A first analysis of ski touring near-miss and accident reports in the SERAC database
04/2020

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In spring 2020 (30/03/2020), the SERAC database contained 335 reports relating to mountaineering-type activities, namely high-mountain rock or traditional climbing, climbing on multi-pitch routes, snow, ice or mixed climbing, icefall climbing and ski touring. The remaining stories recounted events that occurred during single-pitch climbing (62), hiking (18), paragliding (2) and mountain biking (1).

In 162 reports, ski touring was the main type of activity involved, i.e., 48% of the mountaineering reports in SERAC (n=335). Ski touring is by far the most common activity in the SERAC database. This includes ski touring without lift assistance, ski mountaineering combining lifts and unassisted climbing, and gravity skiing, i.e., fully lift-assisted skiing on high-altitude terrain where nothing is signposted from the moment the skier leaves the infrastructures in place.

To read all of these stories, click here.

1. Benchmarks on the type and quantity of ski touring accidents reported in SERAC

1.1. Main types of event

*Reminder: In order to consider both minor incidents and serious accidents, we have chosen to place the undesired event at the moment when the situation can either lead to serious consequences or to an event causing no physical harm. In cases where a chain of events occurs with the potential to produce negative consequences, **the first event in the sequence is taken into account**. For example, if a fall results from a binding malfunction, the cause is considered to be equipment failure. If an avalanche is triggered by the collapse of a cornice, the latter is considered to be the cause of the event if it is clearly identifiable as having initiated the avalanche. If a fall is caused by an avalanche, the avalanche will be our focus.*
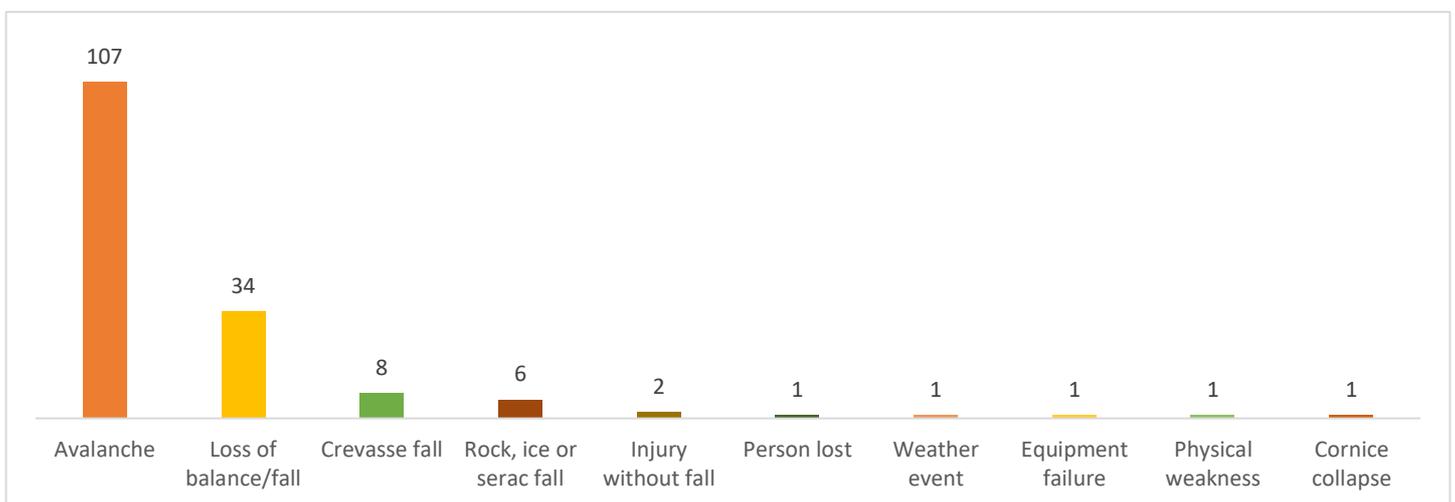
Figure 1: Main types of event relating to ski touring in the SERAC database

Interpretation: There are 107 avalanche stories in SERAC.

Avalanches are by far the most common type of undesired event reported in the ski touring reports submitted to SERAC, accounting for 65% of the incidents recounted (n=107). Falls, or losses of balance from which individuals recover just in time, feature in 21% of the stories.

It is interesting to compare this breakdown with that observed in the database of the French mountain rescue service (PGHM). According to the latter, **falls are the cause of the highest number of accidents requiring a rescue operation**, accounting for 34.2% of cases, while avalanches lead to "just" 10.4% of the rescue operations carried out. Falls are also the biggest cause of accidents leading to physical harm (injury or death)[1].

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[1] Data centralised by the National Mountain Safety Observation System (SNOSM) for the French mountain police force (PGHM) between 2008 and 2018: 5,469 skiers rescued over a 10-year period. The rescue operations carried out by the PGHM accounted for an average of 86.7% of the mountain rescue operations performed in France between 2015 and 2018.
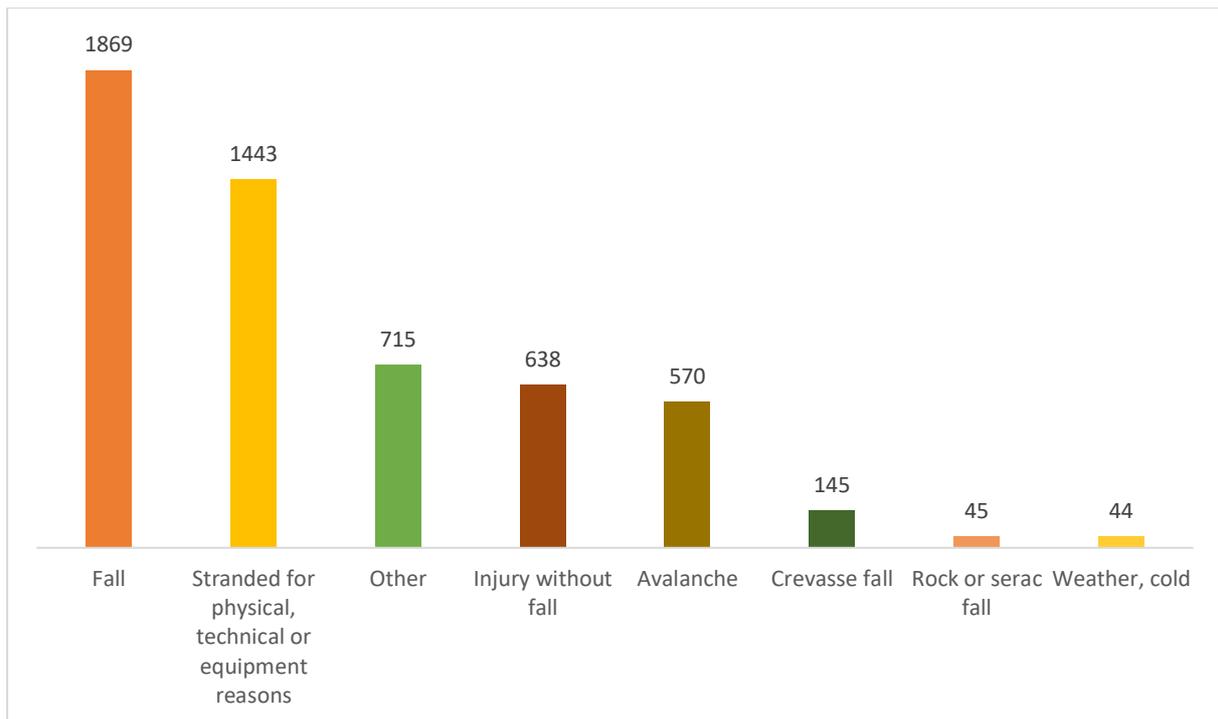
Figure 2: Causes of ski touring accidents leading to rescue operations by the PGHM between 2008 and 2018, according to the SNOSM

Interpretation: Between 2008 and 2018, 1,869 skiing accidents leading to rescue operations by the PGHM were caused by falls.

