solution. This clustering approach has been used to map different individual positions in the process of making sports judgments (e.g., Fruchart et al., 2019).

Several separate fully repeated-measures ANOVAs were conducted on the data from each cluster. A graphical (visual) assessment was used to determine which information integration rules had been applied in the various clusters. We used chi-square tests to establish whether cluster groups were associated with participants' sex and/or their level of experience in mountain hiking. Last, we computed bivariate correlations between the data from each risk judgment cluster and the data from each risk-taking cluster using Pearson's r coefficients, with statistical significance set to $p < .05$.

Results

Cluster Analyses

The results of the hierarchical analysis suggested a tenable four-cluster solution (K = 4). A *k*-means cluster analysis of a four-cluster solution was then conducted, and the four-cluster solution was found to be similar for the two stages of the cluster analysis. A fully

Table 1. Main Results of the ANOVA Cluster x Risk x Environment x Team x Self.

	Effect		Error				
Factor	*df*	*MS*	*df*	*MS*	*F*	*p*	η^2_p
CLUSTER	3	586.10	391	2686.61	28.43	<.001	.18
RISK x CLUSTER	3	4444.21	391	2283.96	253.72	<.001	.66
ENVIRONMENT x CLUSTER	3	313.50	391	1151.07	35.50	<.001	.21
TEAM x CLUSTER	3	461.04	391	987.68	79.74	<.001	.82
SELF x CLUSTER	3	238.32	391	894.90	34.71	<.001	.76

repeated measures 4 Cluster x 2 Risk x 2 Environment x 2 Team x 2 Self Experience ANOVA revealed that the four Cluster subgroups were significantly different ($p < .05$) (see Table 1), confirming a four-cluster solution.

Tukey's test revealed a significant difference ($p < .001$) between Cluster 1 ($M = 4.83$; $SD = 0.06$) and the three other clusters: Cluster 2 ($M = 5.68$; $SD = 0.13$), Cluster 3 ($M = 5.21$; $SD = 0.05$), and Cluster 4 ($M = 5.64$; $SD = 0.08$); and it also showed significant differences between Cluster 3 and Cluster 2 and between Cluster 3 and Cluster 4. The difference between Cluster 2 and Cluster 4 was not significant ($p = .999$).

Repeated-Measures Analyses of Variance and Graphical Analysis

Overall Repeated-Measures Analyses of Variance. A first set of four fully repeated-measures ANOVAs (one for each cluster) was performed on the whole set of raw data. The design for each was a 2 Risk x 2 Environment x 2 Team x 2 Self Experience ANOVA. The main results are summarized in Table 2 and the four clusters are depicted in Figures 1 and 2. Figure 1 characterizes the four clusters according to judgment of risk and risk taking. Figure 2 illustrates the combined effects of the Risk, Team, and Self Experience factors on the participants' estimations in each cluster. The pairs of panels (a) to (d) corresponded to clusters 1 to 4, respectively. In Figure 2, for each pair of graphs, one corresponds to risk judgment and the other corresponds to risk taking. The estimated mean ratings are plotted on the y-axis. The two levels of the Self Experience factor are plotted on the x-axis. Each line corresponds to one level of the Team factor.

Cluster 1 contained 117 participants (30% of the total). The mean risk judgment rating ($M = 4.64$, $SD = 0.21$) for Cluster 1 was slightly lower than the risk-taking rating ($M = 5.00$, $SD = 0.19$). In both panels of Figure 2, the lines formed a broad fan opening to the left, indicating that the participants in this cluster used a disjunctive integration rule for risk judgment and risk taking.

Cluster 2 contained 27 participants (7% of the total). For Cluster 2, the mean risk judgment rating ($M = 5.52$, $SD = 0.69$) and mean risk-taking rating ($M = 5.84$, $SD = 0.82$) were not significantly different. The lines in the left panel (risk judgment) were parallel, indicating that the integration rule was additive. The lines in the right panel

Table 2. Main Results of the ANOVAs of Each Cluster.

