A Comparison of Single Rope Rigging Techniques in Caving: the differences between America and Europe

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1 Abstract

The study looks at a comparison of Single Rope Technique (SRT) used by cavers in America and Europe. There is a great deal of information available about SRT but little of this explores comparisons between different styles used across both continents in caving. This study aims to advance the literature available concerning SRT and caving. The study utilised a convergent parallel mixed method approach encompassing quantitative and qualitative research data collection. The study concluded that there may be cultural rigging styles but that this difference was more likely to be due to the divergent cave formations found on each continent. The study proved its hypothesis that in comparing the SRT styles used in America and Europe it was predicted that the style of rigging that is adopted for specific pitches or pits is linked directly to cave formation.

2 Technical Disclaimer

Serious injury or death could result from the use of the techniques described in this study. It is the reader's responsibility to seek instruction from a qualified individual. A misunderstanding or misinterpretation in this study could lead to life threatening situations. This study does not confer any liability upon the author or the university, and it is solely up to the individual to act appropriately, as failing to do so could result in injury or death.

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6 Acknowledgments

I would firstly like to thank my supervisor Mr David Larkin for his continued guidance and support during this study, which enabled me to write on a topic which is of great interest to me.

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I would also like to thank my family and friends for their moral support, throughout this study. I would also like to express my gratitude to the caving community as a whole for their responses to the survey and for their sustained support of my personal development as a caver and to the interviewees who put their time aside to help make this study possible.

7 Technical Abbreviations

European: Includes UK and France

America: Only includes United States of America

8 Introduction

This study will be looking at a comparison of Single Rope Techniques (SRT), rigging and cave progression both individually and as a group. The study's structure will follow a review of the literature looking at the history of SRT and the differences of equipment and rigging styles in both America and Europe. The methodology will then be addressed, which shows the structure of the study and the mixed method approach. The third section will present the results from the survey and interviews, this was when the original hypothesis was formulated suggesting one system was superior to another. A discussion follows this looking in depth at the findings and this is supported by a review of current literature in this area. The conclusion covers the main finding which shows that cavers adapt depending on individual cave formations which determine the overall rigging deployed and personal equipment (for ascending and ascending) that is chosen.

9 Aims

To examine the preference for bolts and anchors used in SRT by cavers in America and Europe.

To investigate SRT methods used in America and Europe in caving to highlight similarities and differences and looking at the use of repeated rebelays and how this affects mental and physical performance.

To explore the preferences for "light and fast", "heavy and slow", "heavy and fast" and "light and slow" mountaineering concepts in SRT in caving.

10 Hypothesis

In comparing the SRT styles used in America and Europe it was predicted that the style of rigging that was adopted for specific pitches or pits was linked directly to cave formation.

11 Literature Review

Introduction

This literature review will explore Single Rope Technique (SRT). It will examine the development of SRT from its origins with Dr Karl Prusik and go on to investigate how it came to be used by cavers today. It will pay particular attention to the descending and ascending devices and systems and their role in SRT. The work will then consider how this technique is utilised in America and Europe and highlight any differences. An analysis of equipment used by cavers in Europe and America will be undertaken to examine the similarities and differences in the systems used. The work will conclude with thoughts for further development.

What is SRT and where it is undertaken globally?

In addressing what SRT is and why cavers use it to explore cave systems, Meredith, (1979) explains that SRT is a rope climbing technique which is used to descend and ascend on a single rope. Caves come in many different shapes and sizes and are made up of joints and faults in the rock (Sparrow, 2009) the main reason for utilizing SRT would be for when cavers come across a large cascade, pitch or shaft (Elliot, 1995a). It is at a juncture like this that an SRT line would be utilised and it is put in place for safe passage (See Figure 1).

Figure 1

Fig. 1 (Eavis, 2012) shows a caver ascending a pitch using the single rope technique method.

Lyon, (1983) describes the main SRT caving locations around the world to be found in areas like China, America, Europe, Australia and New Zealand. SRT is more commonly used by cavers than the traditional methods like ladder and line. This method allowed cavers to progress only so far within the cave itself (Elliot, 1995b). However, SRT was created in the 1970's and it ushered in a new age in caving and mountaineering when in vertical environments (Sparrow, 2009). Meredith (1979) believes problems associated with the weight of the original kit and the ladder and line method were surpassed by SRT, and so faster travel in these environments was achieved (Long, Lyon and Lyon, 2001, p.1). SRT has a number of advantages and disadvantages as a technique. As suggested the weight and bulk of kit is lighter (Meridith, 1979), making cave travel easier when using SRT and it has been suggested that it may be more relaxing for the individual (Meridith, 1979). Eliot (1995a) suggested that this can create greater efficiency. These may initially be seen as advantages but could be considered a disadvantage. Ladder and line techniques require a belayer however, SRT can be an

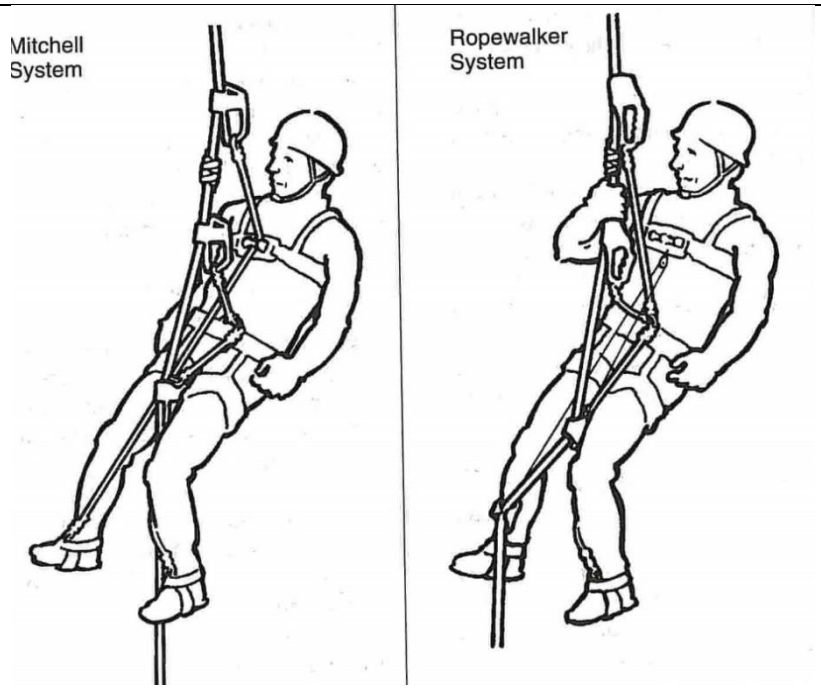
individual activity. SRT allows a caver to explore a cave independently but this would be a practice is frowned upon by cavers who should consider safety as paramount (Hall, 1973; Bird, 2016).

The history of SRT

In 1931 Dr Karl Prusik invented a knot now known as a 'prusik' to enable cavers and mountaineers alike to escape crevasses (Sparrow, 2009). A few years later there were attempts to use SRT in France but these were time consuming and there were problems with equipment failure (Sparrow, 2009). In 1969 the French Caving Federation opened the French Caving School which concentrated upon the expansion of SRT for both clubs and instructors (École Française de Spéléologie, 2013). Between 1960 and 1972 the use of SRT within the caving community was increasing but it was not until 1973 when two explorers from Mexico reached the bottom of Provatina, a 407m deep cave in Greece, employing the technique this is thought to be when SRT, as we know it, evolved (Sparrow, 2009). As a result of this achievement there were two main areas of focus within the caving community: rope protectors and 12mm bolts. Both of these pieces of equipment enabled safer travel and navigation away from hazards when using SRT (Sparrow, 2009).

The normal set up and how Health and Safety affects SRT

A normal SRT set up would include a seat harness, one descending device, an ascending system, which would be comprised of two or three ascending devices, and two cow's tails (Burger, 2006; LaRock, 2016) (See Figures 2 and 3) . These pieces of equipment not only enable the person to descend rope, but also to ascend (Smith and Padgett, 1996). It is not common for cavers to use back-up devices as caving is mainly a recreational sport but also due to the lack of space in which cavers have to drill extra bolts. As SRT focuses upon shedding unnecessary weight, an extra rope and more equipment would be the reverse of this concept. HM Government's Health and Safety Executive does produce guidance that covers the UK and Europe (The Work at Height (United Kingdom measures) Regulations 2005), for individuals who work on ropes but this does not apply at recreational or club basis in the UK and USA.

Figure 2	Figure 3
	
Fig. 2 (Sparrow, 2009, p.100) shows the more standard European and sometimes American set up for SRT using two jammers. Also described as the most popular SRT system in the world (Smith, 2016).	Fig. 3 illustration by Buffington (Smith and Padgett, 1996, p.156) shows an illustration of two different styles of ascending used in America. Americans choose not to wear descending equipment when ascending and vice versa, note that a descending device is missing from the illustrations.

Descending

Traditionally descending devices used steel interlocking carabiners and a steel figure of ‘8’ as means of descent (Sykes, 2015). Currently the most commonly used descending equipment is a Rack, Petzl Stop or Petzl Simple (Sykes, 2015). Cole, (1977) writing in the ‘Descent Magazine’ made a comparison between a ‘Rack and the Whaletail’. Cole (1997) concluded that there were many advantages to the Rack such as both the construction and repair being inexpensive and easier. The Rack system was favoured in the article over the Whaletail because of its versatility with different diameters of rope,

the rack is still favoured today in America (Smith, 2016). However, École Française de Spéléologie (2013) believes that Racks are not used in the European systems because it is not suited to the Europeans caving rigging style. Within Europe, pitches are generally split down into parts if they are greater than 50m in depth whereas in America it is usually rigged in one singe pitch (Elliot, 1995a). The European method enables greater progression for a group (École Française de Spéléologie, 2013) as more people can descend at one time; the same theory is used for ascending.

Ascending

When ascending any pitch there are different styles and varieties of equipment that can be deployed. In the UK and the European Alpine area it is common to use a Croll and Basic and an optional foot jammer as equipment, as commented on by Sykes (2015). This style of ascending is known as 'Frog' (Marbach and Tourte 2002). In America three Gibbs devices known as rope walking systems include Mitchell System, Texas Inchworm Style and Double Bungee Ropewalker are used to ascend the rope (Halliday, 1974; Smith, 2016). This came about as the result of increased reports of accidents. Eavis, (1997) suggested that using three Gibbs devices places more emphasis on having three points of contact therefore increasing safety.

Rigging Rules

There are three rules that are considered when rigging that enable safer travel in Europe. Firstly, the rigging remains consistent. Even though caves can vary it is deemed important to keep the standard of the rigging the same throughout to comply with the group's needs (École Française de Spéléologie, 2013; Marbach and Tourte, 2002). Secondly it is important to ensure the rigging is clear, in terms of being abrasion free, away from the rock and having a dry hang away from any water (Sparrow, 2009). Thirdly it is judged vital that the rigging is comfortable for the rigger and team members, ensuring there is enough rope in the loop at the rebelays or having a long enough sling for the deviation (École Française de Spéléologie, 2013).

The Americans utilise the same method as the Europeans but have noted two additional rules. Firstly, it is thought that after rigging the rope it should be checked to make sure it is long enough to reach the floor prior to weight being applied. Secondly they judge that it is important to rig off natural resources where possible (Smith and Padgett, 1996). However, these natural resources such as large boulders, trees or stalagmites may not be as strong as they seem. École Française de Spéléologie, (2013) suggest that checks are essential before any rigging takes place and if in doubt an alternative anchor should be sought.

Cave formation and rigging

This section is not aimed at giving an extensive description of cave karst formation but to explain simply that caves have formed differently and so diverse styles of rigging have been developed due to this.

It is commonly understood that when clouds become highly saturated they deposit rain that mixes with carbon dioxide contained in air pollution turning it into a slightly acid solution before it lands upon the surface (Sparrow, 2009). Limestone rock is a weak rock because it comprises of composing skeletal fragments of marine organisms (Ford, 1995). This mixture of water, air and limestone rock combine to create calcium carbonate ($Ca(HCO_3)_2$), (Sparrow,2009). Over a period of time this compound percolates through the rock or down a stream of water and can cause erosion that creates a cave or pothole. In wet caves this process continues to make the cave longer and longer (British Geological Society, 2016).

The two main differences between the European and American caves are that in Europe caves tend to be long, very tubular and progress in a horizontal fashion to produce multiple pitches (See Figure 4). In comparison, in the USA although some caves form in a similar manner, many American caves come large enough for the soil to collapse underneath creating vertical pits or sinkholes (See Figure 5) (Palmer, 2016), which may or may not have a horizontal cave system at the bottom. A pit cave, shaft cave or vertical cave is a type of natural cave which contains one or more significant vertical shafts (See Figure 6). The name pit cavers has been given to those that

undertake this style of caving. These pit caves are formed in the same manner as European horizontal caves through long-term erosion by water (Palmer, 2016).

Figure 4

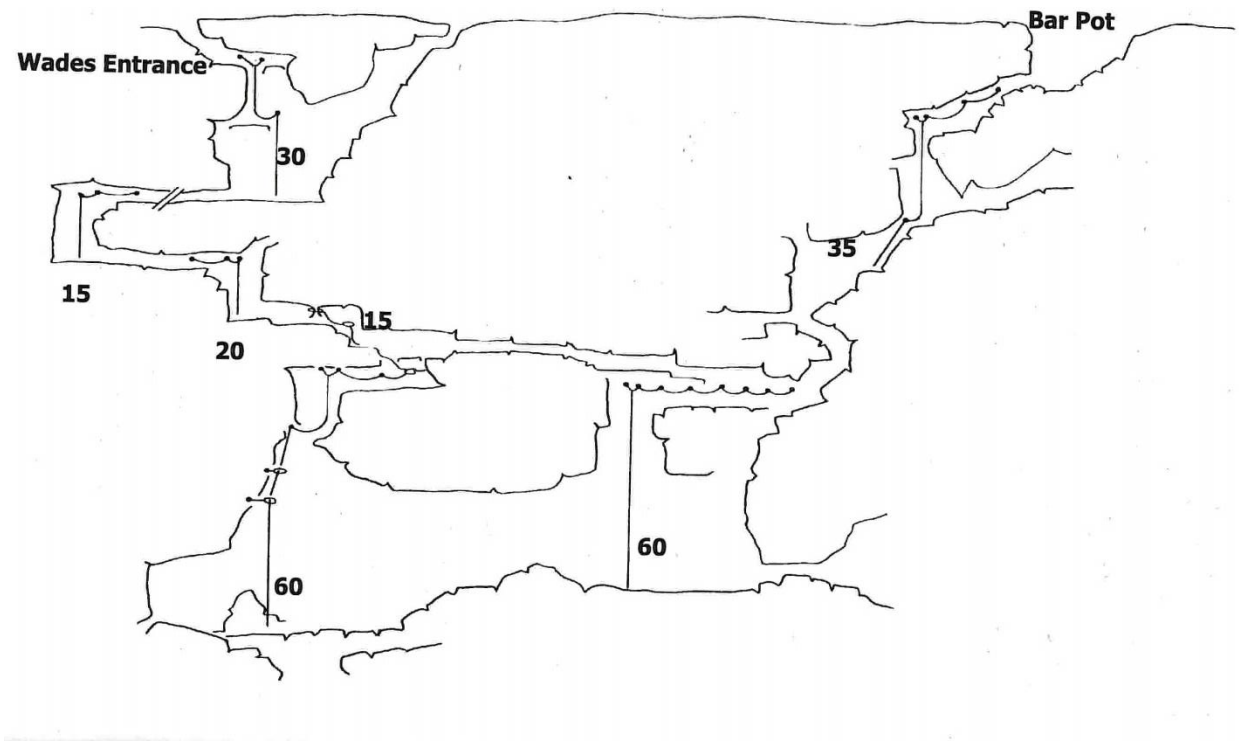


Fig. 4 (Sykes, 2015, p.110) shows a survey of Wades Entrance and Bar Pot to demonstrate the tubular and multiple pitches with rebelays which European caves can have.

Figure 5

Fig. 5 (Yogyakarta Tour and Holiday, 2013) shows an example of how a shaft pit is impractical to rig with rebelays and is much simpler to rig using the straight line approach.

Bolts, Hangers and anchors

There are many different types of hangers and bolts which cavers can use to connect themselves to the rock, these range from artificial (both permanent and non-permanent) and natural anchors (stalagmites, trees and rocks).

Under normal circumstances permanent bolts are placed into a drilled hole in the rock unless self-drilling bolts are utilised. A hanger will be placed on top of the exposed part of the bolt and held tightly by a small nut. There are many different types of bolts, for example Resin and Spit (Sparrow, 2009), Expansion (See Figure 6), Hilti and LucKY bolts (Smith and Padgett, 1996). Whereas, types of common hangers include the Clown, and Twisted (Marbach and Tourte 2002) TiHanger, Coeur (Smith and Padgett, 1996). The French use a method called a flexible anchor that is used for lighter rigging in conjunction with a second, full strength anchor (École Française de Spéléologie,

2013). The use of natural anchors can be utilised, normally on the surface (See Figure 7), although they can also be found underground (See Figure 8).

Figure 6

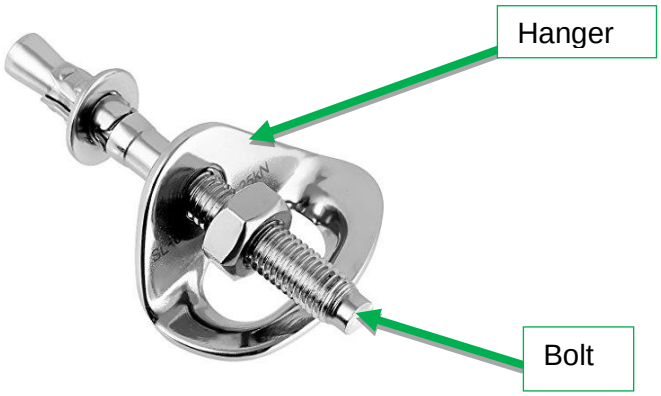


Fig.6 (UK Mountain Sports, 2016) shows an example of an expansion bolt and hanger which can be utilised in a cave.