The high frequency with which avalanches are mentioned in SERAC should therefore be put into perspective. By focusing both on accidents and minor incidents, the SERAC database makes it possible to keep a trace of a large number of innocuous events that are not officially recorded by emergency or medical services. Indeed, **73% of the undesired events relating to skiing reported in SERAC** did not result in physical harm. It is therefore possible that many benign avalanche-related incidents are not included in the rescue data available, which would explain their over-representation in SERAC. This figure also offers an insight into **what skiers who submit reports to SERAC perceive to be the main risk they face**, which is apparently **not the type of accident most likely to prompt a rescue operation**. Skiers are more likely to share their experiences of a type of event that is perceived as common and particularly hazardous in their sport (avalanches), than to mention an event that they consider less serious (falls). There is also a more longstanding tradition of sharing experiences of avalanches and analysing the human factors involved in the latter than there is in the case of falls, which are more often associated with summer mountaineering. The risk of falling is more obvious than that of being caught in an avalanche, which is more insidious and not immediately visible. Any skier exposed to a vertical drop senses the risk of falling quite intensely. The fact that it is so obvious may lead an individual to believe that this type of risk requires less effort to counter or a less in-depth analysis of their behaviour than in the case of avalanches. Nonetheless, possible explanations and preventive measures for falls must obviously take into account the level of ability of skiers, but they appear to be more complex and to involve as many behavioural and perceptual mechanisms as decision making processes in avalanche areas. In any case, it is clear that **falls must not be ignored when seeking to reduce the risks faced by skiers**.

1.2. The context behind the triggering of avalanches

The stories recorded in SERAC do not all provide detailed information on the context in which an avalanche was triggered and its consequences. The following observations are therefore based on a smaller number of stories (between 72 and 87). Nonetheless, it is interesting to note that they concur in almost every respect with the observations of the National Association for the Study of Snow and Avalanches (ANENA) and therefore serve to reinforce the latter.

Human-triggered avalanches

88% of the avalanches reported were human in origin: 78% were triggered by the group affected and 10% by another group. In the latter case, the avalanche was directly linked to the presence of another group, which either led to the area being overloaded due to the proximity of the two groups, or to a slab avalanche being triggered by the group located higher up on the mountain. The remaining 12% appear to have been caused naturally. These results are within two points of being identical to the ANENA data, which identifies 90% of avalanches as being triggered by human activity. In some studies, a smaller proportion of avalanches are attributed to natural causes or identified as spontaneous[2]. This difference can be explained in two ways. Many of the stories in SERAC mention benign avalanche flows that make no contact with skiers. This type of incident, which is rarely included in rescue statistics, may explain the higher proportion of natural avalanches in the SERAC database. In addition, our analysis relies on the accounts of respondents and their interpretation of situations. It is possible that avalanches triggered from some distance away by skiers or another group may have been interpreted by respondents as having been spontaneous.

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[2] Out of 1,000 avalanches that led to casualties in France between 1998 and 2018, the National Association for the Study of Snow and Avalanches (ANENA) reports that 91% were accidental (triggered by skiers) and 9% were spontaneous. As regards the ski touring accidents that occurred between 2008 and 2018, ANENA identifies 90% of the avalanches involved as being human in origin (n=279). This proportion rises to 93.5% if we include off-piste skiing (total n=503).

In Switzerland, over the last 40 years, 95% of avalanche-related accidents have been caused by accidental avalanches and 5% by spontaneous avalanches. Harvey/Rhyner/Schweizer, *Avalanches- mieux les comprendre*, P30, published by the Swiss Alpine Club and the Swiss Federal Institute for Snow and Avalanche Research in Davos, SLF, 2013
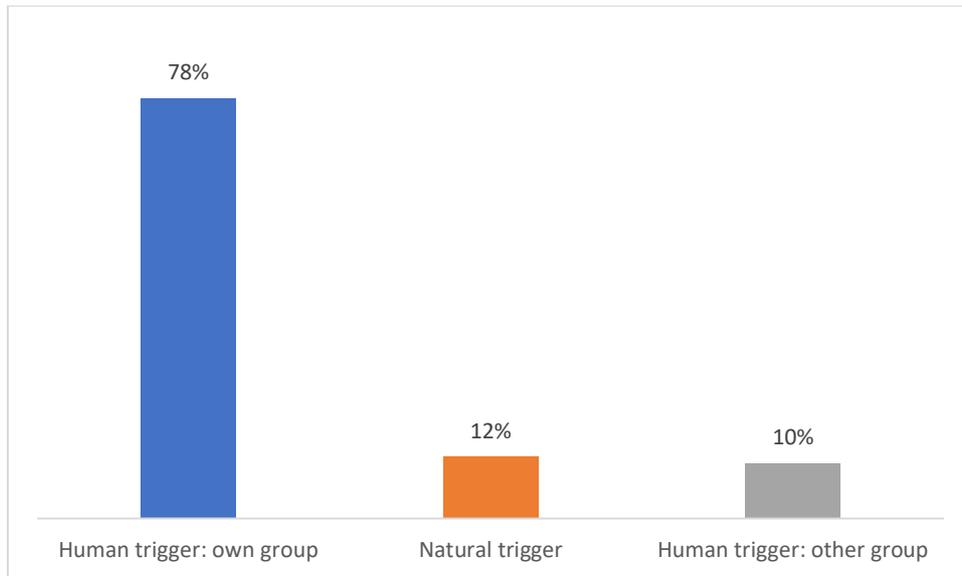
Figure 3: Causes of avalanches occurring during skiing outings in SERAC (n=87)

Interpretation: 78% of the avalanches reported in SERAC were triggered by the group itself.

Types of group involved

74% of the events reported involved a single group. In nearly 15% of cases, several independent groups were involved and were directly responsible for triggering an avalanche (overloading of the snowpack, difficulty involved in communicating safety and distancing instructions from one group to another, another group coming from above, etc.). Unlike in mountaineering (rock, snow, ice or mixed), solo outings are fairly common in ski touring, with 15% of cases involving lone individuals. The ANENA database also shows that 16% of avalanche accidents involve solo skiers.
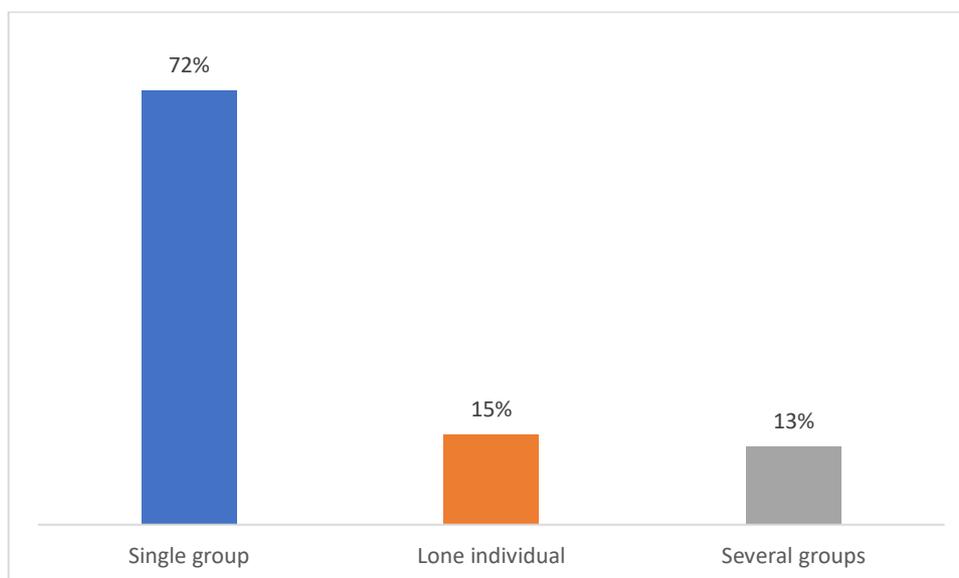