	Effect		Error				
Factor	*df*	*MS*	*df*	*MS*	*F*	*p*	η^2_P
CLUSTER 1							
Risk	1	59.95	116	4.20	14.28	<.001	.11
Environment	1	0.28	116	2.60	1.21	.742	.00
Team	1	2.54	116	2.11	1.20	.274	.01
Self	1	0.90	116	1.80	0.50	.481	.00
CLUSTER 2							
Risk	1	11.02	26	2.81	3.92	.058	.13
Environment	1	232.61	26	8.73	26.65	<.001	.51
Team	1	422.06	26	4.00	105.51	<.001	.80
Self	1	204.19	26	5.29	38.58	<.001	.60
CLUSTER 3							
Risk	1	2648.22	178	4.93	536.72	<.001	.75
Environment	1	58.69	178	2.16	27.11	<.001	.13
Team	1	25.83	178	2.31	11.20	<.001	.06
Self	1	14.25	178	1.82	7.85	<.001	.04
CLUSTER 4							
Risk	1	1850.35	71	11.90	155.54	<.001	.69
Environment	1	59.59	71	3.35	17.80	<.001	.20
Team	1	53.39	71	3.22	16.59	<.001	.19
Self	1	19.01	71	3.18	5.98	.017	.08

Note. Threshold for statistical significance: $p < .05$.

(risk taking) formed a small fan opening to the left, indicating that the integration rule was disjunctive. Hence, participants in Cluster 2 used an additive integration rule for risk judgment but a disjunctive integration rule for risk taking.

Cluster 3 contained 179 participants (45% of the total). In Cluster 3, the mean risk judgment rating ($M = 6.17$, $SD = 0.14$) was markedly higher than the mean risk-taking rating ($M = 4.25$, $SD = 0.19$). In both panels, all the lines were parallel, indicating that the participants in Cluster 3 used an additive integration rule for both risk judgment and risk taking.

Cluster 4 contained 72 participants (18% of the total). In Cluster 4, the mean risk judgment rating ($M = 4.37$, $SD = 0.43$) was markedly lower than the mean risk-taking rating ($M = 6.91$, $SD = 0.29$). The lines in the left panel (risk judgment) were parallel, indicating that the integration rule was additive. The lines in the right panel (risk taking) formed a small fan open to the left, which indicated that the integration rule was disjunctive. As was seen in Cluster 2, the participants of Cluster 4 used an additive integration rule for risk judgment and a disjunctive integration rule for risk taking.

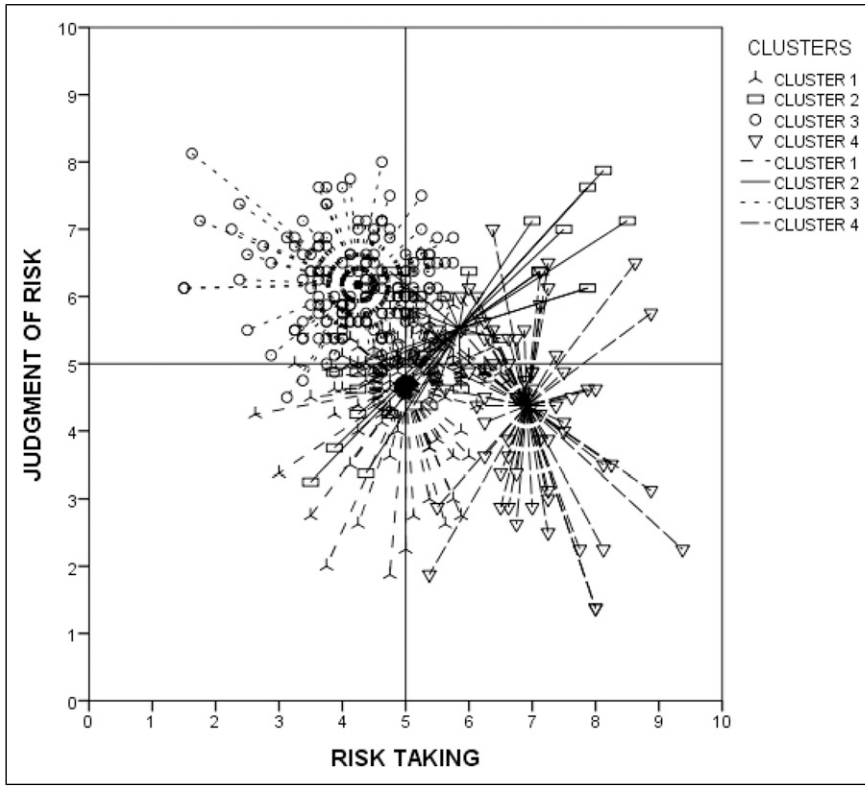

Figure 1. Characterization of the Four Clusters According to Judgment of Risk and Risk Taking