Figure 7

Fig. 7 (Slatcher, 2012) shows a tree being used as an anchor point in Bull Pot De Witches in Yorkshire, England.

Figure 8

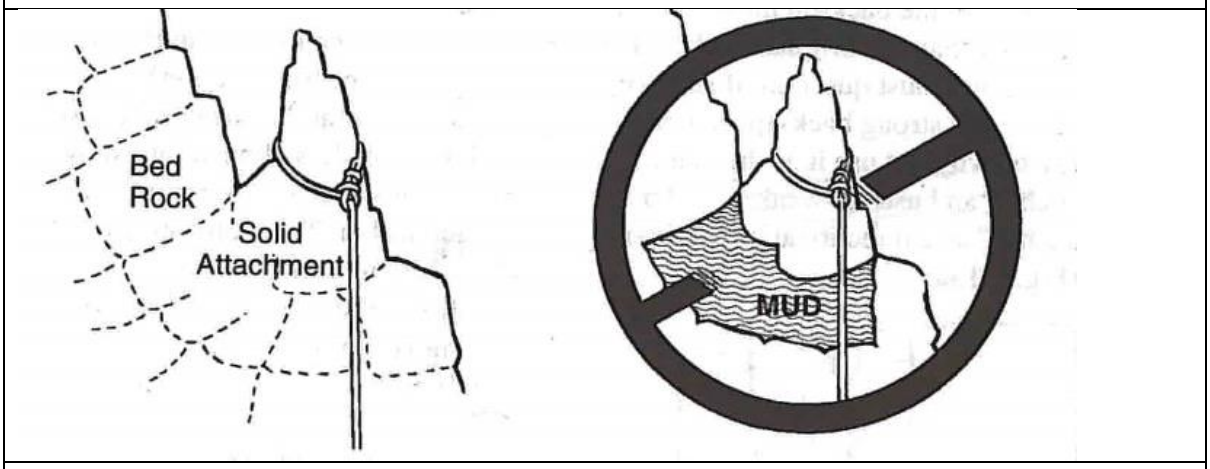


Fig. 8 Illustration by Buffington (Smith and Padgett, 1996, p. 63) shows how a stalagmite can be used as an anchor. This illustration was made for example purposes and should be backup to another anchor artificial or natural especially for SRT.

Non-permanent anchors including Pitons, Nuts and Cams are rarely used in caving even though they are efficient and quick to place (École Française de Spéléologie, 2013).

Sparrow, (2009) suggests that one of the most popular artificial anchors used is the resin anchor (P-bolt) (See Figure 9). Within the UK the Anchor Scheme was brought about by the British Caving Association (BCA) and was started in the 1990s (British Caving Association, 2016). The BCA finances all permanent anchors (British Caving Association Equipment and Testing Committee, 2013). This came about due to the failure of some Spit Anchors that had been in place for a considerable time (British Caving Association, 2016). These Spit Anchors have been replaced but not all with P-bolts, more traditional bolts are still used. This is usually decided by the BCA equipment and testing committee. All replacement anchors must be installed by a qualified individual trained by the BCA (British Caving Association, 2016). Installing a fresh P-bolt is complex and involves the use of a chemical resin which if a caver is exposed to can cause harm to the lungs and can irritate the skin if proper precautions are not employed (British Caving Association, 2014).

Figure 9

Fig. 9 (Maitre, 2015) shows type of resin bolt called a P-bolt due to its shape.

Preparation of ropes

Within Europe and America the method for packing ropes is similar. A stopper knot one meter before the end of the rope then loosely fed rope in the bag (École Française de Spéléologie, 2013; Smith and Padgett, 1996; Sykes, 2015). It is key to add that in America for pit caving of up to 600ft (182 meters) the use of a bag with a square internal structure frame and the rope coiled length ways ensures the rope uses minimal rope space (Smith and Padgett, 1996).

Rope padding and rope sizes

Smith and Padgett, (1996) discuss how American cavers consider rebelays as a European practice. When they chose to not to use rebelays. Americans prefer to use thicker ropes of 11-12mm. This is because of its strength, durability, dependability and comfort for the user (Halliday, 1974; Smith, 2016). They then uses rope protectors to prevent the rope from snagging against sharp rocks (See Figure 13) (Sparrow, 2009). The European strategy is to use 9mm rope and deviate or rebelay around obstacles (See Figure 15) (École Française de Spéléologie, 2013).

Traverses

The first person down the cave is called the rigger and has the most significant role (Marbach and Tourte, 2002). The European method of rigging a traverse line involves the rigger starting with an anchor and then the use of a Hand Jammer or Basic connected to a long taught Cow's tail (École Française de Spéléologie, 2013). From here the rigger would reverse Prussic to the next bolt and rig a butterfly knot, this process would then be repeated to the next and subsequent pitch heads (Marbach and Tourte, 2002) (See Figure 10). It is also possible to use a descender and within some European countries this is considered normal practice. The process is similar to the basic or hand jammer in that the rigger would abseil towards the bolt, lock off and then rig the anchor (École Française de Spéléologie, 2013). Traverse rigging in America seems to be the same (Smith and Padgett, 1996).

Figure 10

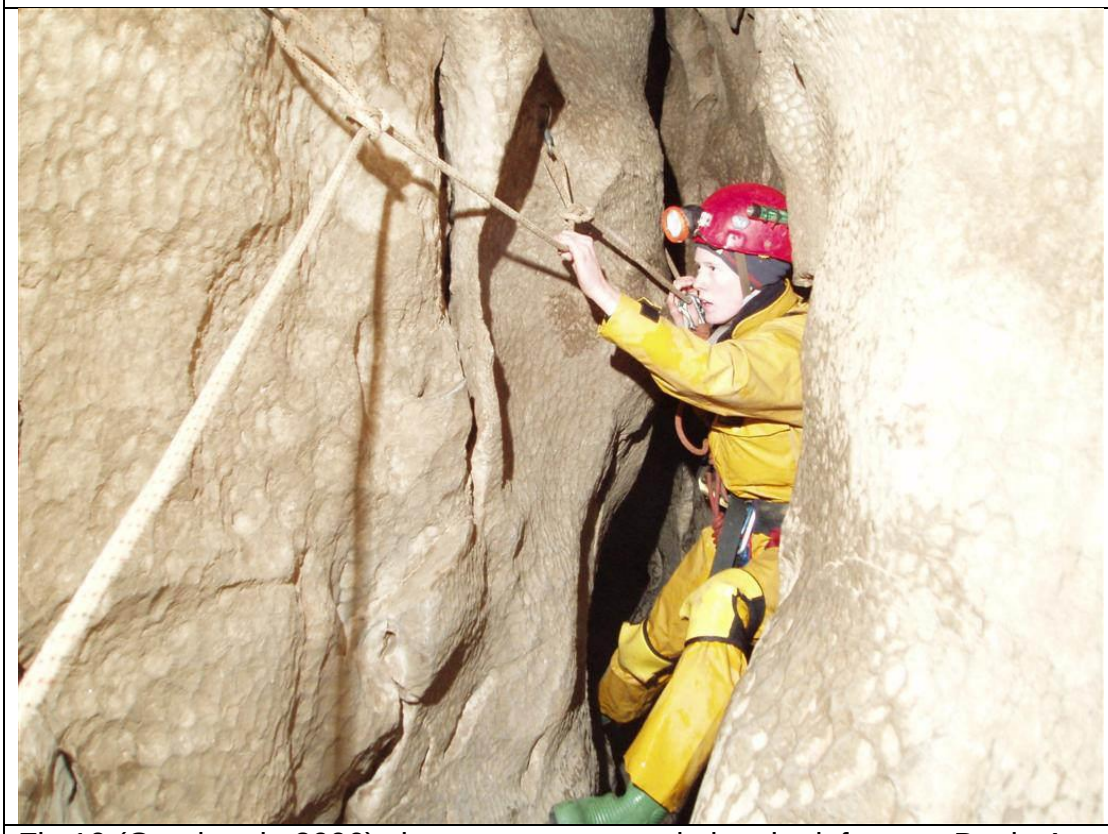


Fig.10 (Gregbrock, 2006) shows a caver completing the infamous Battle Axe in the Lost John's system towards the Valhalla pitch in Yorkshire, England.

Pitch Heads

When caving, it is essential that the pitch head always has good anchors. If the Y hang with the rope is higher it enables easier transition (See Figure 11). Members of the group can transition their weight from the traverse to the descending line or vice versa easier (École Française de Spéléologie, 2013).

However, in America, on pitch heads, cavers use a system called an edge line which is simply a SRT line that lowers down to a safer point (a large ledge for example) to attach or detach equipment (Smith and Padgett, 1996). There is also other practice for protecting pitch heads that utilises a large mat or a log tie back with a mat (See Figure 12).

Figure 11

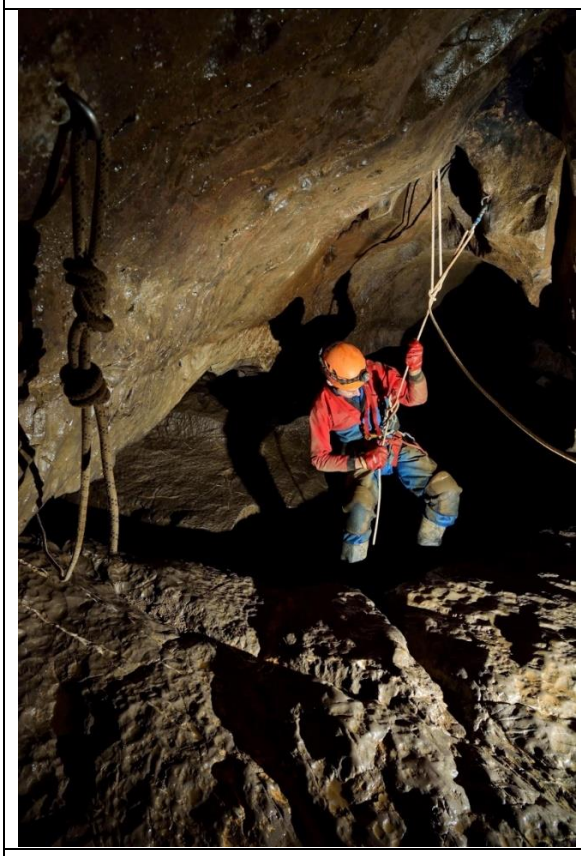


Fig. 11 (Glencoe mountaineer, 2014) shows a caver on an equalised Y hang pitch head, ready to descend down into Kingsdale Master cave system in Yorkshire, England.

Figure 12

Fig. 12 (Hogbin, 2017) shows an examples of how American cavers protect their pitch heads due to the 90º angled ledge.

Deviations

A deviation is a technique used in caving to move the caver away from a hazard e.g. sharp ledge that may abrade ropes. They are used by both European and American cavers. The European method involves the rigger descending down to the same level as the hazard and then on an opposite wall attaching a Cow's tail and threading a cord through the bolt. Then a snap gate is attached to this cord and the descending rope (See Figure 13) (École Française de Spéléologie, 2013; Smith and Padgett).

Figure 13

Fig. 13 Photo by (Wirral Caving Group, 2009) shows a caver that has just passed the deviation on descent. The deviation has been rigged correctly, because there will not be any rope rub against the rock.

Rebelays

Rebelays are used by both European and to some extent Americans cavers to avoid rub points, loose boulders and waterfalls generally. To create a rebelay the rigger firstly descends to the level of the bolts (Skyes, 2015), then clips a short Cows tail into the bolt, adds a loop of rope that is of a suitable length to enable easy transition between lines, then ties a double bowline or equivalent and then completes the changeover as normal (see figure 14) (École Française de Spéléologie, 2013).

However, Smith and Padgett, (1996) discuss how American cavers consider rebelays as a European practice. When rigging their rebelays the American cavers prefer to have a smaller loop which connects to the hanger (Smith and Padgett, 1996).

Figure 14

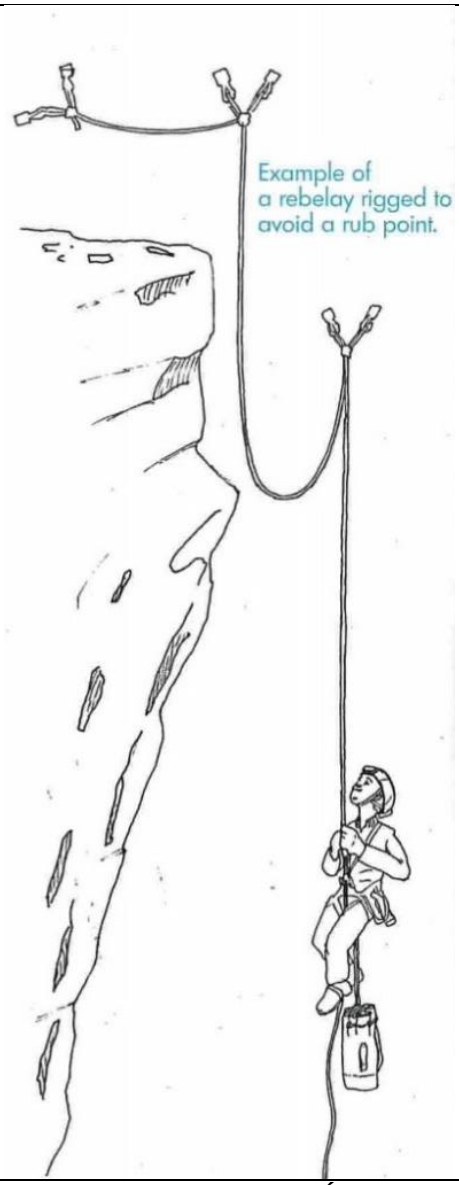


Fig. 14 illustration by Fillols, Gout and Leucart, (École française de spéléologie, 2013, pp. 148) shows an illustration of a caver ascending up a pitch, rigged correctly to avoid any rub points.

Conclusion

The use of SRT has increased amongst the caving community since Provatina, was bottomed in 1973 (Sparrow, 2009). The technique is now used worldwide (Lyon, 1983), and has almost replaced the ladder and line. Cavers can now progress further into caves (Elliot, 1995b). The technique has brought about both advantages and disadvantages for the caver, with the most obvious being caves can now be explored independently by cavers. This is a practice that is not encouraged by caving associations and could endanger the individual (Hall, 1973). The increase in use of SRT has brought about a change in the equipment used. The choice of the equipment used by both European and American cavers is dependent upon the cave formation. It is this cave formation that has determined the manner in which cavers from both continents rig their caves and has produced a fundamental difference between them (École Française de Spéléologie, 2013). This gives the dissertation a good grounding to explore the differences in rigging and the styles that are adopted by cavers on both continents and the reasons behind their practice.

12 Methodology

Introduction

There are two types of research method; qualitative, quantitative. Some researchers combine these to arrive at a mixed methods approach. This study has chosen to follow a mixed methods approach. This methodology will discuss a mixed methods approach and its advantages and disadvantages. The intent of this study and its convergent parallel design will be explored. It will then discuss the methods used for this piece of research including data sampling and data analysis. To conclude it will examine the validity, ethical issues and the limitations of the study.

Overview of Mixed Methods

According to Creswell (2010b), since the 1990's mixed methods approaches to research have emerged and developed considerably. Mixed methods approaches are still in their 'adolescence' compared to purely qualitative and quantitative research methods, and this means there are still unsolved issues within mixed methods approaches (Teddline and Tashakkori, 2003). A definition for a mixed methods approach is the combination of both qualitative and quantitative methods used within a research project (Bergman, 2008). Creswell (2010a) says that research needs to be wide and have depth for the discussion to support a statement, theory, finding or confirmation. There are five main mixed methods approaches Convergent Parallel and Explanatory Sequential are considered basic designs (Creswell, 2010a). Additionally there are three more advanced methods; Embedded, Transformative and Multiphase (Creswell, 2010a).

For this study an empiricism paradigm has been chosen. This is because the author does not know everything on this topic. For this reason an empiricism paradigm has been chosen so both the author and the participants have to gain knowledge through experience on the subject of SRT rigging in caving.

Advantages and disadvantages of a mixed methods approach

One of the basic advantages of undertaking a mixed method approach to research is that it uses both types of data collection, (qualitative and quantitative). Utilizing both of these types of data collection together creates more opportunities to expand on the research (Bryman, 2008) this is because quantitative data collection uses closed questions generally whereas this combination allows for wider open questions, therefore using both enables a wider view in general.

Teddline and Taskakkori (2003) address some of the more important issues that arise from using a mixed methods approach. These include; the designs for other researchers to follow, the logistics issues with undertaking a mixed methods research project and how mixed methods should be used and within this methodology show an example of how a mixed method study can be utilised. In recent years the expansion of mixed methods research has seemed to be more accepted and literature has grown enabling some or all of these answers to be resolved, such as “Do unexpected or surprising results suggest a new kind of question?” (Clark and Badiee, H, 2010). Although it still has issues such as; analysing the data on a more profound level, and that researchers do not take mixed methods seriously enough towards the challenging designs that oppose them (Bergman, 2008).