Figure 4: Skiers involved in undesired events in SERAC (n=72)

Interpretation: 15% of the individuals who reported an avalanche in SERAC were skiing alone

It is interesting to note **that 65% of the avalanches reported in SERAC occurred during the descent**. Beyond the mechanical explanations that point to differences between snowpack loads on the way up and on the way back down, it is important to consider how this result can be interpreted through the prism of human behaviour. There are likely to be factors at play relating to the speed at which skiers descend, which may give them less time to analyse the terrain and implement a risk management strategy (maintaining a distance, planning meeting points, etc.), particularly when the descent does not follow the same route as the ascent. Additionally, the exhilaration experienced during the descent, which is covered in section 2.1, can cause skiers to overlook the need for a proper risk analysis and to take insufficient measures to minimise the risks.

Consequences

The consequences of the avalanches reported by skiers in SERAC were mostly benign or relatively harmless: the victim was swept away but not buried in 49% of cases and not swept away at all in 36% of cases. The ANENA database confirms this proportion, with 49% of victims being swept away but not buried. These results are in line with the level of severity of the undesired events that skiers reported in SERAC, 73% of which did not lead to the outing being interrupted.
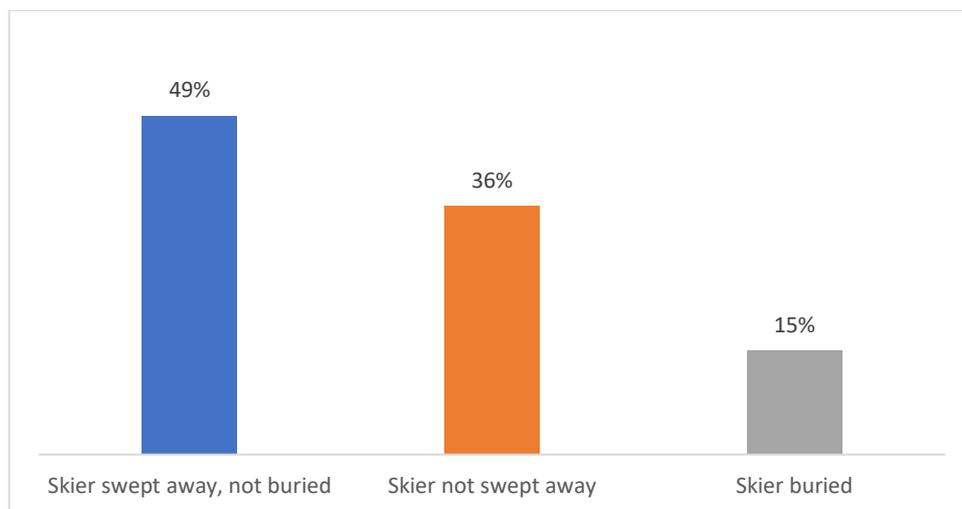

Figure 5: Consequences of avalanches occurring during skiing outings in SERAC (n=72)

Interpretation: 49% of skiers who reported an avalanche in SERAC were swept away but not buried.

Key points:

- Avalanches account for 65% of skiing-related events in SERAC.
- According to PGHM data, falls account for 34% of rescues and avalanches 10%.
- In 78% of cases, an avalanche is triggered by the group itself.
- 15% of avalanches in SERAC involve lone skiers.
- 65% of avalanches occur during the descent.
- 49% of skiers are swept away but not buried by the avalanche.

2. Factors that contribute to critical avalanche situations

Out of 162 stories, 72 provide details of the factors that led to an avalanche situation. The remainder of the analysis will focus on these 72 stories in an attempt to list the factors that contribute to hazardous situations during ski touring.

Reminder:
In the mountains, high-risk situations are complex, dynamic and subject to great uncertainty. They are multifaceted and the critical situations to which they lead generally involve multiple factors. What ingredients, elements and contributing factors combine to generate a situation where an individual loses balance and makes a final error (even slight) that can have dramatic consequences? It is no easy task to place these factors in order of importance so as to determine which event leads to the other and which is truly the "root cause". It is also difficult to establish causal links between the various elements of a situation, individual behaviours, the techniques used and the occurrence of an accident or, in other words, to identify the single factor that was key in enabling the undesired event to take place. Moreover, doing so could amount to an over-interpretation of the facts. The aim is more to describe what mountaineers perceive during a potentially hazardous situation, bearing in mind that none of the factors presented are necessarily dangerous or sufficient to cause an accident if considered in isolation.

2.1. Human factors lie at the heart of risk

Given the wide variety of situations recounted and the fact that we cannot verify the interpretations of individuals out in the field, technical causes and those relating to snow conditions are not examined here. Moreover, because little or nothing is known about the knowledge and experience of the respondents, making it impossible to compare each individual in those terms, it is more difficult to make general points regarding the decisions they made than it is with regard to causes that could be described as objective. Thus, the elements of these stories that are most worthy of further analysis are the impressions of skiers in terms of vigilance, their perception of danger, external influences and decision making. However, it is crucial to bear in mind that the reality of a situation is often more complex than

can be described in a story, making it impossible to model according to general laws. Whether or not a risk factor is mentioned depends on various elements relating to the non-exhaustive nature of the stories in SERAC or, quite simply, on whether or not individuals are conscious of the influence of these factors. The value of the stories recounted in SERAC therefore lies not so much in the ability to draw generalisations from recurring combinations of risk factors, but rather in the impact that certain contributing factors or accounts can have on individual attitudes. **Rather than focusing on the number of stories that refer to a particular factor, a spotlight is placed on the factors that may cause people to reflect on their approach and possibly even on the culture of the sport**. Consequently, the following synopsis does not use quantity as its only classification criterion, but tends to rely more on the quality of stories that have the ability to prompt personal reflection.

We will see that the factors identified relate in great part to influences commonly classed as **human factors**. Most notably, they appear to be consistent with the findings of the studies conducted by North American researcher Ian McCammon on the influence of heuristic traps in avalanche environments. His work and, more broadly, the research conducted in cognitive psychology on unconscious biases, but also in social psychology on the interactions between participants, offer useful interpretative pointers. In addition, risk and the willingness to confront it and accept it to a certain extent are intrinsic components of mountain pursuits. **Our relationship with risk and its representations is constructed both individually and socio-culturally**, while the accident processes stemming from these risks can be interpreted in a wide variety of ways.