Risk Judgment

A second set of four fully repeated-measures ANOVAs were conducted on the risk judgment data from each cluster (Table 3). All three factors were statistically significant ($p < .05$) in each cluster (see Table 3). The Environment × Team × Self Experience interaction was not significant in Cluster 1, Cluster 2 or Cluster 4 but was significant in Cluster 3. The estimated mean risk judgment ratings for each variable and each cluster are shown in Table 4.

Risk Taking

A third set of four fully repeated-measures ANOVAs was conducted on the risk taking data. The findings of the ANOVAs performed on each cluster are presented in Table 5. The three factors were all statistically significant ($p < .05$) in each cluster. The Environment × Team × Self Experience interaction was not significant in Cluster 2 or

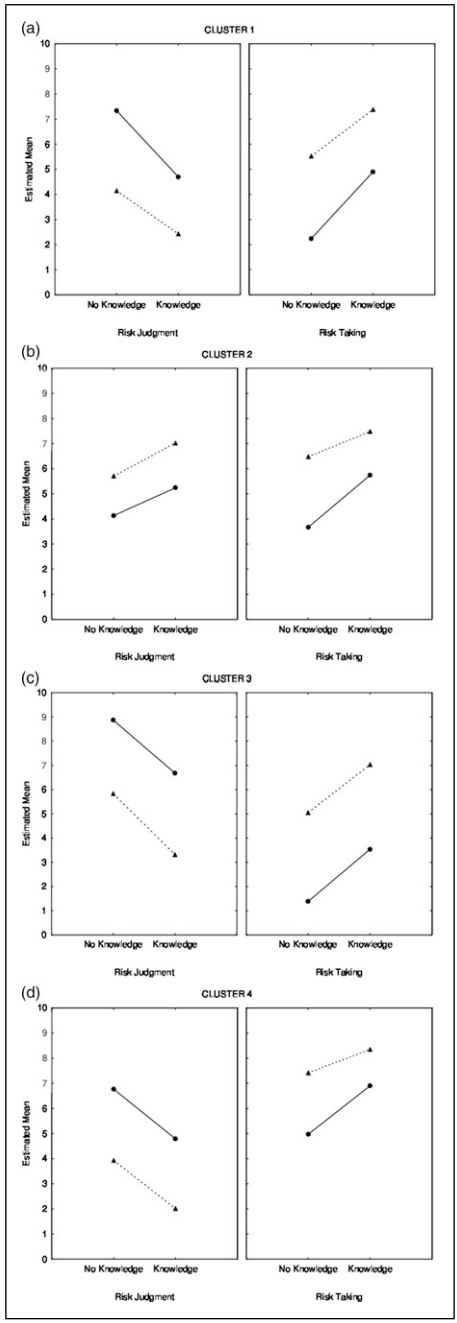

Figure 2. The Combined Effects of Risk, Team and Self on Participants' Estimations in Each Cluster.
Note. Dotted lines correspond to participation by experienced people, and solid lines correspond to participation by inexperienced people.

Table 3. Results of the ANOVAs of Each Cluster (Risk Judgment).