The basic intent of the study and the design

The basic intent of this study was to compare the differences and similarities of SRT rigging and how certain aspects affect the way cavers rig caves. For this study the best suited design was a convergent parallel mixed methods approach (See Figure 15). This allowed for the ability to compare the views of caver’s resident on two continents (Europe and America) about SRT in caving and how the practices differ or are similar in their experience. It allowed the researcher to analyse qualitative and quantitate data separately and then make comparisons. This design emerged from the multimethod approach by Campbell and Fiske in 1959, as psychological characteristics enabled the collection of different data forms (Creswell, 2014).

Figure 15

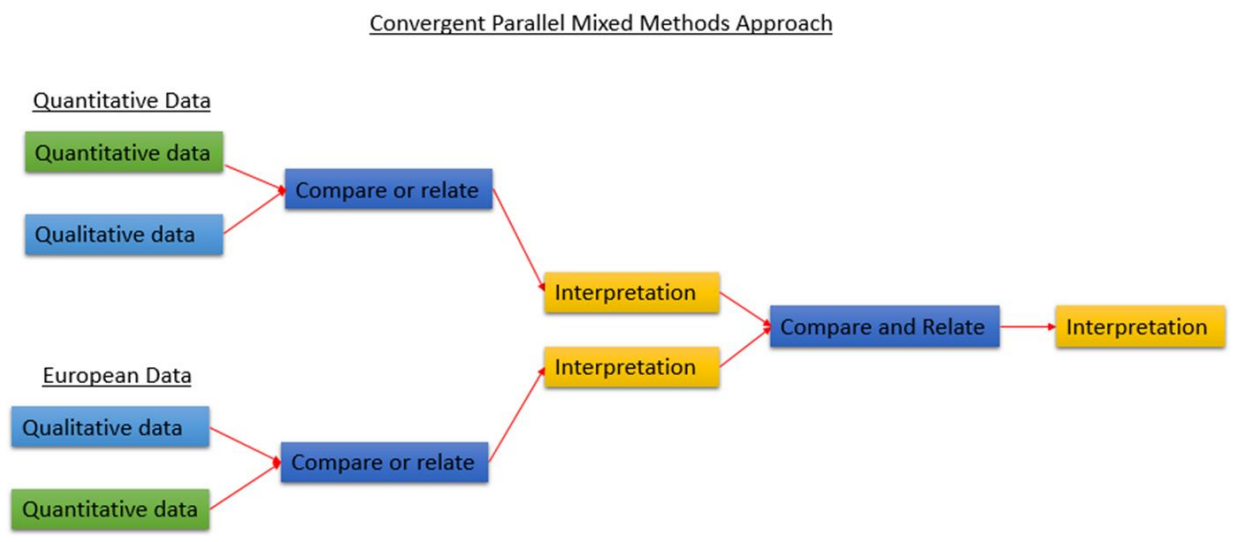


Fig. 15 adapted from (Creswell, 2014, p. 220) Shows how the discussion will be structured with a convergent parallel mixed method approach.

Triangulation is used when a research needs to combine both qualitative and quantitative research and a literature review (See Figure 16) (Bryman, 2008).

Figure 16

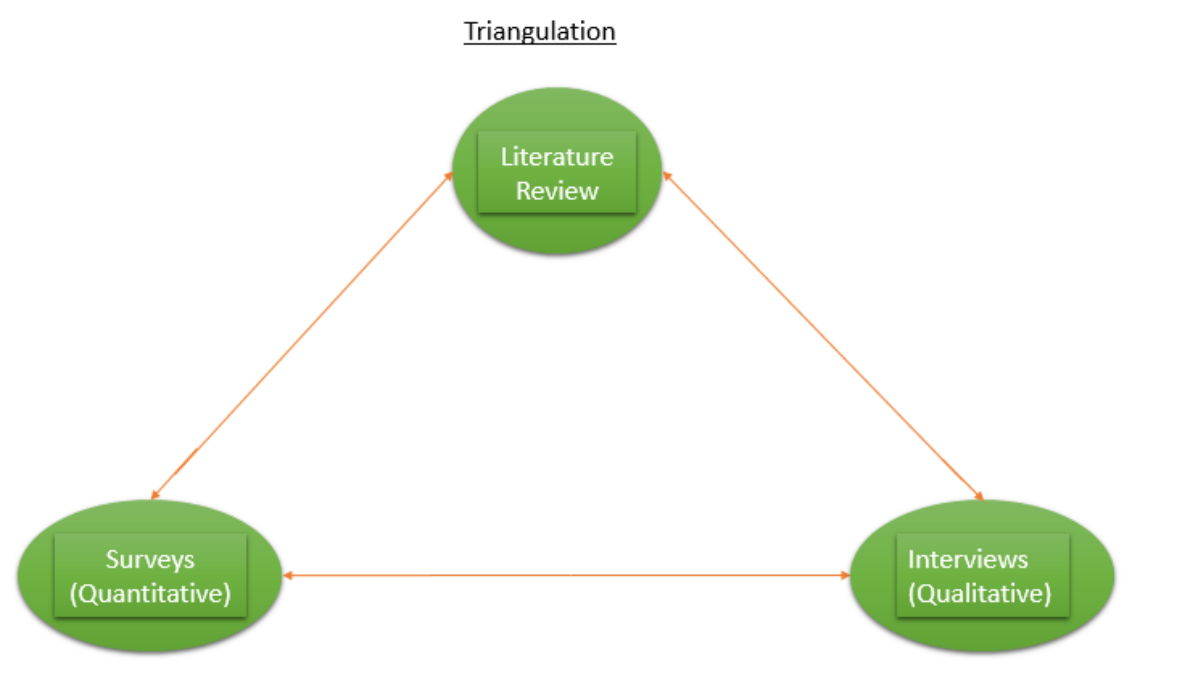


Fig. 16 shows an illustration by author shows how the triangulation has been achieved in this study.

Methods used to query the content of the research

Within this study questionnaires and interviews have been used. Questionnaires were utilised to enable an efficient method of reaching out to as many cavers and clubs, societies and organisations as possible in Europe and America though the internet and social media platforms (Wright, 2005). Interviewing a number of participants was employed to enable the author to follow up on questions included in the questionnaire and gain a more in depth understanding of the practices of cavers on each of the chosen continents. Two of the interviews were conducted face to face with European cavers. The advantage of this was to take into account the social cues and body language of the participants (Opdenakker, 2006). Two American participants have been interviewed via Skype. Opdenakker (2006) also says that internet interviews that use MSN, Skype, etc are good for a researcher on a small budget as it can save time and money on travelling.

Data sampling

Data sampling is the way in which one would choose to how gain data. According to Curtis, et al. (2000), there are six elements to consider when employing a mixed methods approach to research, these have been adapted by Kemper, Stringfield and Teddine (2003) to create seven. These include; a logical progression using the framework to support a discussion, the ability to produce a good database on the aspect of study. Thirdly the study must draw answers from the data and these should enable a credible explanation to address the research questions (Kemper, Stringfield and Teddine, 2003), it also needs to be ethical (Curtis, et al. 2000). Additionally the study needs to make it possible to actually analyse all of the data and the data should enable a generalization within the conclusion (Curtis, et al. 2000). Lastly it needs to be as well-organized as possible, (Curtis, et al., 2000).

The convergent parallel approach selects data for qualitative analysis and this can include interviews, observations, documents and records (Creswell, 2014). Additionally a few examples of how to obtain qualitative data include; instrument data, observation checks-list or numeric records (Creswell, 2014). Creswell (2014) believes that the data

for this design therefore needs to be either parallel, constructivist or conceptual. Within this study there is a questionnaire, this has been completed by 50 respondents from each continent, once 100 had been reached, the survey provider did not allow the researcher to see additional responses. All responses were deleted once 50 from each continent had been reached. This study also conducted four interviews lasting approximately 15 minutes long as advised by the supervisor.

Data analysis

There are many different way to analyse data (Kara, 2015). The three main methods of analysis according to Morse (2003) are side by side comparison (also known as a thematic analysis), changing qualitative into quantitative numbers and then making a comparison and finally to merge the data into a table (See Table 1) (Creswell, 2014). Additionally figure 17 explains how to read the code and find it in the appendices. The basic idea of all three is to render both forms of data by merging them together (Creswell, 2014).

Table. 1 shows an example of how the Interview code will be structured in the results.

Main Theme	Sub Theme	Minor Theme	Code
Cavers positive and negative views on caving	Positive European views	Rigging	1:1:1:1
	Positive American views	Big Abseils	2:2:8:12
	Negative European views	I dislike cold and wet caving for hours	3:4:1:8
	Negative American views	Hard long squeezes	4:3:3:2

Figure 17

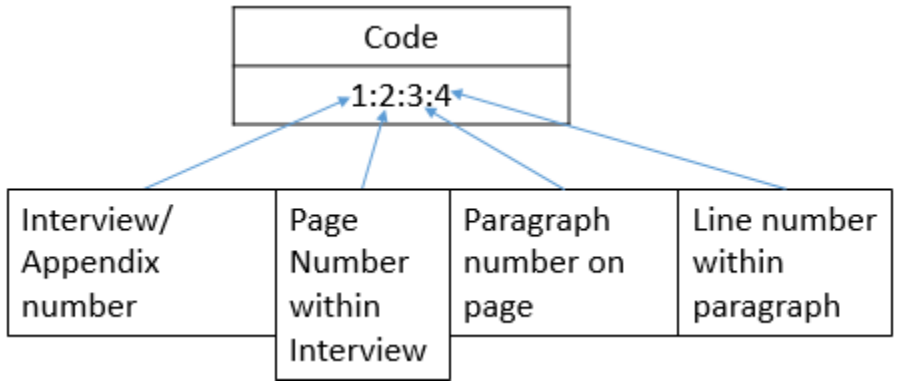


Fig. 17 shows how to find the code within the appendices.

The advantages of using a thematic analysis is too enable the writer to compare themes (Bergman, 2010). This allows the writer to also choose a bottom up or a top down approach in coding (Bergman, 2010). Lastly within the discussion by using a constructivist approach, the author has the flexibility to structure the discussion how they see fit to enable a deeper discussion (Creswell, 2014).

Advantages and Disadvantages of a Convergent Parallel approach

Some of the design negatives include that the researcher is required to fully understand their subject (Creswell, 2011). Unequal sizes of data can be an issue (Creswell, 2011). Lastly a researcher can face issues when quantitative and qualitative research does not match in a coherent way for analysis (Creswell, 2011).

Creswell (2011) believes that a convergent parallel approach is possibly the most intuitive of the designs he discusses. The design has a long history of success being the first mixed method approach (Jick, 1979). Additionally, Creswell (2011) comments that the design is effective as long as all of the data is collected in the same time frame. Lastly, both data types should be analysed separately (Creswell, 2011), so that quantitative and the qualitative data has the best chance of showing what been found.

Validity

Validity is concerned with ensuring that the results are accurate and procedures which a researcher has undertaken are carried out well to make sure the study is correct (Bryman, 2010). Creswell (2014) adds to this by saying there are eight procedures in which a study can be validated which range from triangulation to using an external auditor to review the project. Within this study triangulation was been chosen because this enabled the researcher to examine the evidence from all three sources and build a justification. Once a theme was identified from several sources of data, this helped validate the study.

In some cases the use of a dense description may be useful to allow the readers to understand the findings in more detail Creswell (2014). This can give the discussion an element of shared experiences and can enable the results to seem more realistic, giving the results validity.

The third way the researcher can validate the results is a prolonged time in the field (Creswell, 2014). The researcher has been caving for 12 year and has spent 5 years learning, rigging and teaching the European SRT within a club environment, giving a strong view of the European side.

Potential ethical issues

Within this study, the author does have a bias, this is because he is European, so naturally understands the European system better than the American system. Within this study the writer will note both the advantages and disadvantages of each system to provide a balanced view. All respondents and interviewees have agreed that they understand that any information they provide was kept confidential and that they were able to stop at any time without stating a reason. All respondents had the choice of completing the questionnaire. Interviewees also understood that they did not have to answer any question which they felt uncomfortable with. For this study an ethics form was completed and was approved by Liverpool John Moores University.

Limitations of the study

The main limitation of this study was location. The author resided in the UK and could not access information form large numbers of cavers in America. If this study was to be repeated a broader scale should be used to reach out to interview as many cavers as possible to improve the data collection.

Conclusion

Within this methodology the author has looked at mixed methods approaches as a whole and has then narrowed this down towards the intent of the study and the convergent parallel approach. The methods of data collection were interviews and an online questionnaire. This methodology has also discussed the advantages of both in relation to the study. In addition this methodology has shown that within any data sampling there are seven parts to consider Kemper, Stringfield and Teddine (2003). In terms of data analysis, a thematic approach has been utilised to enable an easy way of analysing and comparing the two styles of single rope technique in caving. The study also looked at validity via triangulation, ethical issues such as a biased view from being European and limitations to the study such as distance between the two chosen locations.

13 Results

Survey Results

These results show graphical representations of the responses from the total number of participants (N=100). For the purpose of these results the responses from the cavers residing in Europe will be called European and for those residing in the USA will be called American. These results are laid out in two parts: European participants (N=50) and American participants (N=50). Coding from the interviews is presented in tables after the survey results.

Figure 18

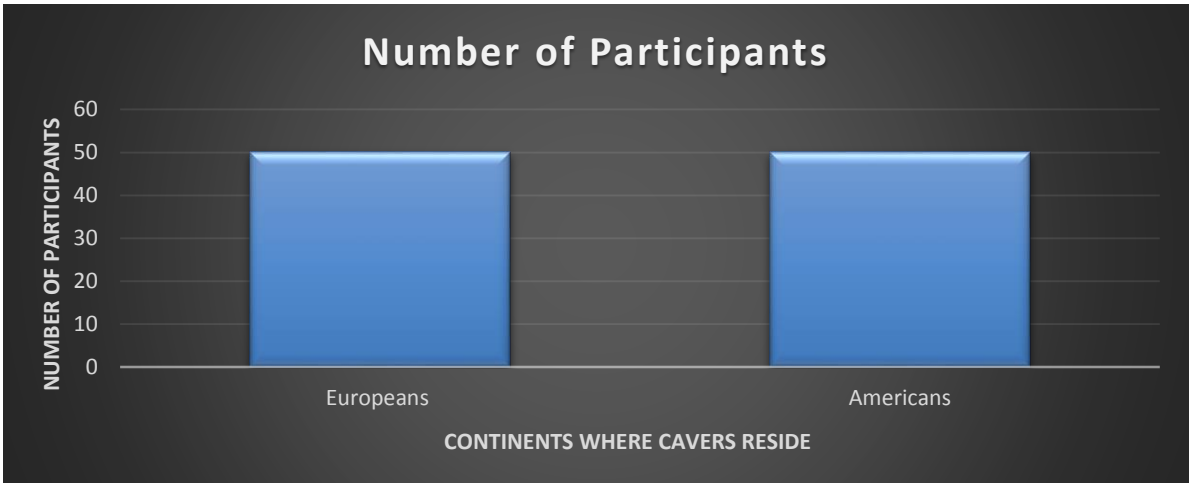


Fig. 18 shows the number of participants reporting to reside in Europe (N=50) and America (N=50).

Figure 19

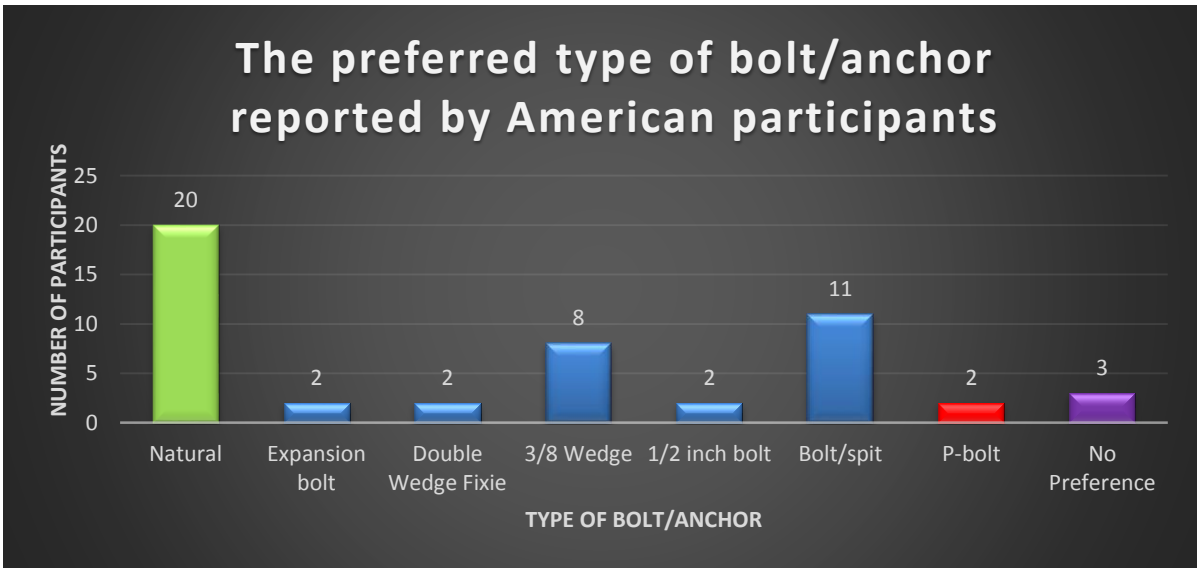


Fig. 19 shows the preferred type of bolt/anchor chosen by American participants. A natural anchor was the most popular (N=20) and a Bolt/spit was the second most popular (N=11).