The first significant finding that confirms the central role played by human beings in preserving their own safety is as follows: in **almost half of the stories submitted (49%, n=35) a risk is perceived, intuited or sensed** by the participants in a more or less conscious way, but they choose to stay committed. Conversely, 13% (n=10) of respondents report an avalanche event whose initiation or magnitude caught them completely by surprise.

During avalanche events more than in any other case, participants describe the feeling of perceiving the danger, or at least **an intuitive sense that something is wrong, but they "carry on regardless"**. Indeed, 35 participants state that they had sensed the danger, but that they remained committed for a variety of reasons, some of which they cannot explain themselves. The following excerpts illustrate the phenomenon:

Springtime snow slab at the Turia Refuge:

> *"We had anticipated that this eastern face would be quite risky, but we were expecting the weather to be overcast. Despite the fact that it was sunny when we arrived at La Gurraz, we decided to head up anyway. Big mistake!"*

Grand Sorbier:

> *"It's very simple. It was dangerous and I sensed that, but the urge was too strong, I was stupid. (…) I could sense the risk from the outset: strong winds meant that there were significant snow drifts and large accumulations of snow. But I was reassured by the climb to the Sorbier, which was nice and stable. On top of that, my eagerness to complete this route, the joy of carving the only tracks in the snow, the quality of the snow and the lovely weather overcame any doubts I had."*

Pic de Bure:

"Although we were aware that this combe is prone to slabs (which was why we had initially decided not to go there), the fact that there were so many skiers in the area, and perhaps also the frustration of not being able to ski the Combe de Mai, prompted us to head into it anyway."

There are many possible reasons why individuals stay committed to a route despite being aware of the risks – this awareness is merely relative because it is not necessarily linked to conscious factors – and SERAC cannot identify them all. Nonetheless, the following contributing factors seem to offer possible explanations or play a role in creating critical situations.

2.1.1. Focalisation on reassuring factors

Twenty-eight stories mention the influence of factors perceived as reassuring, or that the participants focused on such factors rather than on more ominous indicators. The "reassuring factors" identified in SERAC are as follows:
- Social influence.
- A route or section considered easy or low risk.
- Familiarity with the terrain or force of habit.
- A reassuring avalanche bulletin, ski lifts nearby, etc.

These factors lead to complacency when it comes to performing an individual or collective risk assessment. They tend to inhibit personal judgement and analysis, which often leads to reduced vigilance. The influence of reassuring factors can be coupled with the effects of "destinationitis", as explained in section 2.1.2. Here, even though they perceive the risk involved, the participant seeks more or less consciously to justify their decision to continue across hazardous terrain by focusing their attention on these reassuring indicators, or even by actively searching for them in the environment. These may then act as anchor points[3] for the individual's attention, thus hindering their perception of other danger indicators.

→ *Social influence*

Under the banner of "social influence", we have grouped together existing tracks on a slope, the presence of other groups on the same route and the obstinacy of one's own group. Social influence bears a strong relation to the cognitive bias of "social proof" identified by Ian McCammon (2002, 2004). **Social proof** is the tendency to consider behaviour to be acceptable from the moment that others engage in it. A rescuer from the PGHM highlights this tendency: "Skiers sometimes find a way of reassuring themselves. When lots of people have already passed through an area and when everything is tracked out, we all think that this means the risk is low."

We can see from different accounts that this social influence is often coupled with other effects such as the lure of a great descent or a degree of tiredness. The following example illustrates the social influence at play within a group, the influence of existing tracks in the

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[3] This relates to the anchoring bias examined by Kahneman (2011). This is the phenomenon whereby an individual attaches too much importance to the first impression gathered, from which they then struggle to detach their attention. This mechanism can be likened to confirmation bias, or consistency bias, where an individual only seeks out information that confirms their hypothesis (McCammon, 2004; Bellamy et. al, 2018). Anchoring is sometimes described slightly differently to refer to shared beliefs within a community of enthusiasts regarding the main risks encountered (e.g., avalanches, persistent weak layer), good practices, etc.

snow and the force of attraction of a good descent, even when the risk has been clearly identified. We also see other terrain-related factors come into effect ("the normal route isn't steep"), as well as a dynamic whereby skiers "always want to go a little further".

Petit Van:

> After climbing to the cross, we could see that the Vans valley was all white and seemed to have good snow cover. There were already several tracks. Snow was blowing off the ridges and looked to be settling on the north faces. **I told myself (and I said out loud) that it really wasn't the best day to be heading that way.** (…) Alex wanted to climb to the Vans: the snow looked just as good over there and there were tracks. After a discussion, **I ended up giving in. After all, the normal route isn't steep and there were already many tracks**.
> The snow was hard on the right bank of the Combe des Vans (the powder had been blown away), while the left bank was full of powder. We saw several people descending the NW couloir of the Petit Van and it looked like a powder fest! After reaching the pass, we headed towards the Petit Van, which was less exposed to the wind and less frozen than the summit slope of the Grand Van. Alex wanted to ski down the NW couloir. **I said no**, because slabs typically form on that side. **But several people had already taken that route and the skiing looked incredible, so I eventually agreed**."

The following example illustrates how difficult it is to stand firm against the will of a group, especially when one is tired, drawn towards a great descent or overcome by the urge to go a little further:

Mont Charvet:

> "When my companion reached me, I took off my skins. He was surprised, not to say annoyed by my decision, believing it to be premature, as if I were **"giving up"**. **He convinced me that the skiing was going to be excellent and that we would turn back if it looked risky**. The sense of danger remained with me, but I wasn't able to act on it (it had snowed less than 48 hours previously, it was windy, the consistency of the snow had changed and there was a sudden steepening of the slope ahead of us), probably due to **a lack of confidence and undoubtedly as a result of a tiring week in the lead-up to the outing**."

➔ *A route or section is considered easy or low risk*

The assumption that a route or section is easy, the perception that its characteristics make it safe, or even the fact of having overcome its main challenges, all naturally lead to a loss of vigilance. This observation corroborates the results of the analysis of snow, ice and mixed climbing stories in SERAC and the findings of the report on accidents in mountain sports published in 2014[4]. The latter indicates that the majority of fatal accidents involving mountaineers take place on easy terrain, often with no belay in place. In avalanche areas, this phenomenon is often rooted in the outing's preparation and in the way in which skiers approach a route that is generally considered easy or practicable even in bad weather, resulting in less attention being paid to planning and danger signals once up on the mountain. The following excerpt illustrates this phenomenon and shows once again that it can combine with other factors, such as social influence and poor communication, even when participants have a sense of the danger they face:

East couloir of Le Barlet:

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[4] *Accidentology of mountain sports, Situation review & diagnosis (2014).*
https://www.petzl.com/fondation/foundation-accidentologie-livret_EN.pdf?v=1

*"{Outing preparation and choice}: It was my first ski trip of the year so I didn't know much about the conditions. In particular, **I didn't expect there to be so much snow**, I thought it would be much less deep. (…) There was a report on skitour by someone who had been there a few days earlier **and had skied down both couloirs in good powder**. (…) **I knew the Barlet as a "bad weather" summit, which could be done even in poor conditions.***

(…)

*{Description}: During the climb, the third member of the group, who was lagging behind, turned back and **told us later on that he thought the traverse was too much of an avalanche risk**. Once above the lake, we decided to take the E couloir, because there had already been a small avalanche there, which we believed made it less risky. We started to climb in fairly dense powder and noticed that the avalanche was only superficial. More and more small cracks appeared under our skis as we climbed, but they were not very deep. **The cracks should have been a wake-up call**. (…) The moment I entered the narrow couloir, the snow detached itself from the rock 3 metres above me and initially flowed around me. Then I felt the snow under my skis give way and I was carried away (…)"*

→ *Familiarity with the terrain, force of habit and experience*

The sense that an outing is easy is sometimes coupled with the fact that the participants know the terrain well (because they have completed the route several times or it is in a local mountain range) or that they regularly pass through the same spot, are repeating familiar movements almost automatically or have already skied numerous times during the course of the season. McCammon notes that 69% of avalanche accidents take place on slopes that are familiar to the victim. He speaks about **familiarity** bias, which is defined as the tendency to consider behaviour to be correct because one has behaved in that way in the past.