	Effect		Error				
Factor	*df*	*MS*	*df*	*MS*	*F*	*p*	η^2_P
CLUSTER 1							
ENVIRONMENT (E)	1	2076.11	116	4.79	433.42	<.001	.79
TEAM (T)	1	1750.43	116	3.41	512.98	<.001	.82
SELF (S)	1	1107.18	116	3.01	367.93	<.001	.76
E x T	1	5.24	116	2.46	2.12	.147	.02
E x S	1	0.15	116	1.97	0.08	.780	.00
T x S	1	50.77	116	1.64	30.92	<.001	.21
E x T x S	1	1.38	116	2.46	0.56	.455	.00
CLUSTER 2							
ENVIRONMENT (E)	1	86.89	26	7.36	11.80	.002	.31
TEAM (T)	1	151.67	26	3.23	46.83	<.001	.64
SELF (S)	1	79.44	26	4.25	18.71	<.001	.41
E x T	1	8.56	26	1.80	4.75	.038	.15
E x S	1	7.78	26	2.48	3.13	.088	.11
T x S	1	0.56	26	2.55	0.22	.643	.00
E x T x S	1	0.01	26	6.32	0.01	.978	.00
CLUSTER 3							
ENVIRONMENT (E)	1	2168.05	178	3.70	586.54	<.001	.77
TEAM (T)	1	3668.48	178	5.24	699.87	<.001	.79
SELF (S)	1	1980.35	178	2.92	678.34	<.001	.79
E x T	1	388.63	178	2.24	174.43	<.001	.49
E x S	1	62.01	178	2.21	28.02	<.001	.14
T x S	1	9.40	178	1.48	6.36	.012	.03
E x T x S	1	19.24	178	2.34	8.23	.005	.04
CLUSTER 4							
ENVIRONMENT (E)	1	610.50	71	3.08	198.04	<.001	.74
TEAM (T)	1	1136.25	71	4.33	262.25	<.001	.78
SELF (S)	1	546.39	71	2.92	186.97	<.001	.79
E x T	1	4.52	71	1.74	2.60	.111	.04
E x S	1	1.09	71	2.11	0.51	.476	.01
T x S	1	0.14	71	1.54	0.09	.764	.00
E x T x S	1	4.88	71	1.58	3.08	.083	.04

Table 4. Means and SDs of Rrisk Judgment and Rrisk-Taking scores for the Three Factors in Each Cluster.

	RISK judgment								RISK taking							
	Cluster 1		Cluster 2		Cluster 3		Cluster 4		Cluster 1		Cluster 2		Cluster 3		Cluster 4	
Factor	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
ENVIRONMENT																
No appropriate equipment	**6.13**	0.24	**4.89**	0.64	**7.40**	0.15	**5.40**	0.34	**3.49**	0.17	**5.00**	0.76	**2.73**	0.18	**6.33**	0.22
Appropriate equipment	**3.16**	0.17	**6.15**	0.59	**4.94**	0.13	**3.35**	0.33	**6.52**	0.21	**6.67**	0.51	**5.77**	0.16	**7.49**	0.31
TEAM																
Accompanied by non-competent people	**6.01**	0.23	**4.69**	0.62	**7.77**	0.14	**5.78**	0.38	**3.57**	0.18	**4.70**	0.75	**2.46**	0.15	**5.93**	0.25
Accompanied by competent people	**3.28**	0.15	**6.36**	0.47	**4.57**	0.17	**2.97**	0.31	**6.45**	0.20	**6.98**	0.48	**6.04**	0.18	**7.89**	0.29
SELF																
No experience or knowledge	**5.74**	0.20	**4.91**	0.63	**7.35**	0.12	**5.35**	0.37	**3.88**	0.17	**5.07**	0.68	**3.21**	0.13	**6.19**	0.24
Experience or knowledge	**3.56**	0.18	**6.12**	0.49	**5.00**	0.14	**3.40**	0.29	**6.14**	0.18	**6.61**	0.57	**5.28**	0.17	**7.63**	0.17

Table 5. Results of the ANOVAs of Each Cluster (Risk Taking).