Figure 20

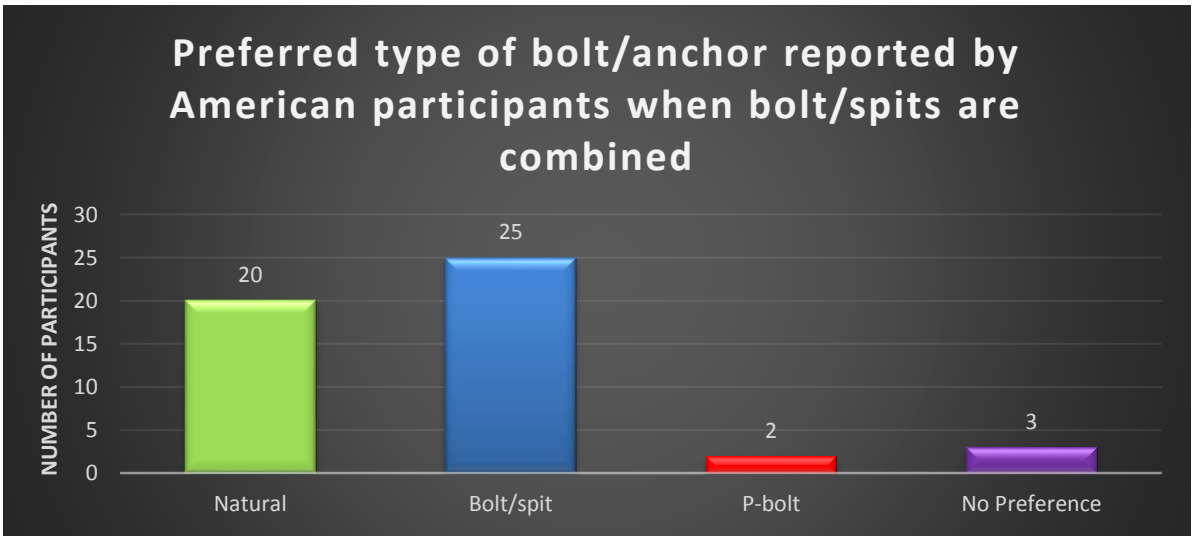


Fig. 20 shows preferred type of bolt/anchor chosen by American participants with bolts/splits combined. When combined the bolts/spits are the most commonly preferred (N=25).

Figure 21

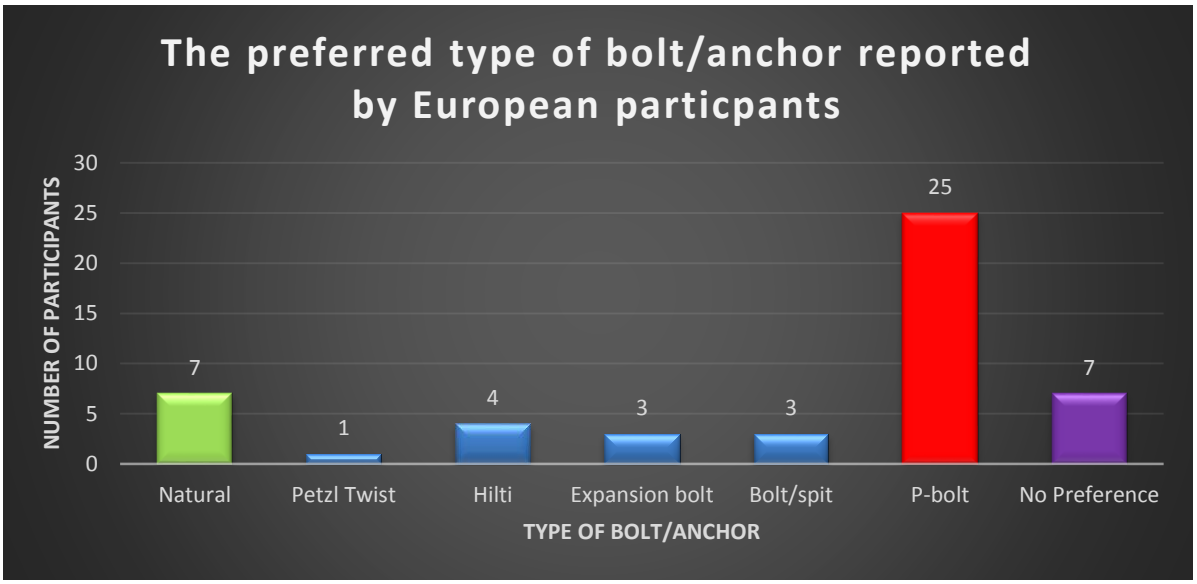


Fig. 21 shows the preferred type of bolt/anchor chosen by European participants. A P-Bolt was the most popular (N=25).

Figure 22

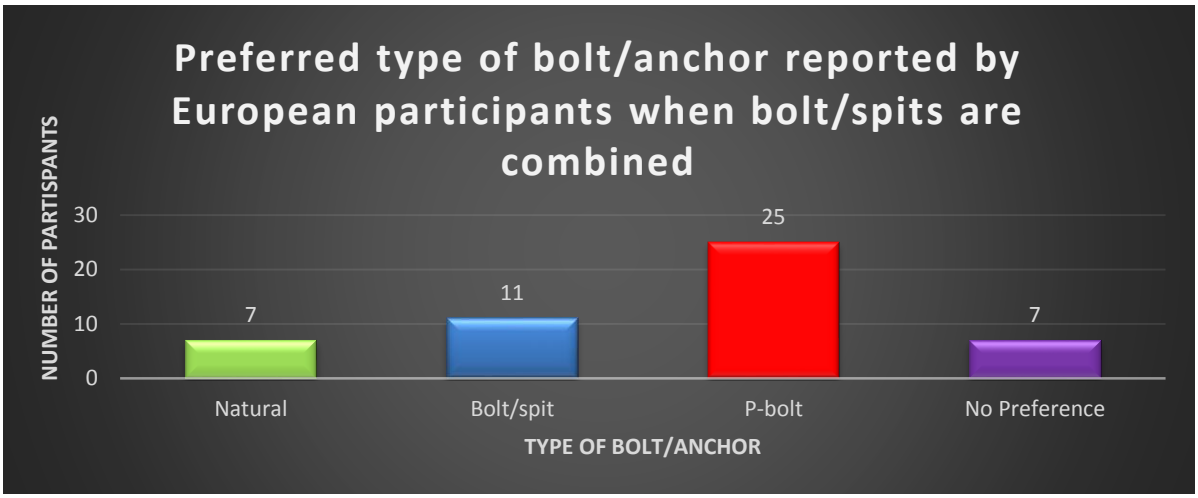


Fig. 22 shows preferred type of bolt/anchor chosen by European participants with bolts/splits combined, when combined the P-Bolt remains the most commonly preferred (N=25).

Figure 23

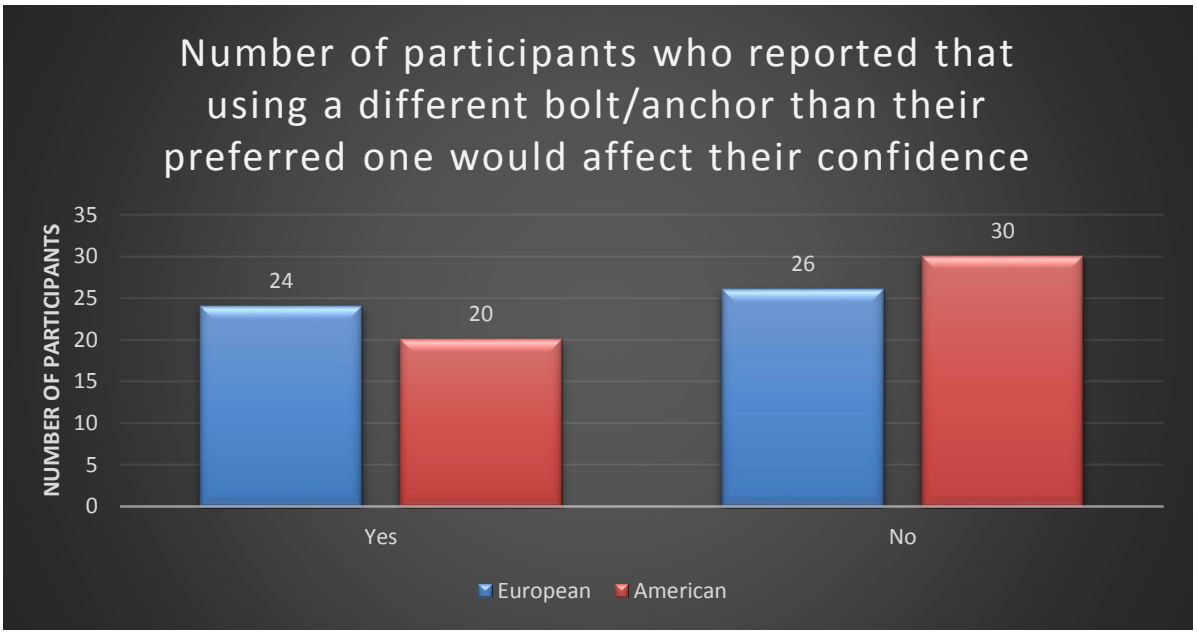


Fig. 23 shows there little difference between those European cavers that reported using a bolt/anchor that was not their preferred equipment having an effect upon their confidence and those for whom it would not (N-2). With the American cavers the difference was greater. (N=10).

Figure 24

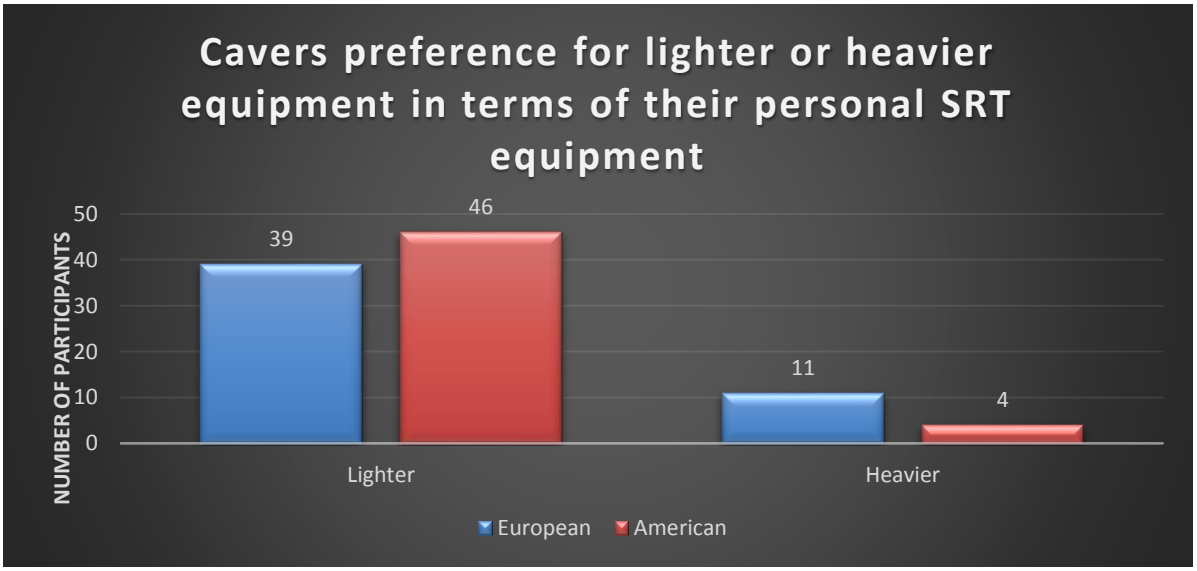


Fig. 24 shows 85% (N=85) of all participants preferred lighter equipment. More European cavers (N=11) than American cavers (N=4) reported preferring heavier kit.

Figure 25

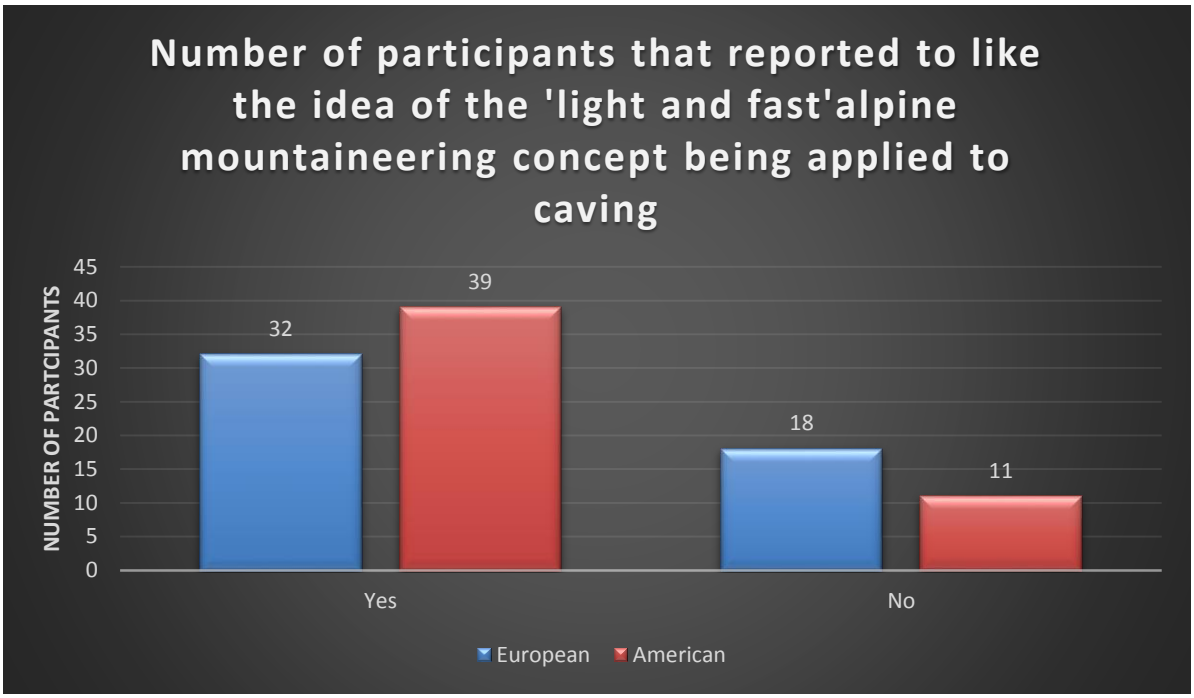


Fig. 25 shows the majority (71%) of all cavers who took part reported liking the idea of the ‘light and fast’ alpine mountaineering concept being applied to caving.

Figure 26

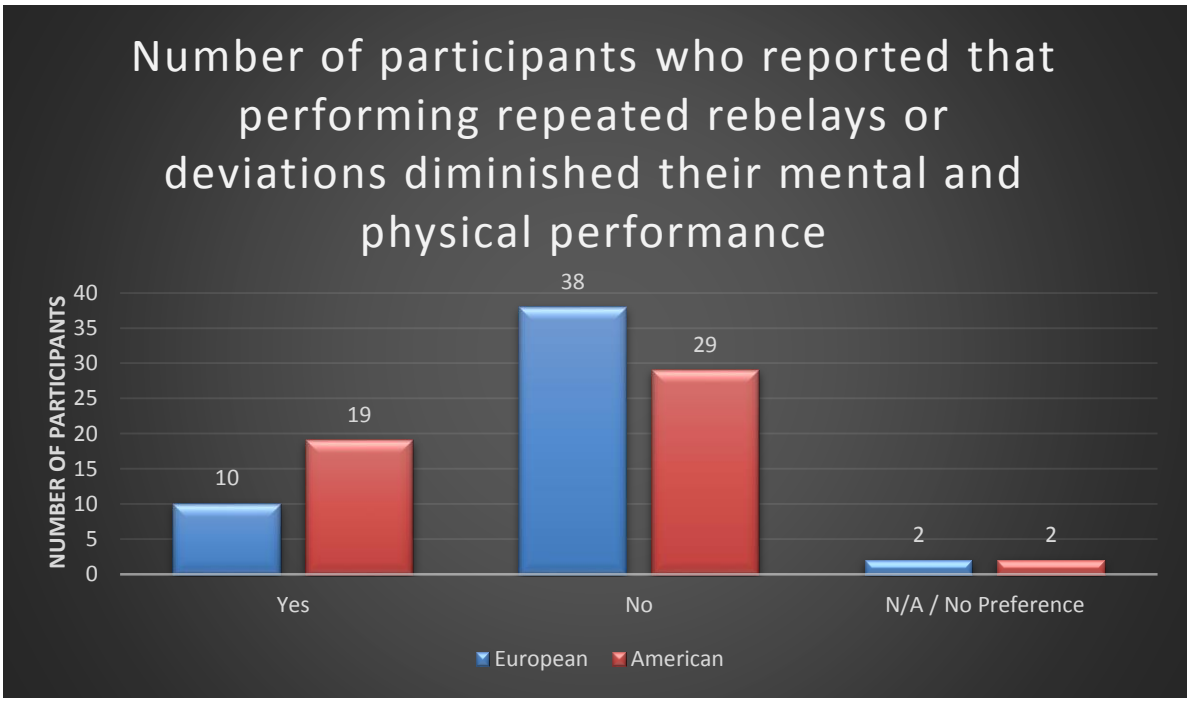


Fig. 26 shows that 67% of all cavers who took part in this research reported that they did not consider repeated rebelays or deviations had a diminishing effect upon their mental and physical performance. Fewer European cavers (N=10) than American cavers (N=19) reported that repeated rebelays or deviations did diminish their mental and physical performance.