Thus, when a situation or a location is familiar, there may be a tendency to follow the strategy one knows best without questioning it, rather than (re)assessing the risks thoroughly. Other phenomena include the **normalisation of risk**, which grows with experience and tends to blunt the perception of risk among seasoned skiers[5], and **overconfidence**, which an individual may feel if all their previous experiences have been positive. When outings have always gone well on this type of terrain or in this area, or simply when the season has gone very well overall and the individual feels "in shape", a feeling of confidence and a tendency to trivialise danger can cause them to overlook the importance of carefully analysing the risks they face at a given moment. The following excerpts underscore this point:

Mont Fromage:

*"We didn't pay enough attention to a strong wind that was causing the snow to drift, **because this is a route we usually take when the avalanche risk is high**. Basically, we were **caught out by our familiarity with a route we thought was risk free**."*

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[5] These biases can also be considered in the light of Kahneman's (2011) theory of the two speeds of thought: he summarises the workings of the mind as being based on two modes of thought, which he refers to as system 1 and system 2. System 2 is a slow, energy-intensive and analytical way of thinking, one that is essential in attaining a deep understanding of situations and involves carefully assessing each option. It requires the individual to be consciously activated. System 1, on the other hand, is a rapid process based on unconscious cognitive shortcuts and, in no small part, on intuition. It requires little energy and is very useful in day-to-day life, because it enables us to make decisions quickly and in a routine fashion, without having to conduct a lengthy and painstaking analysis. Paradoxically, we often rely on system 1 in highly uncertain situations and when we are pressed for time. According to the theory of cognitive bias, this system is subject to numerous biases or errors that can cause individuals to make decisions without considering all the necessary information. This is of particular concern in complex situations where errors of judgement can have extremely serious consequences.

> *"What can we take away from this misadventure? Never be too confident, because **even if you've been ski touring for 40 years you can get lost in your own back yard**!"*

2.1.2. The importance placed on reaching the goal, or "summit fever"

The fact that individuals often give priority to reaching their objective over many other considerations may explain why some remain committed to their plan even when the danger signs are obvious from an objective standpoint. The lure of a longstanding goal, a sense of scarcity (coupled, for instance, with excellent conditions), frequent disappointments during previous outings or earlier in the day, not to mention the investment already made in a project, such as a long drive or days taken off work, appear to have had an impact in 16 of the accounts submitted. These observations, which echo those already made in the analysis of snow, ice and mixed climbing, are reminiscent of the cognitive bias involved in **summit fever**, which causes individuals to focus solely on attaining their goal, whether it be reaching a summit, skiing in good snow or obtaining financial rewards, even if all the signs point to this being unwise. The participant becomes oblivious to indicators of danger[6] from the moment they start down this path, either focusing on reassuring factors or increasingly turning a blind eye to clues that become more and more obvious as they approach their goal and invest ever greater energy to attain it. Munter discusses the notion of ballistic thinking, which focuses solely on the objective[7]. In the aerospace sector, the term "destinationitis" refers to the idea of being fixated on reaching one's chosen destination. These effects may be exacerbated by the **influence of irretrievable investments** (the sunk cost effect), i.e., the tendency to intensify one's commitment to an endeavour in which one has already invested irretrievable resources (time, money and effort), or by the **scarcity effect**, defined as the tendency to assign disproportionate value to opportunities considered rare or limited, or which have not yet been accessed by others.

A parallel can be drawn with **consistency or commitment bias**, as described by McCammon (2004), which refers to the tendency of humans to maintain internal consistency between their various actions and decisions. Indeed, it is easier to make a decision that is consistent with those made previously than to switch to a different objective.

Instead of analysing every new development in a situation, we stick to our first impressions, even if that means ignoring new signs of danger. **Confirmation bias** can then prompt us to scour our environment solely for information and reassuring factors that confirm our initial hypothesis. The following excerpt is very illustrative of this phenomenon. It demonstrates that "destinationitis", combined with the feeling of exhilaration provided by the environment and the promise of a wonderful descent, naturally blunts the perception of danger signs:

> *"When we arrived at the pass at the exit of the couloir, **Jean commented that the terrain looked conducive to the formation of slabs**. (…) But we also remarked that, on foot, it all seemed very stable, and we were overcome by **the euphoria of going over the pass and climbing to the summit**. (…) We left our skis at the*

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[6] The concept of summit fever is also referred to in business and finance. It was cited, most notably, after the tragedy on Everest in 1996.

[7] 3×3, *La gestion du risque dans les sports d'hiver*, Werner Munter (2006)

pass and climbed to the summit and back with our ice axes and crampons. The atmosphere was incredible and worthy of a real mountaineering expedition. A southerly wind accompanied us to the majestic summit before dying down. What a feeling to be up there alone in those surroundings! We were jubilant...

*There was still no wind, our joy was uncontained. We clipped back into our skis for **what was supposed to be the highlight of the outing: the descent via the North couloir! We forgot all about the signs we had observed earlier – which should have prompted us to take the normal route down rather than the couloir – because all that powder was waiting for us!** I set off and made a few turns (…) then suddenly, I triggered a small slab avalanche about 20cm deep and a few metres wide (…). The slab swept away the rest of the couloir. (…) When Pierre caught up with me, the errors we had made became clear: yes, the area was prone to slabs and no, we shouldn't have gone down this couloir, but down the normal route, even though **it would have been frustrating to have climbed all the way to the top "just for that"... We ignored the signs because we felt euphoric about the idea of skiing down the couloir** rather than taking the normal route, which was icy and unappealing. We allowed ourselves to be overcome by the splendour of the route and were impatient to complete it on such a beautiful day"*

2.1.3. The appeal of choosing the quickest or least demanding option

The easiest, quickest or least tiring option sometimes influences our decision, even if it involves greater risks than other possibilities. This influence may explain why individuals head into hazardous terrain despite being aware of the risks. When faced with a longer but less exposed detour or the prospect of having to climb up a whole slope to avoid a section prone to avalanches, we sometimes convince ourselves that "it'll be fine" even though we sense the danger, possibly relying on reassuring factors to justify our decision. This is sometimes qualified as "laziness". The notion of speed also comes into play: the idea that going quicker is invariably safer is palpable in the stories told. Although it is sometimes necessary to move fast in the mountains, doing things in a rush and with excessive urgency can lead individuals to act and make decisions too hastily, without this bringing any benefits in terms of safety. Seeking to improve efficiency by moving faster can be to the detriment of caution, concentration and thoroughness. While it is obvious that reducing the time spent exposed to hazards reduces the likelihood of accidents, it is also important **to consider how risks may be amplified by the negative effects of hastiness**, such as stress and rushing. It can be even more tempting to act hastily in hostile weather conditions, when it is cold and windy and individuals feel the urge to "get out of there".