	Effect		Error				
Factor	*df*	*MS*	*df*	*MS*	*F*	*p*	η^2_P
CLUSTER 1							
ENVIRONMENT (E)	1	2145.18	116	4.09	524.77	<.001	.82
TEAM (T)	1	1944.23	116	3.89	499.36	<.001	.81
SELF (S)	1	1198.16	116	2.65	451.68	<.001	.80
E x T	1	42.31	116	2.13	19.86	<.001	.15
E x S	1	8.46	116	2.37	3.57	.061	.03
T x S	1	37.36	116	2.58	14.47	<.001	.11
E x T x S	1	14.63	116	1.62	9.03	.003	.07
CLUSTER 2							
ENVIRONMENT (E)	1	150.00	26	4.03	37.23	<.001	.59
TEAM (T)	1	280.17	26	2.96	94.50	<.001	.78
SELF (S)	1	127.57	26	2.81	45.33	<.001	.63
E x T	1	12.51	26	2.36	5.35	.029	.17
E x S	1	1.85	26	1.44	1.28	.266	.05
T x S	1	15.57	26	2.89	5.39	.028	.17
E x T x S	1	0.67	26	1.21	0.55	.465	.02
CLUSTER 3							
ENVIRONMENT (E)	1	3194.40	178	4.81	684.57	<.001	.79
TEAM (T)	1	4590.85	178	4.44	1034.20	<.001	.85
SELF (S)	1	1533.75	178	2.79	550.13	<.001	.76
E x T	1	332.47	178	2.40	138.26	<.001	.43
E x S	1	66.25	178	1.66	39.80	<.001	.18
T x S	1	2.51	178	1.87	1.35	.247	.01
E x T x S	1	6.71	178	2.34	2.87	.092	.02
CLUSTER 4							
ENVIRONMENT (E)	1	190.21	71	4.44	42.88	<.001	.38
TEAM (T)	1	546.39	71	4.32	126.47	<.001	.64
SELF (S)	1	296.13	71	3.57	82.94	<.001	.54
E x T	1	2.13	71	1.29	1.65	.203	.02
E x S	1	0.04	71	1.44	0.03	.862	.00
T x S	1	35.50	71	1.74	20.39	<.001	.22
E x T x S	1	33.54	71	14.25	2.35	<.001	.16

Cluster 3 but was significant in Cluster 1 and Cluster 4. Table 4 shows the estimated mean risk-taking rating for each variable in each cluster.

Correlations Between Risk Judgment and Risk Taking

For each cluster, we computed the correlation between the mean risk judgment rating and the mean risk-taking rating. In Cluster 1, the risk judgment was significantly and inversely correlated with risk taking ($r = -.303$, $p < .001$). In Cluster 2, the risk judgment was not significantly correlated with risk taking ($r = -.349$, $p = .075$). In Cluster 3, the risk judgment was significantly and inversely correlated with risk taking ($r = -.292$, $p < .001$). In Cluster 4, the risk judgment was significantly and inversely related to risk taking ($r = -.594$, $p < .001$).

Chi-Square Test for Sex Differences

Table 6 shows the composition of each cluster in terms of the participants' sex. The 2 Sex (male/female) × 4 Cluster Pearson's chi-square test was significant, $\chi^2(3) = 18.23$, $p < .001$. The 3 Frequency (very rarely/sometimes/often) × 4 Cluster Pearson's chi-square test was not significant, $\chi^2(6) = 8.14$, $p = 228$.

Discussion

Our objective in the present study was to map various participant positions on risk judgment and risk taking according to how participants integrated information pertaining to the three antecedent factors of the confidence frame (environment, team, and self-experience). Our first hypothesis was that there would be several different risk positions (i.e., different participants would integrate the information pertaining to the three factors differently ways (e.g., Fruchart & Rulence-Pâques, 2020). This hypothesis was confirmed because an analysis of the whole set of raw data from the two questionnaires revealed three positions about risk. The first position corresponded to Cluster 1, the second corresponded to Cluster 3, and the third position corresponded to Clusters 2 and 4. Our second hypothesis that the clusters' composition would be linked to how often the participants went mountain hiking and to the participants' sex (e.g., Fruchart

Table 6. Sex Composition of the Four Clusters.

Participants	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4	Total
Males	70 (31.8%)	16 (7.3%)	81 (36.8%)	53 (24.1%)	220
Females	24 (26.9%)	33 (6.3%)	37 (56.0%)	19 (10.9%)	175
Total	117 (29.6%)	62 (6.8%)	63 (45.3%)	72 (18.2%)	395

Note. The difference between the percentages was statistically significant ($p < .001$) in the 2 (Sex) x 4 (Cluster) Pearson's chi-square test.

& Rulence-Pâques, 2019) was partially confirmed in that only sex (as opposed to hiking frequency) was associated with the cluster compositions. These results were not consistent with findings from Walker & Latosuo (2016), in which male and female guides did not differ significantly with regard to personal risk tolerance, possibly due to differences between the study populations; participants in Walker & Latosuo (2016) were professional guides who hiked frequently, while our participants were college students with some hiking experience.

Our findings confirmed that the relationship between risk judgment and risk taking is complex (Schürmann et al., 2019) for many reasons. Various factors (such as the antecedents of confidence frame) may impact people's connections with risk, and these different factors may be cognitively combined by individuals when judging/taking risks. Some individual characteristics (such as sex) may influence how people integrate these factors for judging and taking risks, since our first overall analysis showed that the participants varied with regard to judging a risk and (hypothetically) taking a risk.