Figure 27

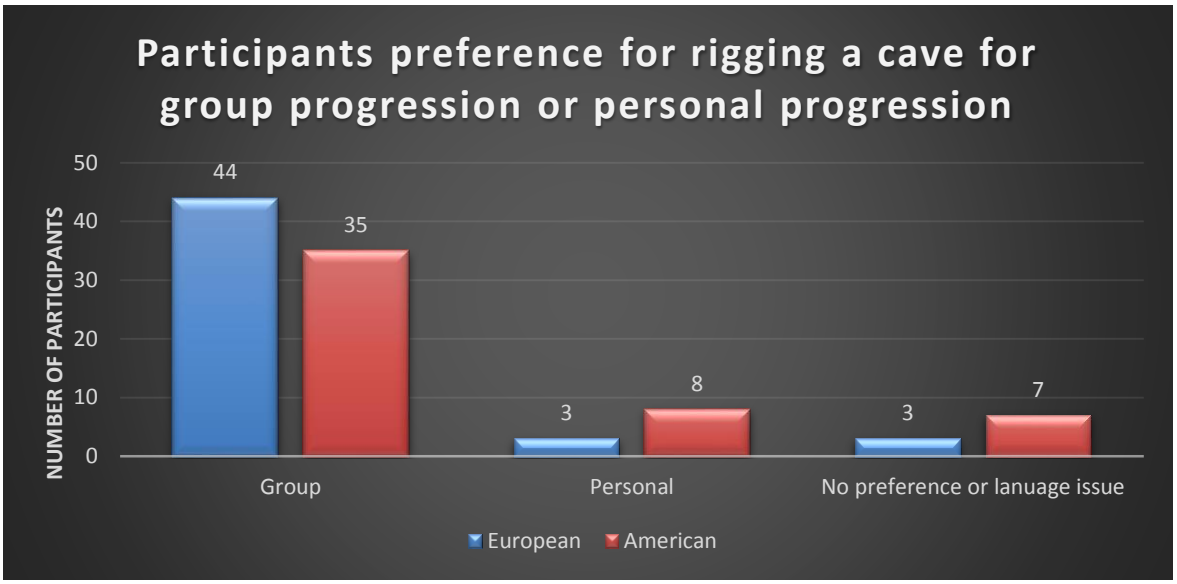


Fig. 27 shows that the majority (N=79) of all cavers who took part in the research preferred to rig for group progression. 10% (N=10) of cavers had no preference or did not understand the question.

Figure 28

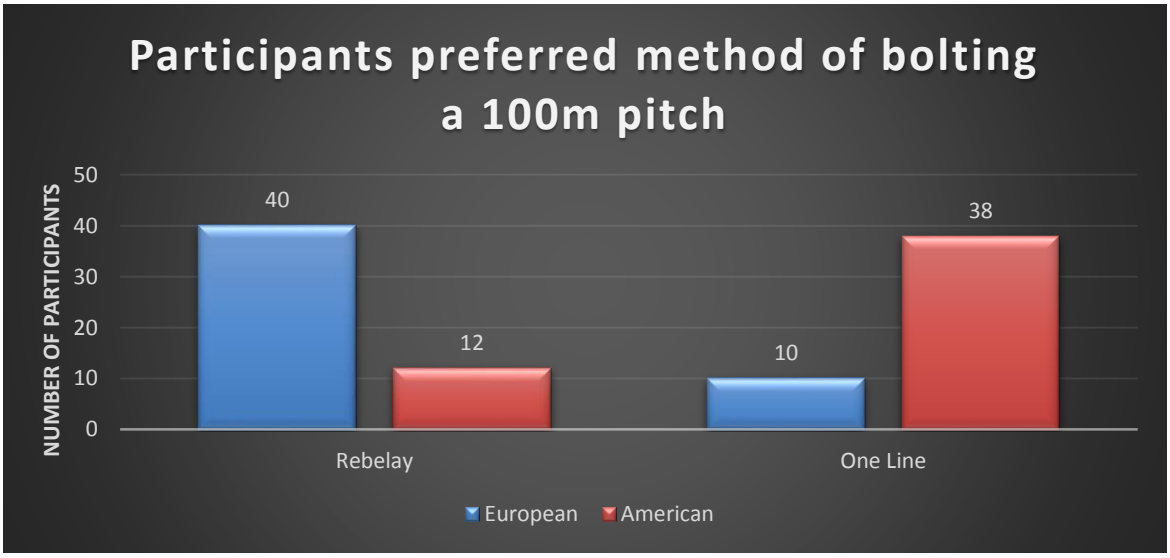


Fig. 28 shows a clear difference between the European and American caver's preference for bolting a 100m pitch. 40% (N=40) of Europeans preferred to rebelay the pitch compared to 12% (N=12) of the Americans. 38% (N=38) of the Americans preferred to use one line to bolt the pitch compared to 10% (N=10) Europeans.

Figure 29

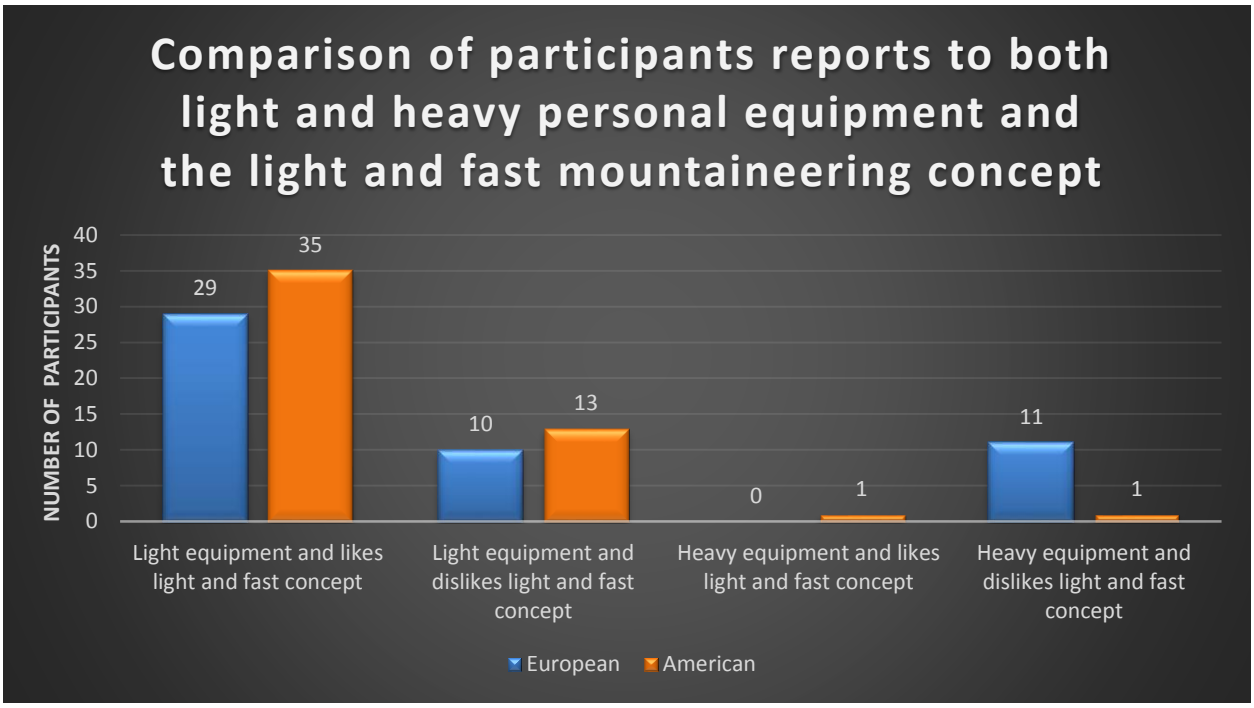


Fig. 29 shows the number of European (N=29) and American (N=35) cavers who took part in the research who reported a preference to use the light and fast alpine mountaineering concept to their caving combined with the use of light equipment was 64% (N=64). 23% (N=10 Europeans and 13 Americans) of all cavers taking part preferred to use light equipment but not apply the light and fast concept to their caving. 11% of all cavers (N=11 Europeans and N=1 American) that took part reported to prefer heavy equipment and did not apply the light and fast concept to their caving.

Interview code

Table. 2 shows all participants views on not being able to use preferred bolts/anchors.

Highlighted: Red			
Main Theme	Sub Theme	Minor Theme	Code
Different bolts views	Different America	Natural bolts	3:4:7:1
		Stronger bolts	4:3:7:1
		Natural backup	4:3:7:2
	Equal Europe	All bolts pull out	1:1:2:1
		Exactly the same	1:1:2:10
		Back it Up	2:4:5:2

Table. 3 shows all participants views on cave formation determining style of rigging.

Highlighted: Blue			
Main Theme	Sub Theme	Minor Theme	Code
Rigging Views	Culture related view to rigging for Europeans	Light and Fast	1:2:1:1
		P-bolts trust	1:1:2:8
		P-bots paid (UK)	2:4:5:2
		Environment	1:5:1:2
	Culture related view to rigging for Americans	Thicker rope and pads	1:2:3:7
		Tensionless hitches	4:4:3:10/1:4:4:13
		Expansion bolts	3:1:2:2
		Bolts are second, naturals first	3:1:8:1
		Rope walker technique	3:2:5:2
	Cave Formation determines rigging	Own problem to tackle	3:4:5:1
		Complex shafts	1:2:3:1
		Vertical Pitches	1:2:3:5
		Cave pending	1:2:3:11
		Golden Dreams	1:4:3:1
		Missive Shaft issues	1:4:3:6
		European Caves Sharp	1:4:3:9
		Practical	1:5:3:3
		Cave determines	1:5:3:5
		Cavers need to be open	1:6:1:6
		Tie around tree	3:3:3:3
		Fill Out	3:4:3:1

Table. 4 shows that all participants preferred the light and fast, heavy and slow, heavier and faster and light and slower mountaineering concepts.

Highlighted: Green			
Main Theme	Sub Theme	Minor Theme	Code
Personal kit views and the mountaineering concept	Lighter and Faster Europe	P-bots are easy	1:1:2:4
		Limit to light and fast	1:1:4:1
		Realistic on light and fast	1:1:4:6
		Important	1:2:1:7
	Lighter and Faster America	Longer trips	3:2:3:5
		Frog	3:2:5:1
		Munter hitch (Italian hitch)	4:2:2:3
		Micro rack	4:2:2:3
	Heavier and Slower Europe	Expedition	1:1:4:7
		Ware out on expedition	1:2:1:9
		Modern Kit	2:1:2:2
	Heavier and Slower America	Short Trips	3:2:3:1
		Dirty kit	4:1:6:1
		Durable and Rugged	4:1:6:3
	Heavier and Faster Europe	Rope Walker	2:2:4:4
	Heavier and Faster America	J-Frame/J-bar	4:2:1:4
		Durability	4:1:6:3

Table. 5 shows participants options on group versus personal progression.

Highlighted: Pink			
Main Theme	Sub Theme	Minor Theme	Code
Vertical progression	Group Europe	Casualty Rescue	1:3:7:4
	Group America	Tandem Climbing	3:4:1:1
		Speeds up group	3:4:1:3
		Moving steady	4:3:3:5
		Rebelays and multi legs	4:3:3:2
		Getting people down	4:2:6:3
	Personal Europe	Self-rescues	1:3:7:1

Table. 6 shows participants views on both straight line and rebelays methods of rigging.

Highlighted: Grey			
Main Theme	Sub Theme	Minor Theme	Code
Method of rigging	Straight line disadvantages European	Behest of what's below	1:4:3:11
		Problems with overtaking	2:3:5:3
	Straight line advantages European	Thicker rope	1:2:3:12
		Access to everyone	1:6:1:13
		Sit around if on EU system	2:3:5:1
	Reblays Advantages Europe	People not stuck 100m off the floor	1:4:3:7
		Take a rest	1:4:3:9
		Away from hazards	1:4:3:10/ 3:4:5:4
		Not waiting around	1:4:3:15/ 3:4:1:4
		Ascending closely together and communication increase	1:4:3:17
	Reblays Advantages America	Group progression	4:2:6:5
	Reblays Disadvantages Europe	Difficult on rope walker	1:6:1:13
		More energy used	2:3:3:3
		Rigging done correctly	2:3:1:3
		Not practical on bell shafts	1:4:3:3
	Reblays disadvantages America	Missing steps and falling	3:3:3:5
		Little speed advantage	4:2:6:8
		Rope everywhere	3:4:5:3

14 Discussion

Anchors and Bolts

Sparrow, (2009) suggests that one of the most popular artificial anchors used is the P-bolt. It is clear from this research that within Europe P-bolts where the preferred type of bolt or anchor with 25 participants preferring a P-bolt compared to 12 participants favouring a drilled bolt and 5 respondents preferring Hilti bolts. P-bolts are widely available to buy, are strong (Sparrow, 2009) a permanent cave anchor (Sparrow, 2009) and as such are compatible with the light and fast alpine mountaineering concept of travelling quickly. They are quick to rig off in a cave (Sparrow, 2009) and they can secure between 26kn and 79kn (Bolt Products, n.d.). Interviewee 1 supported this view when commenting on P-bolts saying that;

> *" you trust them a lot more so you're a lot more confident in rigging."*

(See in appendix: 1:1:2:8)

Interviewee 2 commented on the use of P-bolts by the British Caving Association (BCA) suggesting that they are all;

> *"…paid for generally by the BCA, British Caving Association and the local regional council".*

(See appendix: 2:4:5:2)

The British Caving Association chooses to use P-bolts to replace old anchors in caves across the country (British caving Association, 2016) suggesting that P-bolts are a reliable component to safe caving in Europe. In this research 50% (N=25) of the European cavers that took part preferred to use P-bolts. In comparison only 4% of American cavers taking part reported that they preferred to use P-bolts. 40% (N=20) of the American cavers reported to prefer natural anchors compared to 14% (N=7) of their European counterparts. There are many different types of hangers and bolts which cavers can use to connect themselves to the rock, these range from artificial (both

permanent and non-permanent) and natural anchors (stalagmites, trees and rocks). The use of natural anchors can be utilised, normally on the surface (see figure 8), although they can also be found underground (See Figure 9). Smith and Padgett (1996) judge that it is important to rig off natural resources where possible.

Interviewee 3, and American caver, discussed the use of natural anchors suggesting that they can be unreliable;

> *"... of course you're going to rig off a natural anchor if you can find one, but then if you look around and you're like 'well this rock looks to be about 300 lbs and I'm 180, I might move it if I fall and so you're definitely very careful with stuff like that, especially if it looks like there's a chance the rock could break……"*

(See Appendix 3:4:7:2)

There are many different types of bolts, for example Resin (P-bolt) and Spit (Sparrow, 2009), Expansion (See Figure 7), Hilti and LucKY bolts (Smith and Padgett, 1996). The French use a method called a flexible anchor that is used for lighter rigging in conjunction with a second, full strength anchor (École Française de Spéléologie, 2013).

It was found through American interviews that the selection of bolts available to buy in the USA can be limited;

> *"…..go the local caving stores and they don't even have resin bolts, they don't do any of that,"*

(See Appendix 3:1:2:3)

However, 50% (N=25) of the American participants reported that their preferred bolt or anchor was a bolt/spit compared to 22% (N=11) of Europeans. Smith and Padgett (1996) suggest that 3/8 '' bolts are the most common type of bolt used in America. This study's results shows there has been little change in preference since the publication of Smith and Padgett's book in 1996. Sparrow (2009) believes that any bolt including the Expansion bolt is safe to use.

Interviewee 3, who resided in Tennessee on the East Coast of America said;

> *"….well we just don't use resin bolts, they use them a lot out West but we just use expansion bolts here"*

(See Appendix 3:1:2:1)

Preference of bolts and anchors are very personal to cavers with more Americans in this research choosing to utilise natural anchors and Europeans preferring P-bolts. It was interesting to note that 44% of all participants reported that if their preferred bolt/anchor was not available that this would affect their confidence (See Figure 23).

However, during interviews when respondents were asked to further elucidate on this topic, a European interviewee reported;

> "….*no I don't change my attitude to rigging at all, it stays exactly the same as it would be if I was rigging up dodgy bolts."*

(See Appendix 1:1:2:10)

Style of rigging

The research found that there was a clear distinction between the style of rigging adopted by the Europeans and Americans. This may be due to the different kinds of caves found on each continent. The two main differences between the European and American caves are that in Europe caves tend to be long, very tubular and progress in a horizontal fashion to produce multiple pitches (See Figure 5). In comparison, in the USA although some caves form in a similar manner, many American caves are effectively vertical pits, which may or may not have a horizontal cave system at the bottom. A pit cave, shaft cave or vertical cave is a type of natural cave which contains one or more significant vertical shafts (See Figure 6). The name pit caving has been given to those that undertake this style of caving. These pit caves are formed in the same manner at the European horizontal caves through long-term erosion by water (Revolvy, n.d.). The European cavers that took part preferred to rig with rebelays, this is because Alpine caving is cold, with active rivers and hypothermia is a real risk in caving in general

(Sparrow, 2009). Diverting the rope in European caves is an essential not an optional task (École Française de Spéléologie, 2013). A European caver said;

> *"What you need to do is really be thinking about caves rather than actually the rigging, because the caves dictate the type of rigging that you use."*

(See Appendix 1:5:3:5)

During interviews with American cavers it became clear that the straight line descent is favored in the USA. Speaking to interviewee 1 he said;

> *"…so they'll* (Americans) *just drop these massive shafts and then come up again, and that's a different style of caving."*

(See in Appendix: 1:4:5:7)

An additional factor may be the way the cave has been formed over centuries which could mean it is impractical or impossible to rig rebelays.

> *"A lot of our bigger pits down here fill out once you get passed (past) the lid"*

(See in Appendix: 3:4:3:1)

The way a cave has been formed must be respected in order to arrive at the best solution to rigging it to make it practical for all cavers to access. Figures 33, 34 and 35 show how each style of caving is suited to the respective cave formations.