One might be so bold as to suggest that such haste may also be rooted in the "culture of speed". Today, mountaineering places a considerable focus on speed, on quickly linking sections together, on lightweight equipment that allows individuals to climb faster, and on the time taken to complete such and such an ascent. Gaston Rébuffat, Christophe Profit, and, more recently, Kilian Jornet, Uëli Steck, Paul Bonhomme and Alex Honnold are just some of the high-profile personalities within the sport who have gained a reputation for their ability to complete several routes in a short amount of time.

A combination of speed and excessive haste can be counterproductive in terms of safety. The idea of finding the **right compromise between efficiency and thoroughness[8]** seems crucial. The following excerpt illustrates the appeal of taking the least technically demanding option, coupled with a harsh wind and the influence of a reassuring factor (avalanche danger level 1):

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[8] Hollnagel (2009, 2017) discusses the "Efficiency-Thoroughness Trade-Off" in the field of business security.

> *"Poor snow conditions (frozen spring snow + balls of snow) prompted us to leave the usual climbing route at this point and **seek out areas that would be easier to ski up (even if steeper and more loaded with snow).**(…) The weather was clearly a decisive factor: **had it not been for the strong wind and the snow blowing around, which meant you had to shield your face during this part of the climb, I would have taken more care in choosing my route.** Also, **had the avalanche bulletin been less reassuring,** I wouldn't have gone in that direction."*

The following excerpt describes a sequence of events (route error – harsh weather conditions – excessive haste) that led to a more exposed route being chosen for reasons of speed:

> *"A slight route error resulted in us tackling this slope. This was due to a lack of route planning and the fact that we were playing it by ear (**it was very cold and the wind discouraged us from taking breaks and reading the map**) -> Given the conditions, I didn't think this was a problem at the time. In terms of route choice, in hindsight **I could easily have avoided the slab, especially given that the alternatives were not as steep, but I was in a hurry to get over the hill**."*

2.1.4. Communication, group composition and leadership

It is widely accepted that communicating effectively and allowing all members of a group to express themselves freely lead to better risk analysis and management. Leaders alone cannot perceive everything and be vigilant at all times, partly because of the various biases mentioned above. They must therefore make use of all the resources available within their group. In 11 of the accounts submitted, the author mentions a lack of communication or the fact that they had expressed doubts that were not taken into account in the final decision. This bears relation to the social influence at play within groups, as described previously. Moreover, when the members of a group get on and know each other well, this is presented as a positive factor in the accounts submitted, as this should facilitate communication and an analysis of the risks. In 10 of the accounts submitted, however, familiarity between members of the group is cited either as a preventive factor or, on the contrary, as a factor that does not favour effective communication. The risks faced by groups of individuals who know each other well can vary. When a group is comprised of experts or close friends, there can be a tendency to place too much trust in one's companions, leading to a **dilution of responsibility**[9]. Each participant relies on the backing of their companions when making a decision, the unspoken assumption being that, if there is a problem, the others, or the leader, will speak out. If a risk is not **verbalised**, the group will keep to the initial plan despite the dangers silently identified by the participants. This is particularly common when the group fails to designate an individual in charge of analysing the risks at the start of the outing or if an individual is implicitly proclaimed to be the leader in view of their status or experience.

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[9] The **dilution of responsibility** is a psychosocial phenomenon that occurs in large groups when none of their members act in the event of a critical situation. McCammon (2004) points out that in groups whose members have a similar level of experience, each individual tends to rely on their companions, which hinders decision making.

Furthermore, when the members of a group are friends, getting on can become an obligation, taking precedence over a risk assessment that may lead to an "unpopular" decision. This is known as the **desire to please**[10], or **groupthink** or consensus bias[11], where greater importance is placed on group cohesion than on risk analysis.

Rather than examining the nature of the relationship between participants (closeness, knowledge, responsibility), it is useful to **focus more on communication and on the type of leadership put in place**, while bearing in mind that **clear and effective communication requires a certain amount of attention and effort** (it is not automatic). The leader's role may involve **sharing out responsibility for analysing the risks, as well as fostering a climate of trust** that encourages all participants to communicate their feelings and perceptions regarding the risks. Here, the leader is not just in charge of choosing the route, but is also responsible for organising interaction within the group and dividing up the task of analysing the risks. To help establish virtuous communication, certain techniques can help, e.g., briefing, debriefing, collegial decision making, sharing of gestural instructions and allocation of caricatured roles (optimist, pessimist, devil's advocate, etc.).

The following excerpt illustrates the difficulties involved in communicating and making decisions within a group:

Pic du Rognolet:

> "The debriefing highlighted the fact that the leader hadn't done his job. Having convinced the group to give up on the route we had initially planned to take, but also on plan B and even on reaching a summit that is usually very popular, he wrongly abandoned his "systematic frustrator" role. Basically, **he allowed himself to be influenced by certain members of the group** whose desire to go off the beaten path was obvious. (…) At this **point, the communication established within the group, which had been good up until then, began to deteriorate and there was no mention of the snow drifts caused by the wind**. It became apparent that the other skiers were not overtly aware of these factors."

2.1.5. Poor time management

Lastly, a failure to keep to the schedule appears to have played a part in an undesired event in eight of the stories. This is often the case when an avalanche takes place in heavy springtime snow. Here again, this is a factor often linked to other effects, such as the appeal of the least demanding option or a desire to advance quickly, leading to excessive haste. Poor time management as of the route planning stage can sometimes cause participants to act too hastily when they realise they are behind schedule, resulting in a failure to take certain safety measures or to notice an important sign of danger. Lastly, the pressure to achieve the goal initially set can lead participants to neglect the impact of a delay.

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[10] **Social acceptance**, social desirability or seduction bias is the tendency to act in such a way as to be accepted or noticed by a group of individuals. This may entail taking more risks in order to fit in with the culture of a particular social group or simply to impress one's peers. McCammon (2004) identifies a gender-related social acceptance bias according to which, in some circumstances, men tend to take more risks when women are present.

[11] **Groupthink:** when a group endeavours to seek a consensus even if the potential consequences are negative (Bellamy et al, 2018).