Risk Position 1 (Cluster 1): Use of a Disjunctive Integration Rule

For the first risk position, people used the same disjunctive integration rule for both risk judgments and risk taking. When the hiker's Self Experience factor (experience and knowledge) was present, it was given considerable weight; with weight given to the Team factor (participation with (in)experienced people) reduced proportionally.

The risk judgment level was slightly lower than the risk-taking level, and this position was more frequently endorsed by males than by females. This is consistent with prior literature showing that males perceive activities to be less risky and are more likely to take risks than females are (Reniers et al., 2016; She et al., 2019; Willick et al., 2019). The lower the judged risk, the more likely the people were to take it. This position confirms a previously discovered negative correlation between risk judgment and risk taking (Reyna & Farley, 2006).

Risk Position 2 (Clusters 2 and 4): Use of an Additive Integration Rule for Risk Judgment and a Disjunctive Integration Rule for Risk Taking

In the second risk position (Clusters 2 and 4), the integration rule used for risk judgment (additive) differed from the integration rule used for risk taking (disjunctive). With regard to risk judgment, the Self and Team factors had the same weight, but for risk taking, the Team factor was given less weight by experienced, knowledgeable hikers.

The participants represented in Cluster 2 judged mountain hiking to be sometimes risky, and they sometimes took risks. As suggested by Brewer et al. (2007), risk judgment was not linked to risk taking. The position in Cluster 2 was more frequently endorsed by males than by females. This result extends previous findings of sex differences in risk judgment and risk taking (e.g., Reniers et al., 2016; Willick et al.,

2019), by further stipulating the absence of a link between risk judgment and risk taking among males.

For members of Cluster 4, their risk judgment level was clearly lower than their risk-taking level. The less they estimated risk, the more likely they were to take risks. This position confirmed the previously reported negative correlation between risk judgment and risk taking (Reyna & Farley, 2006). However, this correlation was stronger in this second position than in the first position. The position in Cluster 4 was more frequently endorsed by males than by females, confirming that males judged the risks to be low and therefore took risks more readily (e.g., Willick et al., 2019).

Risk Position 3 (Cluster 3): Use of an Additive Integration Rule

In the third risk position, people used the same (additive) integration rule for both risk judgment and for risk taking. Whatever the situation, the Self Experience and Team factors had the same weight in the integration process: the greater the hikers' levels of knowledge and experience (the Self Experience factor) and the greater the extent of their participation with experienced hikers (the Team factor), the lower their risk judgement level. Conversely, the greater their levels of knowledge and experience and the greater the extent of participation with experienced people, the greater the risk taking.

The members of this position judged mountain hiking to be very risky and so did not wish to risk engaging in this activity. We observed that the higher the estimated risk, the less likely people were to take it. This position was more frequently endorsed by females than males, confirming that females perceive the mountains to be more risky and take fewer risks than males do (Reniers et al., 2016; Willick et al., 2019)

The Relationship Between Risk Judgment and Risk Taking

Our results highlighted the existence of two different relationships between risk judgment and risk taking: a negative relationship and no relationship (Mills et al., 2008; Reyna & Farley, 2006). Our results did not reflect the positive relationship between these variables highlighted by Reyna and Farley (2006), perhaps because the latter researchers studied adolescents, while we studied young adults and these populations may differ in their views of risk (Frühauf et al., 2020).

We found a negative relationship between risk judgment and risk taking. Three types of negative relationships were identified: (a) low risk judgment scores and high risk-taking scores (mainly male participants), (b) high risk judgment scores and low risk-taking scores (mainly female participants), and (c) intermediate risk judgment scores and slightly higher risk-taking scores (mainly male participants).