Figure 30

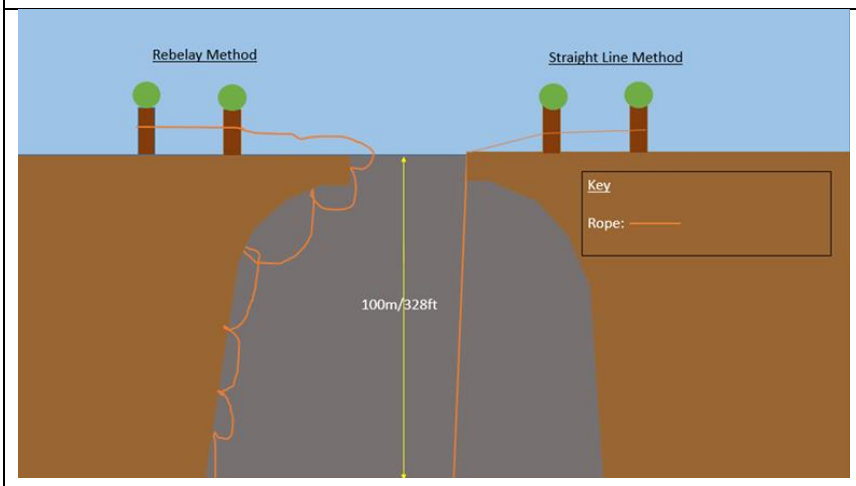


Fig. 30 shows illustration of both European and American rigging styles. The American style is more appropriate for this type of cave formation.

Figure 31

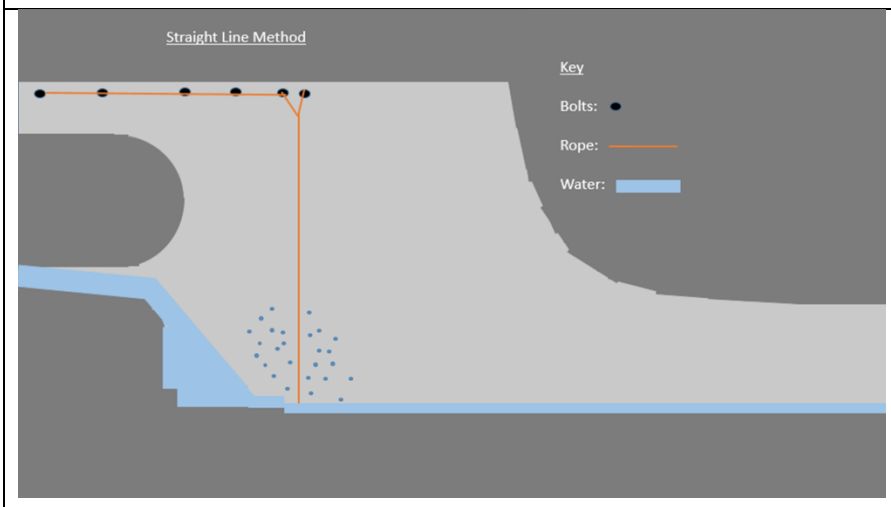


Fig. 31 shows illustration of how the straight line approach would be inappropriate in this type of cave formation.

Figure 32

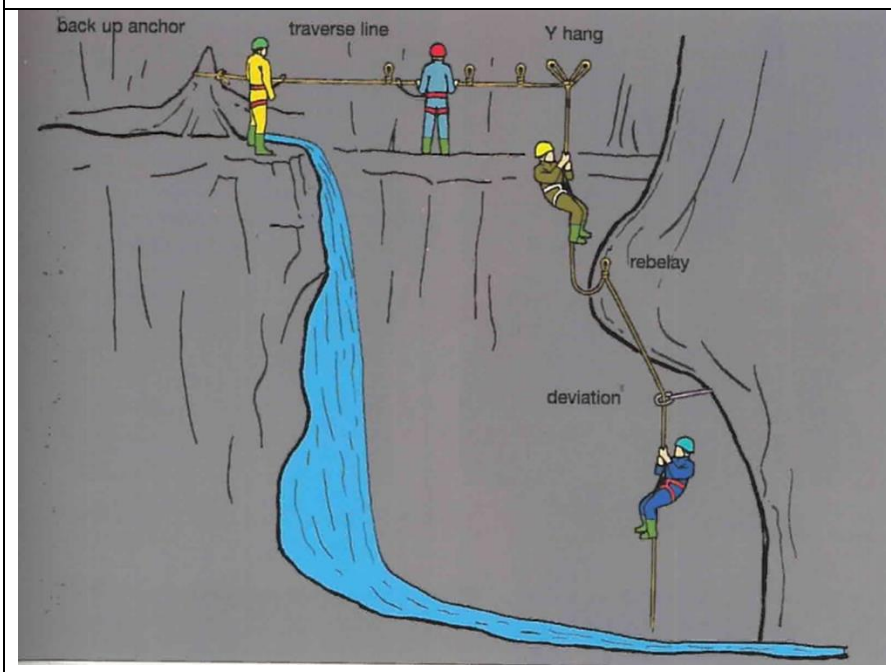


Fig. 32 illustration by Sparrow (2009, p.99) to show how the rebelay method avoids hazards such as the waterfall.

Interviewee 1(European) pointed out how difficult it could be to rebelay with a ropewalking system;

> "*I'm not going to think about rebelays because if you're using a rope walker, the last thing you want to do is pass a rebelay so you need to pad it out…"*

(See in Appendix: 1:6:1:13)

The style of rigging sometimes determines the type of clothing a caver uses. In America where pit caving is conducted in warmer climates or open air shafts over heating could be an issue, American cavers have adapted to these conditions by not using the Undersuit/Oversuit combination, which is a common type of clothing utilised in Europe commented on by Proudlove, Danilewicz and Ramsden (1995).

Interviewee 1 (European) stated when he goes pit caving in America;

> *"It's very hot so they very often don't wear caving gear, they might wear shorts and t-shirt because it is really, really hot and muddy"*

(See Appendix: 1:4:5:8)

However, in Europe, due to the cold, often harsher environments in terms of temperature, a thermal layer is used under an oversuit made with PVC (École Française de Spéléologie, 2013), another popular choice is Cordura (Rykwalder, 2016).

Interviewee 2 stated;

> *"as soon as you start getting into rebelays you use an awful lot more energy, so you're going to be more knackered and so therefore things are going to be more difficult,"*

(See Appendix: 2:3:3:3)

As caves in America can be hot adding rebelays into the American style may lead to a higher possibility of heat exhaustion. Conversely, if a straight-line method was used in European caves this could lead to hypothermia or getting too close to boulder slopes or descending through waterfalls (École Française de Spéléologie, 2013), which could also be dangerous.

Methods of rigging: advantages and disadvantages

It can be argued that the straight line method of rigging is a very traditional one; therefore the disadvantages associated with it have mainly been resolved. It is viewed as the conventional method of ascending and descending a cave regardless of formation. Whereas the use of rebelays in rigging is a more modern style of assent and descent and so has been less practiced by comparison. As it is a newer style there is

room for improvement. This study does not suggest ideas to resolve these issues but highlights them.

The results in Figure 30 show that the 52% (N=52) of all participants reported rebelays as their preference for bolting 100m pitch (N=52) whereas only (N= 48) preferred the single rope method of SRT rigging. In this study the difference is not great (N=4).

The interviewees were asked to elaborate upon their view of this;
A disadvantage of the straight line approach was commented upon from Interviewee 1 (European);

> "If you drop a single rope down obviously you're just at the hest (behest) of wherever that rope drops down"

(See Appendix 1:4:3:11)

A caver may not actually know what he/she is dropping their rope down onto and could be taking a risk if it is sharp or smooth. A way which Americans address this problem is to;

> *"…pad all the edges…"*

(See Appendix: 1:2:3:7)

Americans use rope protectors to prevent the rope from snagging against sharp rocks (Sparrow, 2009).
In an emergency it is possible to overtake someone in a cave. To do so a caver using both the American and European technique of rigging can do this mid rope.

Interviewee 2 (European) stated that;

> *"…obviously you'll get problems if someone else needed to come up behind…"*

(See Appendix: 2:3:4:3)

Another advantage of the straight line approach is seen on bigger pitches of 100m or more where using thicker rope of around 12mm is common.

> *"…big pit drops using thick ropes and just padded edges…"*

(See Appendix 1:2:3:12)

This is because when using thicker rope of 11-12mm the strength is increased and it provides durability, dependability and comfort for the user (Halliday, 1974).

Interviewee 2 discussed how if the caver was to use a single rope combined with the European ascending system (a frog) he felt it was more comfortable if he wanted a break.;

> *"…go up a single rope and you can sit around if you use a European type SRT system…"*

(See Appendix: 2:3:5:1)

Interviewee 1 went on to say that the single rope method of rigging made caving more accessible as it was less technically difficult.

> *"...make it accessible to everyone…"*

(See Appendix 1:6:1:15)

Interviewee 4 (American) stated an overall advantage of rebelays is;

> *"…so you could conceivably get as many people down with rebelay maybe even more than you can with a long rope…"*

(See Appendix: 4:2:6:5)

Rebelays help to keep a team relatively close even on big pitches. This can contribute to an increased level of communication and so enhanced moral support says Interviewee 1;

> *"…you're not waiting for somebody to go up a big pitch, you can be actually ascending; as soon as they're passed the rebelay you can start ascending, and you can actually be ascending almost together, because you can be relatively close to each other so you can give each other moral support as well as physical support, and the communication is a lot more efficient if you split the pitches up…"*

(See Appendix: 1:4:3:15)

Long pitches that use the straight line approach where team members are far apart could potentially have counterproductive effects on the individual members. Lone working, which the individuals would be undertaking, may cause an increase of stress, anxiety, fear and depression according to the Health and Safety Executive (HSE, 2017). These may be the mental consequences of prolonged time of working alone, without close proximity of peers. If doing extensive Prussic work alone then these mental factors could possibly be felt by the caver.

In addition Interviewee 1 also mentioned that with rebelays;

> *"…it breaks up the pitch, so it means that if there's a problem anywhere somebody's not stuck 100 metres off the floor and somebody has to go and get them"*

(See Appendix 1:4:3:6)

With the straight line approach if a caver was to become stuck it could take a long time to reach them, whereas with the rebelays approach, it is much more likely the caver will have a peer close by to help out if needed.

Smith and Padgett (1996) commented that from an American point of view that Europeans seems to have adopted rebelaying due to cave formation and the potential hazards within compared to pit caving which utilises the straight line approach.

Although there are advantages for the rebelays there are also a number of disadvantages which were identified through interviews. One disadvantage is that rebelays require considerable physicality as Interview 3 states;

> *"…when you're doing multiple rebelays you have to, you're always on the rope but you're taking ascenders on and off the rope, and so it's definitely easier to miss a step somewhere"*

(See Appendix: 3:2:3:5)

Fatigue can be caused by prolonged hours of ascending and doing rebelays and this can cause dehydration or missing a step. There are no steps to miss using the straight line approach but is not to say it is less physically demanding.

Another disadvantage to the European system of rigging is that it is less compatible with ropewalking techniques such as the Texas rope walker or the Mitchell system.

> *"I'm not going to think about rebelays because if you're using a rope walker, the last thing you want to do is pass a rebelays"*

(See Appendix: 1:5:1:23)

It could be argued that rope walking techniques (See Figure 3) are simply not designed for complex cave rigging and therefore not best suited to straight line ascents (Sparrow, 2009).

In addition it was commented by Interview 1 that rebelays are not always practical;

> *"…it's just not practical and it would mean you have to get to the edge of this big bell shaft for no reason whatsoever…"*

(See Appendix: 1:3:5:3)

An unrealistic demonstration of this theory is supported in Figure 32, showing how it is impractical and unnecessary to rig rebelays in a bell shaft. The rigger would have to swing to the edge of the shaft, from there the rigger would have to drill and hold onto the

rock simultaneously. If the rigger was somehow bolted this may result in a very large rebelay or having to use an umbrella technique (where you descend and ascend almost simultaneously). This technique is not practiced often because its technical aspects limits a caves access. If the first set of bolts failed under the lip of the rock for any reason, this could create a massive dynamic swing onto the natural anchors or bolts possibly resulting in these anchors failing.

Finally it is necessary for the rebelays to be rigged correctly;

> *"…you've got to rely on the rebelays being rigged properly, and invariably they are not necessarily rigged properly…"*

(See Appendix: 2:3:1:3)

This can lead to a caver being hung up on a rebelays but also this can slow down the progression of the group (Sparrow, 2009). Sparrow (2009) therefore suggests that a 1.5 meter loop should be used to allow easy passing on the rebelay.

Cave progression

Participants were asked if they thought group or personal progression was more important and in interviews were asked to elaborate on this matter.

79% (N=79) of all participants thought that group progression was most important, although there were 11% (N=11) of all the participants who preferred a more personal approach to caving (See Figure 29).

Interviewee 1 reported;

> *"I think everyone should have the ability to get themselves out of a situation, you shouldn't be relying on somebody else to rescue you…"*

(See Appendix: 1:3:3:1)

École Française de Spéléologie (2013) agrees that cavers should have the skills and knowledge to enable themselves to carry out an effective self-rescue to get out of a risky situation.

The interviewees who favoured group progression concentrated mostly on group cave management in their discussions. They focused on the fact that being in a group is safer because support can be deployed as necessary to help friends or peers. However, Sparrow (2009) agrees with this he does state that this could lead to individuals taking more risks than if they were alone. Interviewee 3, an American was asked if he considered the straight line approach to suit group progression;

> *"…so we do tandem climbing where you have two or three people on the same line at one time, so it gets really tricky at the top when there's weight on the rope below you but it is possible to do…"*

(See Appendix: 3:3:9:1)

This technique enables better chances of a rescuing in big pits as it may be a long way to the top or bottom, so travelling in groups of twos is safer in terms of group management and in rescue situations.

Another solution to personal progression within big pits could be to dual rigging. This method is uncommon in UK caving and is not generally done within a recreational environment but can sometimes be deployed by UK caving instructors as it enables them to be on an independent rope while ascending and descending next to their client. Within America this may be used because of the availability of tress or other natural anchors on the surface, this would allow two or more lines to be dropped in close proximity to one another. This would set up a good scenario for a Rope-cutting method (École Française de Spéléologie, 2013; Sparrow, 2009), if in close proximity.

Breaking up the pitches into rebelays can provide a more group centered approach.

Interviewee 3 was asked if they practiced rebelays.

> *"…we really don't train for them at all…"*

(See Appendix: 3:29:1)

Due to the style of a more traditional rigging found in American caves and pits, practicing rebelaying is not necessary. In contrast in Europe it is common to find scaffolding platforms and climbing walls which can facilitate practicing this feature of SRT. Many clubs in the UK provide opportunities to facilitate this because it has become part of the style of rigging that been adapted to fit the formation of cave structures in Europe. Interviewee 3 agreed that for training, in America, practicing for the use of rebelays is minimal (See Appendix 3).

29% (N=29) of all participants in this study agreeing that repeated rebelays did have an effect on their physical and mental performance (See Figure 27). Of these 19% were American and 10% European. 76% (N=38) of Europeans and 58% (N=29) of Americans reported that performing repeated rebelays did not have an effect on their mental and physical performance. This is a surprising result in the light of interviewees reporting that Americans did not practice rebelays (See Appendix: 3:29:1).

Interviewee 3 (American) suggested that repeated rebelaying could affect physical performance;

> *"…when you're doing multiple rebelays you have to, you're always on the rope but you're taking ascenders on and off the rope, and so it's definitely easier to miss a step somewhere…"*

(See in appendix: 3:2:3:5)

From a European perspective the opposite opinion was proposed Interview 1 (European) shared his views on rebelays;

> *"…it means that it breaks up the pitch so that you can take a rest if you want to…"*
>
> (See in appendix: 1:4:3:9)

> *"…as soon as they're passed the rebelay you can start ascending…"*
>
> (See Appendix: 1:4:3:16)

However, interviewee 2 (European) also shared his views;

> *"…as soon as you start getting into rebelays you use an awful lot more energy…"*
>
> (See Appendix: 2:3:3:3)

The light, fast, heavy and slow concepts of mountaineering linked with kit

The number of European (N=29) and American (N=35) cavers who took part in the research who reported to prefer to apply the light and fast alpine mountaineering concept to their caving combined with the use of light equipment was 64% (N=64). 23% (N=10 Europeans and 13 Americans) of all cavers taking part preferred to use light equipment but not apply the light and fast concept to their caving. 11% of all cavers (N=11 Europeans and N=1 American) that took part reported to prefer heavy equipment and did not apply the light and fast concept to their caving. It is possibly an important time to note that cavers in Europe mainly use one system, the Frog (Sparrow, 2009) which is considered a light system. Whereas in America cavers not only use the Frog but also use the heavier rope walking techniques that include but are not limited to the Texas Inchworm or the Mitchell system/box (Smith and Padgett, 1996)

64% (N=32) of the European cavers asked liked the light and fast mountaineering concept.

Interviewee 1 (European) reported how permanent P-bolts fitted with the concept of light and fast mountaineering techniques;

> *"…P-bolts have made rigging easier because obviously you can see the P-bolts and they're there and you can clip them and they're very straightforward…"*

(See Appendix: 1:1:2:4)

Although he did further comment that;

> *"…*you should be lacklustre and not back them up or not use double bolts*…"*

(See Appendix: 1:1:2:6)

Carrying many bolts can be heavy and add considerable weight to a cavers gear. P-bolts enable the caver to strip all of this weight off as the bolts are permeant within the cave.