2.2.   Summing up: a combination of multiple factors

Critical situations often result from **the interaction of multiple factors**. As we have seen in the various story excerpts, the factors described above often act **in combination as part of a general dynamic**. Events that take place in the mountains are closely conditioned by the context and each individual's personal history, perceptions of the environment, relationship with risk, etc. Understanding this overall context after the fact is complicated, because it is impossible to gather all the necessary information from the stories alone. Moreover, the interpretation of accidents after they have taken place is vulnerable to **reconstruction bias**, which can be problematic. This refers to the ease with which we can judge a situation to be obviously dangerous once removed from the context, but also to an overeagerness to see causal relationships between the presence of particular factors and the occurrence of an accident. Thus, rather than providing systematic explanations for accidents, the contributing factors identified here highlight **the presence of dynamics that increase the likelihood of accidents** and the ways in which they can form. Quite often, after making a series of small decisions that are apparently without consequence, and encouraged by **various self-reinforcing factors** that affect the perception of danger, participants find themselves in a critical situation in which a final lapse (a turn made in the wrong place or a loss of balance) can cause a situation that is already on a knife edge to become the scene of an accident. In what could be described as a **"funnel" dynamic, the margins of error gradually shrink** and a cascade of events takes place, pushing the individual to make a final "error" that would be considered minor if taken in isolation. The dynamics that increase the likelihood of an accident and the hierarchy of contributing factors will vary according to the situation and are difficult to model in a systematic manner based on a sample of accidents. The chart below (figure 6) represents the main factors identified in SERAC that contribute to the occurrence of critical situations. A critical situation is the result of various factors, each playing an equal role that cannot be ranked. What the chart shows is that they are interlinked and potentially self-reinforcing. The undesired event is "sparked" by a triggering factor. A critical situation can therefore tip over into an incident or accident because of a minor event.
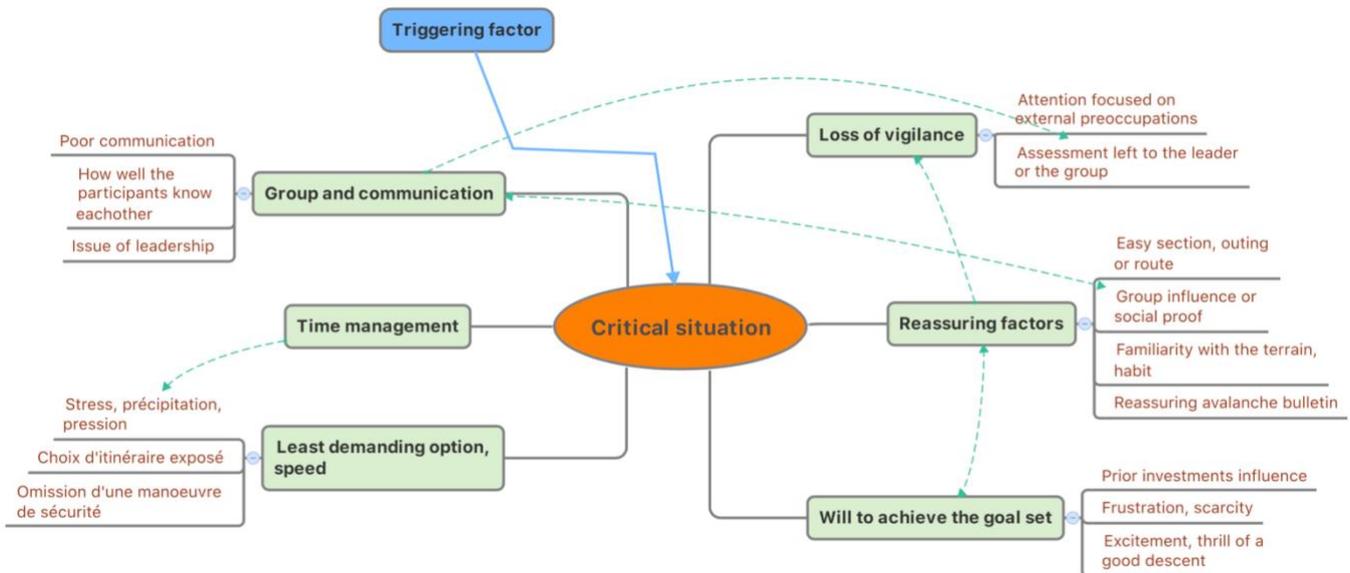
This chart reinforces the observations that can be made based on the story excerpts. It presents the various contributing factors and the links between them: the influence of reassuring factors is related to the pressure of reaching the goal, time management is related to excessive haste, and the group and communication are linked to the social proof that sometimes amplifies the reassuring factors present. All of these can lead to a loss of vigilance, mainly in terms of the attention paid to risk analysis. Vigilance is a cross-cutting notion that is not listed among the factors put forward in section 2.1. It encompasses phenomena relating to the care taken during technical manoeuvres and when analysing the terrain. Finally, it is worth reiterating that these different factors often interact in **contexts where individuals perceive or sense a risk. They offer a possible explanation as to why participants remain committed to their plan or downplay their perception of the risk.**

3. Factors that contribute to falls in ski touring

There are only a limited number of stories (29) that allow us to analyse the context of falls and the factors contributing to them. Nonetheless, it is important to look into these factors, given that falls are a frequent cause of accidents and can have serious consequences according to PGHM data (34% of rescue operations, 96% of which involve injury or death), even though they are sometimes ignored by efforts to reduce the risks involved in ski touring. Five key contributing factors emerge:
- A loss of vigilance.
- The perception that a route is easy or that the hardest part is over.
- Tiredness at the end of an outing.
- The accumulation of fatigue before an outing.
- Excitement, the thrill of the situation and the environment.

The following chart indicates their frequency and their interactions. What it shows is that vigilance lies at the heart of the factors that contribute to falls during ski touring and that these other factors are also interconnected.
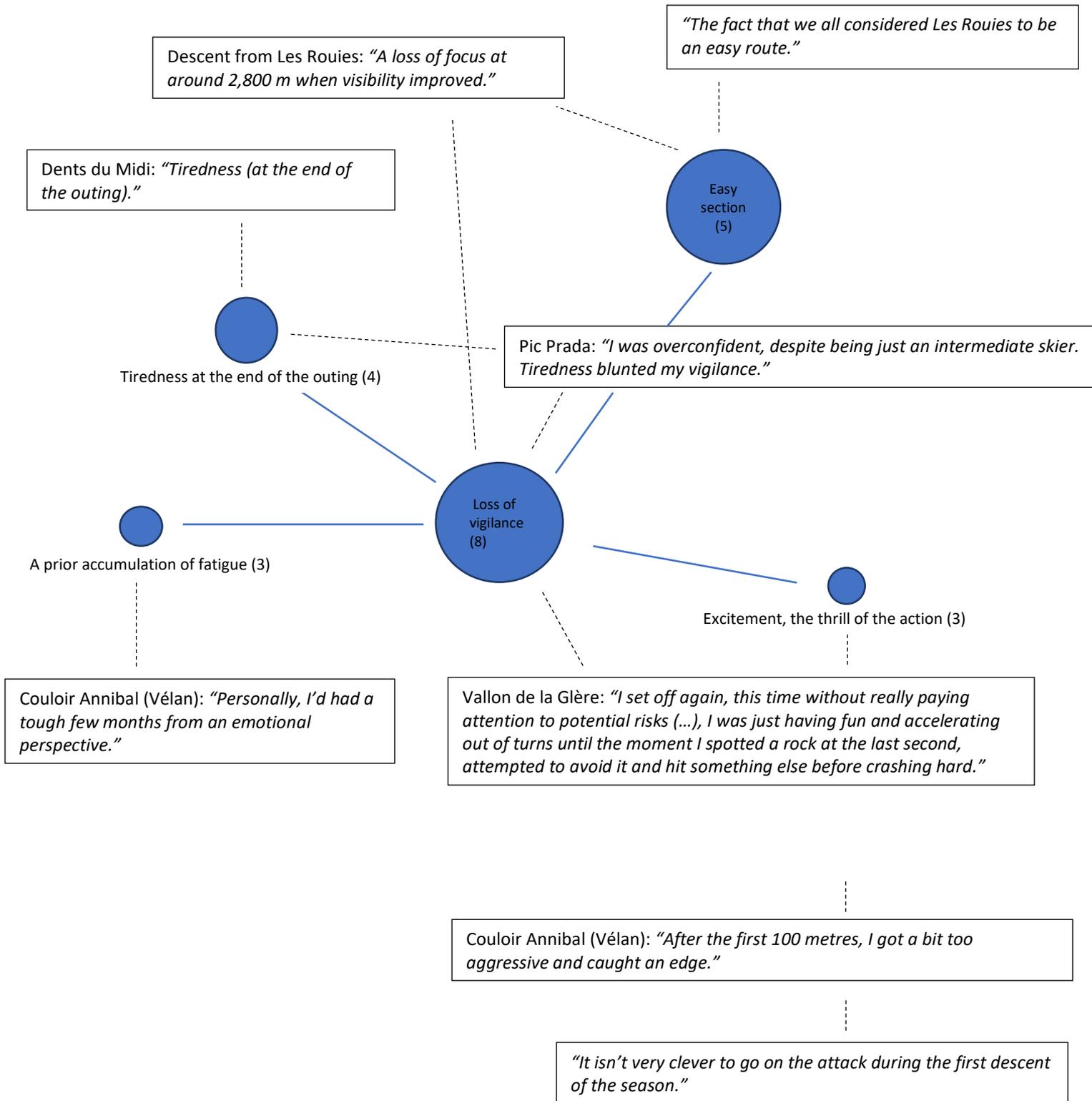
Descent from Les Rouies: *"A loss of focus at around 2,800 m when visibility improved."*

"The fact that we all considered Les Rouies to be an easy route."