Although our results highlighted differences in ways of thinking about risk, one finding was consistent in all risk positions: the three confidence antecedents (i.e. self-experience, team, and environment (Males et al., 2015)) were negatively associated with risk judgment and positively associated with risk taking. Individuals considered

mountain hiking to be riskier if they did not have appropriate equipment, if they were accompanied by inexperienced, non-competent people, and if they had no practical personal experience or knowledge. Conversely, individuals considered taking more risks in the mountains if they had appropriate equipment, were accompanied by experienced, competent people, and had prior experience. This finding confirms that people who participate in mountain activities may take risks that align with their confidence frame (e.g., Houge Mackenzie & Kerr, 2014). Our observation of several different risk positions suggests that the emergence of a confidence frame produces different views of risk during mountain activities (Kerr & Houge Mackenzie, 2012). Our results extend earlier findings in this area by emphasizing the different ways in which confidence frames may be integrated into risk judgments and risk taking.

Limitations and Directions for Further Research

Among our study's limitations is that we used only three kinds of confidence frame antecedents (environment, team, or self-experience); others should be investigated in the future (Males et al., 2015). Second, our three independent variables were associated with only two modalities or levels (e.g. with or without equipment for Environment). In future research, all independent variables might include at least three modalities to further facilitate the identification of integration rules used by the participants (Anderson, 2008). Third, a third dependent variable could have usefully completed our experimental design. Just as information integration theory has been used to investigate the acceptability of an act in sport (Fruchart et al., 2019), the acceptability of risk could also be studied. Risk acceptability is essential for understanding the complex construction of risk taking (Tchiehe & Gauthier, 2017). Fourth, given that adolescents and adults may differ in their approach to risk (Frühauf et al., 2020), further studies should map the cognitive processes involved in risk judgment and risk taking by participants of varying ages. Fifth, we did not probe other risk factors reported in the literature, such as years of experience (e.g., Mannberg et al., 2018) and age (e.g., Frühauf et al., 2020), or personal temperament, such as having a high level of self-belief (Clough et al., 2016) and self-efficacy (Houge Mackenzie et al., 2011). Thus, the practical implications of our study cannot necessarily be extrapolated to these higher-risk groups. Sixth, we studied university students, rather than a more diverse population of hikers in the general population, limiting our ability to generalize from these data. Last, the information integration approach was not ecological because we used imagined scenarios in a laboratory context and did not study these phenomena in real situations. While one might wonder whether these risk-related cognitive processes operate in real situations, the information integration approach has already been validated in the field of sport (Fruchart et al., 2007), such that judgment patterns obtained from a questionnaire closely matched real patterns obtained on the field. Furthermore, with this approach, we were able to identify the relative weights of various factors when they were cognitively integrated, allowing us to reveal the existence of different integration rules in

standardized, controlled situations. To complete this approach, a regression analysis would allow to confirm the relative weights of factors.

Conclusion

We mapped three different positions for risk judgment and risk taking. These positions were based on Anderson's integration rules and on how individuals cognitively combine three informational factors in their confidence frame (environment, team, and self). Our main results have implications for stakeholders in mountains sports, such as managers, coaches, mountain guides, instructors, ski patrollers, etc. In a mountain environment, a hiker must process several factors when making a judgment or a risk decision. Applying Anderson's (2008) information integration theory might provide solutions to these problems that enhance enjoyment of mountains sports and increase levels of safe participation.

First, risk judgments and decisions in outdoor mountain recreational environments are affected in complex ways by a wide range of interacting environmental and human factors. Individuals can specify the factors likely to influence their own risk judgments or risk-taking and communicate a rank order of importance for these factors. Second, the information integration approach is simple to implement via pencil and paper measures. Third, the information integration approach can answer a multitude of questions in the field of mountain sports when factors other than the three we chose (self-experience, team, and environment) are studied as well. Fourth, our approach might have value in teaching and training. For instance, scenarios dealing with problematic, potential risky situations (such as those in the present study) could be incorporated into briefings before a mountain hike, making the hikers' answers the starting points for training programs designed to reduce risky behaviors or increase hikers' levels of confidence (Mannberg et al., 2018). Fifth, our approach might be useful for risk prevention by helping to distinguish hikers on the basis of their views of risk and then suggesting appropriate activities. Further research should focus on accident prevention and the identification of risk factors for falls in mountain hikers. Knowledge of the specific internal factors (fatigue, fitness, experience, etc.) and external factors (weather, altitude, etc.) involved in mountain hiking accidents and how these factors are cognitively integrated by mountain hikers could be of the utmost importance for developing evidence-based preventive measures (Faulhaber et al., 2017) and risk learning (Landrø et al., 2022).

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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