Interviewee 1 expressed a strong opinion that the light and fast approach important;

> *"…I've always thought fast and light is important for caving and for mountaineering, you know the least amount of time you spend on the hill or underground the better, because the less chance anything could go wrong, and you're in and out nice and swiftly…"*

(See Appendix: 1:2:1:7)

Although he also stated that cavers need to be realistic in their approach to the light and fast concept discussing how the kit needed to be sturdy enough to safe and this might affect the weight;

> *"….I think there comes a point where because the underground world is so hard on kit, you have to kind of be realistic…"*

(See Appendix: 1:1:4:6)

Interviewee 3 discussed how the Americans may have an additional meaning to light and fast that does not include just the traditional SRT kit;

> *"…I'm going on a trip and I'm planning on being underground for anywhere between 10 and 20 hours…because you're also carrying all your food and all your water, all your stuff in case something goes wrong, and so you just want to take the smallest and lightest ascenders that you can, leave any extra stuff behind and just really cut down the weight and the size…"*

(See Appendix: 3:2:3:4)

Also Interviewee 3 reported that for real lightness;

> *"…sometimes I'll use, I have a steel Carabiner and I'll hook it with a Munter…"*

(See Appendix: 4:1:6:6)

For European cavers a Munter hitch is equivalent to an Italian hitch (Animated knots, 2016).

Interviewee 4 (American) discussed descenders;

> *"…I use that in caves in West Virginia, micro-rack because I'm doing shorter drops, I need to be getting into smaller spaces, if I use a micro-rack it's stainless steel bars…"*

(See Appendix: 4:2:2:3)

All interviewees expressed an opinion that they were not overly concerned with the light and fast or heavy and slow concepts. They thought that the cave itself would determine the type and weight of kit used. They were more interested in durability.

Interview 1 (European) believed;

> *"…I think there's a limit to how light and small equipment can get for the underground world, because underground stuff gets beaten up…"*
>
> (See Appendix: 1:1:4:1)

Interviewee 4 (American) stated;

> *"…so I want equipment that's going to be more durable and rugged because I'm willing to wear heavier equipment…"*
>
> (See Appendix: 4:1:8:3)

Although equipment for shorter trips interviewee 3 said;

> *"…so if it's going to be a shorter trip I'll take a lot of big, bulkier heavy gear because I think a more padded harness is going to be more comfortable, and big bulky knee pads are going to be a lot better, and then you've got different climbing styles, like a walking system would be a lot easier to get up the rope…"*
>
> (See Appendix: 3:2:3:1)

Interviewee 2 (European) described the rope walker system as;

> *"…fast because you literally walk up the rope, and that is why it is fast, it's no pushing up and then sitting down and pushing up and sitting down, you literally walk as if you're walking along a straight path…"*
>
> (See Appendix: 2:2:4:4)

This is a reference to the Frog style of ascending (Sparrow, 2009).

Interviewee 4 (American) suggests that with a heavier and faster kit this results in;

"…little bit more weight because you get durability…"

(See Appendix: 4:1:8:4)

Interview 4 goes onto say that;

"For my long repels I'm going to use a J-frame or a J-bar…"

(See Appendix: 4:2:2:7)

The J-frame/J-bar racks generally weigh more because they are longer and bigger than micro racks (Smith, 2016).

15 Conclusion

One of the aims of this research was to examine the preference for bolts and anchors used in SRT by cavers in America and Europe. Sparrow, (2009) suggests that one of the most popular artificial anchors used is the P-bolt. This research agreed with his finding; 50% of the European cavers reported they preferred the P-bolt and one interviewee said it was ”you trust them a lot more so you’re a lot more confident in rigging.” (See in appendix: 1:1:2:8). However, more of the American cavers in this research preferred to use natural anchors and bolts/spits (40% and 50% respectively). Only 4% of American cavers preferred to use p-bolts. This research showed a distinct difference between the bolts and anchors preferred by the two groups of cavers.

The study investigated SRT methods used in America and Europe in caving to highlight similarities and differences. Some of the differences discovered included that cavers thought the straight line method favoured by the Americans was more compatible with rope walking than the belaying method favoured by the Europeans. It was thought that rebelaying was a more technical method and less accessible than the straight line method. The straight line method utilised pads to avoid rope abrasions which the belaying method did not. Rebelaying was thought to be able to provide physical and mental advantages due to the close proximity of other cavers; this would be more challenging with the straight line method. It was also noted that in terms of practicality on a bell shaft, the use of rebelays could create a large rebelay or an umbrella technique after the rock lip and could cause accessibility issues for those not trained in these techniques (See Figure 32). European cavers in this study tended to choose lighter equipment compared to their America counterparts who focus on slightly heavier equipment.

The number of cavers who reported preferring group progression to individual progression was heavily weighted towards the groups. 11% of all the cavers asked said they preferred individual progression 8% of these were American (See Figure 29). This could be due to the method of rigging that these cavers choose; straight line rigging lends itself to individual progression whereas belaying is more of a group activity.

However, it was considered that rescuing a caver in difficulty would be no more challenging if using the straight line method than rebelaying as both provide opportunities to pass on a rope.

The similarities were fewer. When looking at the use of repeated rebelays and how this affects mental and physical performance both sets of cavers agreed that repeated belaying could affect the caver physically and mentally but surprisingly 58% of American cavers asked said they did not think it would affect them. Further on in the interviews the American cavers had said that they did not train for rebelaying. "…we really don't train for them at all" (See Appendix: 3:29:1). All climbers that commented on it said that the most important aspect of the kit was not necessarily the weight but its durability. "…I think there's a limit to how light and small equipment can get for the underground world, because underground stuff gets beaten up…" (See Appendix: 1:1:4:1)

When exploring the preferences for "light and fast", "heavy and slow", "heavy and fast" and "light and slow" mountaineering concepts in SRT in caving, these results did not uncover a clear preference for personal equipment. The results are contradictory at times; both European interviewees disagree with each other, one preferring lighter equipment whereas the other preferred heavier equipment. The Americans seemed to prefer heavier but again the data collected was not clear enough.

This study was unable to conclude that one rigging style was chosen over another. A larger, sample size would be needed to discover if there was any significant difference between the two styles and a preference for personal equipment.

All the data collected in the research has proven the hypothesis that in comparing the SRT styles used in America and Europe it is predicted that the style of rigging that is adopted for specific pitches or pits is linked directly to cave formation.

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17 Appendix

Appendix 1

Interview 1

INT: Right okay, so I've printed out your questions and your answers, on question two you quoted that you like to use resin P-bolt hangers but when you choose a different anchor, say a spit, you don't change your mentality even though it may be slightly weaker bolt. Why would you not change that?

RES: Well because the rigging should be the same for everything, regardless of the fact that it's supposedly a solid bolt, you should treat every bolt as though it can pull out, so you rig exactly the same way as you would do if it was a dodgy flake or an ancient 8mm spit or whatever. You always rig the safest possible way, so P-bolts have made rigging easier because obviously you can see the P-bolts and they're there and you can clip them and they're very straightforward, but it doesn't mean you should be lacklustre and not back them up or not use double bolts. I guess the question is a little bit ambiguous because of course obviously mentally you trust them a lot more so you're a lot more confident in rigging. You don't rig differently just because it's a supposedly better one, because I've seen P-bolts pull out and fail. So no I don't change my attitude to rigging at all, it stays exactly the same as it would be if I was rigging up dodgy bolts.

INT: Okay, question two; in response to questions 4, 5 and 6 which is about lighter equipment and the mentality of the European climbing culture to caving, do you feel that Petzl equipment are going light and fast over concise, do you think there's a fine line between being too light and being far too light, and being dangerous?

RES: I think there's a limit to how light and small equipment can get for the underground world, because underground stuff gets beaten up, I mean we've seen recently with the failure of the new Croll, which had a problem when it started to wear down and it got really sharp. Basically because it's very small and light and it's the way it sits on your body, the rope rubs against it and makes a really horrible, sharp point in it; I think there comes a point where because the underground world is so hard on kit, you have to kind of be realistic, and actually if I'm on expedition, so if I'm away for like two or three months on expedition I'll take as brand new kit as I can take, and it'll be as robust as I can take, so it's not necessarily light, but maybe if I'm doing a little trip in Yorkshire

with a couple of mates I might use some lighter kit because you can just move a lot faster, but it's not going to wear out in that one trip, whereas if you're away on expedition you can wear through bobbings on stops and Crolls and cams and all sorts of thing, in the period of time that you're there, and in fact that's happened many times, so I think there has to be a limit to how small and light kit can get, but likewise it's like some light kit you can use underground, and some kit in certain situations you probably wouldn't want to use underground, so yeah I think fast and light is important, I've always thought fast and light is important for caving and for mountaineering, you know the least amount of time you spend on the hill or underground the better, because the less chance anything could go wrong, and you're in and out nice and swiftly but again there has to be a limit to what you take; you can't start cutting bits of kit out just because you want to be a few grams lighter.

INT: Question three; do you feel that doing more rebelays has ingrained that motion into your head so that you find it easier, because I know in the American SRT style they don't do so many rebelays?

RES: Again I guess I don't quite understand the question; rebelays are a necessity for the way that we rig in Europe because of the way that we use thin, single ropes and we rig, generally rig complex shafts, so you've got multiple ledges and multiple areas where water's hitting, so it's a very different environment than a lot of American pitches, particularly in TAG which is Tennessee, Alabama and Georgia, where a lot of the pitches are entrance pitches, they're big vertical shafts, there's no need to stick rebelays in, they use thick 12mm ropes, pad all the edges and they use a different ascending and descending system, so they'll use a rack to descend and they'll use like a rope walker system to ascend, just mainly because the pitches are so big, and again my personal feeling is that there is scope to use both types of rigging, and in fact over the years as I've done more and more caving, I will rig differently depending on the cave and depending on where I am, so I've certainly been to the States and done big pit drops using thick ropes and just padded edges, and using rope walker systems because that's the most practical way of doing it, whereas if I'm in a European cave or a complex cave system I'm going to be using complex SRT rebelays and deviations, so my personal feeling is I think it's important as a caver to be able to do all those techniques; it's no good just being able to climb up and down a rope on a rope walker, because that restricted what caves you can go in; you need to have that flexibility and that variety, and that ability to be able to say 'okay well this cave is a bit more complex, we're going to have to use rebelays', and I see that a lot on expeditions; a lot of people from the States and various places come on expedition, because quite often on expedition you're going to be using light alpine rigging techniques; some of them don't have the skills and the experience to follow multiple rebelays and deviation from the ground, so they're kind

of lacking those skills, so yeah personally I think it's important to have a wide arsenal of skills, and I think there is scope to rig differently depending on where you are, and depending on the cave, so I don't think there's any one particular system that is better than others to be honest.

INT: Okay. Why do you prefer to ascend faster, what factors make this important to you?

RES: Sorry ascending faster?

INT: Yeah on question 8 you said that you prefer to ascend faster than to descend.

RES: Yeah well descent is always, it should be a cautious exercise because when you're going down it's very easy to get out of control, so you need to be in control all the time. It's very easy to not see where you're going properly and kind of go the wrong way or go over a lump of rock the wrong way and the rope's rigged to go over another way, or maybe there's loose rock or something, but on the ascent generally the rope's in place, you can see where you're going, the rope's tight all the way up and basically you just want to get up the pitch as quickly as you can and as efficiently as you can, whereas as I say, descent should always be cautious and it should always be in control, so speed is not important on the descent.

INT: Question five; even though you work as a team in SRT, SRT has a lot of emphasis on being an independent working, do you feel this is good or bad and why?

RES: I think everyone should have the ability to get themselves out of a situation, you shouldn't be relying on somebody else to rescue you, that's very important; you should know how to use your kit, and know how to modify your kit if there is a problem or if you need some assistance or whatever. Also I think it's important to know how to rescue your mates, so if your friends get into trouble for whatever reason, you should have the skills and the ability to actually assist them in some way, so I think it's kind of like cave diving, where yeah okay, generally in this country cave divers dive on their own, but in Europe and around the world generally you dive as a pair, and there are drills and exercises to actually help your buddy if anything goes wrong, but you still need to be self-sufficient yourself; you still need to be able to deal with situations yourself, and it's the same with SRT. I think the problem with that is that a lot of people rely on other people to get them out of situations; they don't have the skills to deal with problems, and

I think everyone underground should have those basic skills to actually assist themselves, and to basically assist their colleagues.

INT: I think you've already slightly answered this question, but why do you prefer to rig with lots of rebelays rather than having one direct line?

RES: There's loads of reasons for that, and again it depends on the cave; if you're doing something like Golden Dreams in Mexico which is a 1200 metre shaft then you're not going to put rebelays in, it's just not practical and it would mean you have to get to the edge of this big bell shaft for no reason whatsoever, so generally you're going to drop down that but again if you're in complex pitches, or even less complex pitches, putting rebelays in has many advantages; it breaks up the pitch, so it means that if there's a problem anywhere somebody's not stuck 100 metres off the floor and somebody has to go and get them; there's always going to be something there, but also it means that it breaks up the pitch so that you can take a rest if you want to, you can get away from any hazards and obstacles, so with rebelays if there's loose rock somewhere you can get away from that, whereas if you drop a single rope down obviously you're just at the hest of wherever that rope drops down; you can avoid water and hazards much more easily, and it means [1]you can get more people on the shaft, so particularly on expedition if you've got lots of people who are full in kit or taking equipment in and out, you're not waiting for somebody to go up a big pitch, you can be actually ascending; as soon as they're passed the rebelay you can start ascending, and you can actually be ascending almost together, because you can be relatively close to each other so you can give each other moral support as well as physical support, and the communication is a lot more efficient if you split the pitches up, so I think there's loads of advantages to rebelays, and again like in the previous question, it really depends on the cave and it depends on where you are.

INT: Do you feel there are any advantages to the European system over the American system?

RES: Again you couldn't rig a European cave the way the Americans would, generally, and don't forget that...don't get sucked into this American/European rigging; there are certain parts of the States, the States is a huge country, and there certain parts of the States like TAG, Tennessee, Alabama and Georgia where all the caves there are big pitches, generally just a single drop and people will go in and just drop these single pitches; it's quite big, and often there may be another pitch beyond that, but that's all there is, there's no other shafts up the cable at all, so they'll just drop these massive shafts and then come up again, and that's a different style of caving; it's very hot so

they very often don't wear caving gear, they might wear shorts and t-shirt because it is really, really hot and muddy, whereas slide over to the European caves; they're cold, they're wet, they're narrow, very sharp in places, so you couldn't rig the cave like that, and yet there are places in the States which have similar caves, so for instance West Virginia has caves that are bit like South Wales; big, long caves but with the occasional shaft in pitch, which can often be rigged in European style and a lot of American cavers cave abroad and they take their rigging, they'll learn rigging skills from caving in Europe, so don't get sucked into thinking there's an American way of rigging and there's a European way of rigging; it depends on where you are in the States, it depends on what sort of cave you're doing, and it depends on who you're caving with, and there are definite advantages to the type of caves that Americans cave in, to rigging the way that they rig, and there are definite advantages with regard to the actual technical aspect of rigging the way they rig; they often use tensionless hitches, so they're putting less load on their bolts, they're not using as much equipment so there's less connections that can go wrong, there's less problems with regard to passing rebelays, so if you read through the accident statistics, a lot of people in European and UK caving are hung up on the pitch or stuck on a rebelay or whatever; well that doesn't happen because it's just a single rope, so there are disadvantages and advantages but they're very different styles of caving, and cavers have come to those caves in a completely different way, and don't forget 40 years ago we would have been dropping ladders down pitches doing exactly the same thing; dropping them straight down into the water, not avoiding any hazards, so caving in Europe has developed depending on the types of caves, rigging in the States has developed depending on the types of caves, and there are advantages and disadvantages to both styles of rigging, and I've certainly used both of them many times.

INT: And lastly, again I think again you've kind of summed this up, but as a European caver do you agree with the rigging that you do compared to the American style of rigging?

RES: Well again I've already answered that, I mean I wouldn't rig, if I went to the States to drop a big drop I would use an American technique because that's what they use and it's practical, whereas I wouldn't do that in some horrible, torturous cave in mainland Europe because you couldn't rig in the same way, you can't do it, and there are advantages and disadvantages to both. What you need to do is really be thinking about caves rather than actually the rigging, because the caves dictate the type of rigging that you use, and certainly something like Golden Dreams which you basically tie to a tree and then abseil 1200 feet, that's American technique; you're not going to be using the frog system because it'll take you forever to get up a pitch like that, you're going to be using a rack because you want it dissipate on the descent, and you're probably going to be using a rope walker to ascend it because that style of cave

requires that style of caving, whereas if you're in Yorkshire or Meregill Hole you're going to rig very differently because you're going to be going through water, the pitches are shorter so you can use frog, you've got to be more versatile to be able to take the equipment off to get through restrictions and awkward bits of cave, so the cave dictates the type of rigging, not where you are in the world, if that makes sense, and I think and as I said right at the top of the interview, I think cavers need to adopt a more open approach to rigging so that they can understand that yes actually there are advantages to rigging in what you might call an American way, and there are advantages to rigging in what you might call a European way, and you should be able to use both techniques for various different types of caving and caves, it shouldn't be restrictive, so I would certainly modify my ascending and descending rig if I'm caving in some big pits in TAG, because I don't want to be frogging the pitch when I could be using a rope walker, and also I'm not going to rig those pitches the same way, I'm not going to think about rebelays because if you're using a rope walker, the last thing you want to do is pass a rebelay so you need to pad it out, make it accessible to everyone, so yeah I guess it's a different way of looking at it; it's not an 'us and them' thing, it's what can we learn from all those techniques and how can we use techniques in lots of different styles of caves and caving?

INT: That answers everything, thank you very much.

Appendix 2

Interview 2

INT: I'm here with Interviewee two who's just filled in a survey. First question then, you don't like the idea of light and fast mountaineering but you agree with heavy equipment, why do you have this preference?