Dents du Midi: *"Tiredness (at the end of the outing)."*

Easy section (5)

Pic Prada: *"I was overconfident, despite being just an intermediate skier. Tiredness blunted my vigilance."*

Tiredness at the end of the outing (4)

Loss of vigilance (8)

A prior accumulation of fatigue (3)

Excitement, the thrill of the action (3)

Couloir Annibal (Vélan): *"Personally, I'd had a tough few months from an emotional perspective."*

Vallon de la Glère: *"I set off again, this time without really paying attention to potential risks (…), I was just having fun and accelerating out of turns until the moment I spotted a rock at the last second, attempted to avoid it and hit something else before crashing hard."*

Couloir Annibal (Vélan): *"After the first 100 metres, I got a bit too aggressive and caught an edge."*

"It isn't very clever to go on the attack during the first descent of the season."

Figure 7: Factors that contribute to falls in ski touring

4. Possible prevention measures

Resources on the preservation of safety in ski touring are abundant and detailed. The results presented here are not intended to replace them or to blaze new trails in this area. However, they do confirm, objectify and place a spotlight on known phenomena using tangible examples. The aim is to **enable individuals to reflect on their own experiences, or those of others, by highlighting real-life situations**. However, we have formulated a number of suggestions that may reduce the impact of the factors identified:

- Take care to **scour** your environment and look within the group for **unfavourable indicators** (observable and pointing to risks) that you may overlook if you focus solely on reassuring factors (favourable weather, presence of tracks or other skiers, equipment in place, route reputed to be easy, etc.). You can go a step further by applying the devil's advocate method yourself or by assigning the task to another participant: what factors (conditions, terrain, group) might justify a change of plan today?

- **Identify risk assessment biases**: summit fever, investments already made, group influence, a personal analysis focused on reassuring external factors, etc. It is difficult to actively eliminate these factors, so unconscious are they in nature. Setting up communication and verbalisation techniques, playing devil's advocate, being careful to scour the environment for unfavourable indicators and identifying "**false reassuring factors**" will tend to reduce the influence of these biases. The issue of cognitive bias, sometimes referred to more generally as "human factors", remains to be examined more deeply, not least so as to limit its effects.

- **Place a strong emphasis on communication** and making decisions jointly. Again, the issue of communication methods requires further reflection and there are techniques available. Is every participant able to express themselves regarding the objectives, their feelings and their personal assessment of the risks? What is the group's true motivation? What do we feel like doing today and do we agree? The individual(s) leading the group has/have a lot to gain from making this type of communication possible and taking this information into account when making decisions.

- **Leadership or membership:** the question of responsibility (managing the group, monitoring risk indicators, decision making) is crucial, especially in groups of friends with the same level of ability. It is an issue that demands further examination and on which no consensus has been reached by existing resources. While naming an outing leader can limit the dilution of responsibility to a degree, studies show that groups without a leader that operate on the basis of cooperation are less likely to fall victim to an avalanche than groups in which leaders have been more or less formally designated[12]. We have also seen that vigilance is a central factor in critical situations. But it is **impossible to be vigilant at all times**, just as it is difficult for one person to pay attention to every important factor at once. The idea of sharing responsibility, by capitalising on a group's combined capacity to focus, observe and analyse, followed by

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[12] Christian Morel (2012), *Les décisions absurdes, II*

methodical verbalisation and cooperative decision making, appears to be a promising alternative. This is closer to the notion of "membership" and we might suggest approaches involving the naming of two leaders, role rotation or the sharing of responsibility between group members. Ultimately, paying particular attention to the questions of leadership and allocating responsibility within an autonomous group is crucial, because they are far from being self-evident.

- **Slowing down to save time:** speed is not always a guarantee of safety. Excessive haste can lead to critical situations that result in lost time and reduced safety. The aim should be to find **the best compromise between speed/efficiency and thoroughness/caution.**

- **Be prepared to adapt and change the plan: planning** the outing the day before allows participants to anticipate key sections, determine the points at which decisions will need to be made and observations verbalised, identify any areas requiring greater vigilance, and look for alternative routes in case the plan needs to be changed. Seemingly insignificant events can unexpectedly increase the likelihood of an accident occurring. In such cases, we must be prepared to react to a situation that we had not anticipated, i.e., "**be prepared to be unprepared**". **Choosing a route that offers a wide variety of options** allows us to adapt as the situation develops, while also keeping in check the sometimes unconscious effects of fixating on the goal set. Anticipating and keeping open as many route options as possible for as long as possible allows participants to counter the "funnel" dynamic that can cause individuals to enter a situation in which they have little room for manoeuvre, and where a final lapse may have dramatic consequences.

Decision support tools in ski touring

A number of risk analysis and decision support tools are available to reduce the likelihood of being caught in an avalanche. These are rarely mentioned in the stories submitted to SERAC. Such tools allow as much available information as possible to be taken into account on the eve of an outing and once up on the mountain, so as to better anticipate and assess the risks. While they reduce the influence of cognitive bias and the types of factor that contributed to the events highlighted here, they are not intended to replace the assessments performed by individuals and groups, but rather to guide them. Very often, they do not provide a fully formed answer to skiers confronted with a critical slope and it is always advisable to assess the situation on the ground by using one's brain, experience, feelings and perception of the environment, as well as listening to one's companions. Different types of tool exist and they can be used in different ways and be adapted to different stages of the outing (during its preparation or on the mountain). They can be classed according to the type of information they are able to process:

Risk assessment support tools:

Tools such as the <u>3X3 method developed by Munter and the NivoTest are designed to help individuals identify critical clues when they are on the mountain. They provide a list of observable categories to prevent the user from overlooking crucial information. The guided vigilance method</u> lies at the intersection between two categories, since it combines a search for observable factors on the ground with various levels of vigilance, although it does not provide a specific operating procedure.

These tools seem particularly well suited to analysis on the ground but also to the planning stage, because they allow us to anticipate clues that we may spot subsequently.

Risk assessment tools:

These methods are defined as probabilistic because they make use of existing accident data. They include standard reduction methods (basic, professional, etc.), notably those used by the Yéti app, to provide a zone-by-zone risk assessment based on a colour-coded or digital scale. Other tools, such as skiturenguru.ch, use the quantitative reduction method to provide a risk assessment for every route and section. These tools offer an overall risk assessment that is intended to serve as a basis for decision making. They appear to be particularly useful when planning an outing, but they also need to be supplemented by an observation of critical signs once up on the mountain.

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