RES: I don't think I necessarily agree with heavier kit for caving, caving kit is the lighter the lit the better, but the trouble is the modern kit is light, yes okay, but it doesn't last, I mean you know, it's rubbish basically, some of it.

INT: What parts of it make it rubbish compared to others that are out on the market?

RES: Bad design, it's got too small so it's not even functional sometimes, sometimes you can't, I mean if you take modern Petzl Croll for instance, I mean with the Croll you used to be able to get your finger in a hole to actually open the blinking thing, these days you've got to try and clip it, so unless you've got really tiny fingers within the actual vice grip it's almost impossible to open under certain circumstances, so it's absolute rubbish.

INT: Question two, what issues do you have with the European design in terms of the kit issues versus the American kit, such as the system like Mitchell?

RES: I've got no problems with either of them really except that things like a Mitchell box, I don't know whether they still use them but a Mitchell box we use with rope walkers is so much faster and quicker, but you've got to be reasonably fit and strong and know what you're doing, but it's an incredibly fast way of doing things, I mean yeah okay the European system, the chain of fault system is safe because you can sort of sit down and relax, but trying to get the kit coordinated and designed to suit you is incredibly difficult, and a lot of harnesses these days are absolutely rubbish from the point of view of being comfortable, I mean they really are absolutely atrocious, and there are so many of them and trying to find the right one for being comfortable for you, I used to have an oak climbing harness which so comfortable it was unbelievable; you'd sit around in it for ages, but it was a climbing harness so you know, a regional Petzl harness I bought as well, which was really, really comfortable again, but I've not found a comfortable harness since then.

INT: Do you think that's part of the light and fast option that's been adopted towards?

RES: Not necessarily, there's just too many things on the market and they make them too complicated, I mean that's the problem; a lot of them are just too complicated. I did find one harness that somebody lent me a while ago and I was going to buy one when I could get hold of one, but I've now forgotten what it was unfortunately, which is unfortunate.

INT: Why do you think that the Mitchell system is maybe faster than the frog system?

RES: Because it's you say Mitchell system but it's actually rope walking, I mean the Mitchell system I'm assuming you're talking about using a Mitchell box on your chest, and rope walkers being one, like something similar to an original Gibbs on the knee and one on the ankle, literally it's fast because you literally walk up the rope, and that is why it is fast, it's no pushing up and then sitting down and pushing up and sitting down, you literally walk as if you're walking along a straight path.

INT: Wouldn't that be kind of the same if we had a Pantin as well, if you had the core strength to be able to hold your body weight?

RES: Yeah but I mean the problem, I mean a Pantin is very useful, and it actually does make life a lot easier but Pantins are actually quite difficult to actually get on to the rope; they fall off the rope when you don't want them to fall off the rope, and if you're on a vertical pitch and it's a single pitch, a Pantin is really brilliant, but if you've got to do any rebelays at all it's a pain in the arse, it really is a nuisance more than anything else, and trying to get it on the rope when you're on a rebelay, to put it back on after the blinking thing has fallen off, which it invariably will fall off, involves an awful lot of extra strength and it's difficult.

INT: Why do you prefer to ascend faster than descend faster?

RES: I want to get out to the pub.

INT: Any other reasons or is that the main reason?

RES: Well it's not a case of descending faster or ascending faster, I mean everything's relative isn't it? I mean you know, why do you necessarily want to descend faster, and why do you necessarily want to get out faster? I mean speed is almost irrelevant when you're underground, at the end of the day you want things to go smoothly up and down.

INT: And lastly, why do you prefer to rig with one main line, which may be considered more of an American style of rigging?

RES: The thing about going up one single rope is that it's, you expend an awful lot energy, you're still using SRT and whichever method you use, you still have to climb a rope and you expend a certain amount of energy; as soon as you start getting into rebelays you use an awful lot more energy, so you're going to be more knackered and so therefore things are going to be more difficult, and you've got to rely on the rebelays being rigged properly, and invariably they are not necessarily rigged properly, because people who do rigging, rig them for themselves normally and I don't think that generally they're particularly. Sometimes they're good, but quite often they're not and every single rebelay depends on the individual that's actually doing it as to how easy it is, because it needs to be rigged for the individual person, so if you're going to set up a single rope it's a damn sight easier; quicker and easier.

INT: So physical performance is better?

RES: I think physical performance would be a lot better if you go up a single rope and you can sit around if you use a European type SRT system, you can sit around on the rope and relax and you know, obviously you'll get problems if someone else needed to come up behind you but yeah.

INT: And you said in your survey that one bolt that's safe to rig off, and then you followed up by saying that the anchor as long as it's placed safely then that's the main thing.

RES: The main thing about any anchor is it doesn't have any direct relevance as to whether or not it is a P-hanger, I mean a P-hanger actually really can be quite good, but the problem with them is that the resin has to be up to date, people have to put them in correctly, you have to clean out the hose so there's a lot more difficulty in actually placing a P-hanger properly, and there have been lots of problems with them being twisting and turning, not necessarily pulling out but I mean certainly being loose, raw bolts and spits are fine, I mean we never in nearly 50 years of caving we've never had

any problems with any single one of them really. The main thing about them is they need to be placed correctly and then they'll be easier to use more than anything else, and that's a major factor.

INT: In America they predominantly have these bolts that go in and then they expand once they're in there to jam them up, what do you think about that?

RES: Yeah well I'm not sure what's meant by that, because that's basically a raw bolt, but there are different types of bolts I mean raw bolt tends to be used as a generic term because they were the original manufacturers of a bolt of that type, but there are loads of other types of bolts which have a similar sort of principle, which are made by different people, and basically the principle is really sound, I mean there's no reason why any of them should fail. It depends on the material of the bolts, I mean you can buy cheap ones which are rubbish here, or if you go back years of course they were all much bigger and they were more substantial, and the same with lots of older stuff is that it was better quality than modern stuff.

INT: Are the rubbish bolts that you can think of, are they cheaper or more expensive than the bolts than you consider better?

RES: It's difficult to say because P-hangers in this country are actually not, I mean paid for generally by the BCA, British Caving Association and the local regional council, so we don't tend to have to pay for them so I mean, so they're the cheapest by far but then again I mean, what you have to remember is there have been major problems with P-hangers, I mean there was a huge batch of them which were bought which were manufactured by a quality manufacturer and certified, which were fine, they stopped making the things so we had a load made, and the ones that were made were not up to standard, and they have been taken out, so you know, you can't necessarily guarantee that any P-bolt is necessarily going to be any good.

INT: So you should always check it?

RES: Well you don't know, you can't check it because you don't know; if you go down a cave and there's a P-bolt there you're going to use it, you don't know whether it's one of the ones that was rubbish; you rely on other people to do that.

INT: Check the bolt's quality, check its moving?

RES: You could check the bolt's moving but then again, invariably any of these things are going to be reasonably safe anyway, and you'll always have a backup. If you don't have a backup then you're potentially suicidal so you back up anything; whatever it is, you back it up.

INT: Thank you for doing this interview.

Appendix 3

Interview 3

INT: Right so in the survey you said that you like half in fixie bolts, why do you prefer this over maybe a different type of bolt, maybe like I know you don't use so much resin bolts, but do you know about resin bolts?

RES: I do, but out in the South East for climbing as well we just don't use resin bolts, they use them a lot out West but we just use expansion bolts here, and so like you go the local caving stores and they don't even have resin bolts, they don't do any of that, they do only expansion bolts.

INT: Okay, so am I right in saying these expansion bolts, they're spits are they, or what kind of category do they fall under, are they just bolts?

RES: Yeah.

INT: So in the cave wall you'll have maybe like a little circle hole and you would screw the bolt in, am I right?

RES: So you drill a hole and put the bolt into the hole, and then as you're screwing it there's a piece in side that will catch and then expand and it gets stuck so you can't screw it all the way.

INT: Okay so they become permanent?

RES: Yeah so you know the first person in there makes the sacrifice of installing this bolt, and it becomes permanent and then after so many years when they start to rust and they start to look terrible, then someone else will come in and replace them.

INT: Okay, that sounds very different from what our norm is in the UK is, which is we just basically drill a hole and then put a P-bolt in and then glue/resin it in, that's the very basic view and then the councils help maintain that for us. Do you think that would work in America?

RES: Yeah I mean I think it could, but where I live right now within an hour's drive I've got like 4000 caves, a lot of them are on private property, some are government owned but nobody really maintains them, so when I go and visit a cave I may be the only person to go for three or four years, so you don't know the history of this cave, you don't know where the bolts are, if there's bolts, but I don't really think. I say it could work with resin bolts, but expansion bolts are just kind of what we have.

INT: On your survey you commented about light and fast; there's a balance between being too light and then being to light. You say there's relevance between light and fast versus heavy and slow, do you want to expand on that because you just kind of left it there?

RES: Yeah so if it's going to be a shorter trip I'll take a lot of big, bulkier heavy gear because I think a more padded harness is going to be more comfortable, and big bulky knee pads are going to be a lot better, and then you've got different climbing styles, like a walking system would be a lot easier to get up the rope, but like tomorrow I'm going on a trip and I'm planning on being underground for anywhere between 10 and 20 hours, and so if we're doing a couple of miles back in the cave then you just want to go as light as possible, because you're also carrying all your food and all your water, all your stuff in case something goes wrong, and so you just want to take the smallest and lightest ascenders that you can, leave any extra stuff behind and just really cut down the weight and the size, so when you're dragging your bag through a hole it's not getting caught up and it's not heavy to pull behind you.

INT: Okay, you said that as you mentioned, you were talking about your ascending system; which ascending system do you prefer to use, because I know there's quite a few?

RES: Yeah so I have a frog system and that's my go-to system, it's the simplest one, and I also have a rope walkers system, like a Texas rope walker that I'll use for like an open air pit which will be more comfortable because it's a lot bulkier, but much more efficient climbing the rope with it.

INT: So your frog, do you use that for more, I guess, alpine caves, like lots of rebelay sort of stuff?

RES: Uh huh, if there's going to be lots of rebelays you can get like a chest roller for a rebelay and it's a pain to do, but the frog system is just real quick and easy, to just carry a third ascender and just slap that on and just go for it.

INT: Awesome, that's great. Why do you think it takes a serious amount of concentration to do rebelays, do you maybe not train for them so much in America?

RES: Yeah that's a huge thing; we really don't train for them at all. My girlfriend wants to get involved and go caving and I'm having a hard time doing a rebelay above ground to teach her that, because a lot of stuff we do we just tie a rope around a tree outside the cave and drop down the pit, I mean we could rebelay and then go but a lot of times it's just easier to use the rope, but when you're doing multiple rebelays you have to, you're always on the rope but you're taking ascenders on and off the rope, and so it's definitely easier to miss a step somewhere compared to if you're just going up one rope the whole way, there should never be a reason to come off if you're only on one rope.

INT: Would you say, in that case, rope walker is really good because you don't have to take off any gear so there's likely the chance to mess up basically?

RES: Yeah.

INT: Opposed to the frog where you can mess up if you're not watching, or you're not being careful?

RES: Yeah.

INT: Cool. This question had lots of different views; why did you prefer to ascend faster, was it to get to the pub, or just to get out of the cave or underground exposure; you don't want to be down there too long?

RES: Yeah I mean a little bit of everything, like if we've got eight people in our group and we've all got to get up the rope if you take your time then whoever is at the bottom is getting cold so you just want to speed it up, I mean like I enjoy being on the rope and I enjoy being underground, but there comes a time where it's like we just need to walk a little quicker or climb a little faster to get it done with.

INT: Fifth question; group progression versus being on one line, if you like the idea of group progression but you only have one line, that seems to be more personal progression, what do you think about that?

RES: Yeah so we do tandem climbing where you have two or three people on the same line at one time, so it gets really tricky at the top when there's weight on the rope below you but it is possible to do, which will speed up that process but I definitely see how a rebelay would definitely help in speeding that up; as soon as you get passed the first set of bolts the next person can hop on without pulling the rope or anything.

INT: Do you think that would be something that, I'm not saying you need to go to all American caves now and readjust all your caves by any means, but do you think that would be a better way of group progression in caves on your bigger pits, or do you think the way they are is right?

RES: A lot of our bigger pits down here fill out once you get passed the lid, so if the bottom drops out from under you then you really can't set a rebelay because then you'd have to get somebody at the bottom to swing you 30feet over the wall.

INT: Yeah that seems pretty extreme and probably not much gain in the end of it. Do you think that caves have a right to be rigged in the way that they're intended to be, meaning that if something needs to be rigged to rebelays, it should be done that way versus your normal pit way, it's a normal vertical descent?

RES: Absolutely, I mean every cave, every pit is its own problem to tackle, so if it needs a rebelay then absolutely put one in, because we do have some caves that have two or three rebelays and you've just got ropes going everywhere, but it's needed because there's a lot of sharp edges and there's a lot of zigzagging down the pit or something like that.

INT: Okay and lastly, why do you change your mentality for rigging with different anchors and bolts, or would you change your mentality? So if you were choosing an expansion bolt, if you chose something else, maybe like a natural or a resin bolt, would you change it because you don't feel as safe on that specific bolt?

RES: Yeah so if you use like a natural anchor and it's your first time through the cave, nobody had been in this cave before, of course you're going to rig off a natural anchor if you can find one, but then if you look around and you're like 'well this rock looks to be about 300 lbs and I'm 180, I might move it if I fall and so you're definitely very careful with stuff like that, especially if it looks like there's a chance the rock could break, but

then if you use half inch or even three quarter inch bolts, they go 8 inches into the rock, you're going to really trust this but if you're using a teeny tiny bolt then you're just going to climb real slow and be really gentle along the rope.

INT: Okay, that's everything I've got for you. There was something that popped into my head; it's gone now so obviously it wasn't important enough to be remembered, thank you for coming along and doing it for me.

Appendix 4

Interview 4

INT: So firstly, on your survey you put that you didn't prefer light and fast.

RES: Well I did not prefer light and fast.

INT: Would you like to explain why you prefer maybe heavier and slightly slower?

RES: With regards to the caving gear?

INT: Yes.

RES: Well I go to Germany Valley, when I'm going down all those ropes, those ropes get very dirty and when I go in light I will burn off gear very quickly; gear vendors know me very well because I'm always buying, so I want equipment that's going to be more durable and rugged because I'm willing to wear heavier equipment if it will last for a year instead of 3 months or 5 months, so that's why I prefer it to be a little heavier, and I'm enamoured with fast, yes I like fast on the rope and off the rope, sometimes I'll use, I have a steel Carabiner and I'll hook it with a munter, so I do like fast in that regard, and I didn't think of fast to mean that, but I prefer to go down slowly because I'm in confined spaces and I don't want to be...I have to make sure of where I'm going; did you mean that way or on and off the rope?

INT: In terms of descending and ascending more than horizontal cave travel

RES: Okay I'm going to be measured in the way I go down, now in Alabama when I have my two foot long rack it's fun to have a little bit of light smoke come off my rack. I had a half mile of white smoke coming off my rack, but no in a cave I want to be. I'm okay with a little bit more weight because you get durability, and I'm okay with going down slowly and carefully to make sure I don't hit things when I go down the way I want to go.

INT: Okay, just while we're talking about racks, which type of rack do you actually hold, because I know there's like a is it an Hyper-Bar rack, and there's like three different ones that I think I've read about?

RES: Yeah they really the two types that I'm aware of there's a U, and you just put your mallion through the bottom of the U and then you have your two bolts up top, and your bars go across that; that's for a micro-rack, I use that in caves in West Virginia, micro-rack because I'm doing shorter drops, I need to be getting into smaller spaces, if I use a micro-rack it's stainless steel bars, and I have a hyper bar in mine because that is the fastest and easiest way to lock off, very effective and very efficiently because your hand's free in a matter of seconds. For my long repels I'm going to use a J-frame or a J-bar, you have an eye on the bottom and that would be stainless steel; I do have some 15, 16, 18 inch racks, they are also with eyes and a J-frame , but I generally for better efficiency only use my 24 inch Rack because I'm familiar with it.

INT: Right okay so it's about familiarity and being comfortable with what you've got?

RES: Absolutely, in my mind my gear needs to be an extension of me, and I cannot be uncomfortable, it has to be a natural movement so I try to settle in with a micro-rack so I'm always using the same thing.

INT: Next question; so European alpine caving is a bit like lots of rebelays to go down one pitch versus the more standard American big pit kind of caving, which is one straight drop. Which one do you think is better for group progression and why?

RES: I can do rebelay really fast, going down it takes me 30 seconds; I don't feel that rebelays are that much of a impeditive for speed, plus it's possible to get people. You have to trust the bolts, you have people on different legs so multiple people can be coming down the rope, I would think that when you have rebelays if you trust the bolts you don't have to worry about rock fall, so you could conceivably get as many people down with rebelay maybe even more than you can with a long rope, although with a long rope when I've got smoke coming off that thing, very few people would be faster than me, so it's a tossup; in caves I'm comfortable with rebelays and I don't think there's that much of a speed advantage.

INT: Okay, you also commented that you prefer to descend more, is that because it's easier or it's preferred to yourself?

RES: Well I prefer to descend more because gods helping me out as opposed to climbing out where I've got a team below and I'm heavy and sweating and all that kind of stuff, because remember when I'm going out, when I'm coming in my camp pack is what, 2.2lb per kilogram; I have a 10-12kg pack going in and it helps me go down very easy, but coming up is a bitch because I've got to fit that thing any place I go.

INT: Awesome. Question four; so you commented that you like group progression, this is something I've been asking other Americans, so you prefer group progression but would this be considered slower because you've only got one main line?

RES: I'm not thinking of it from a speed thing as much as a safety thing; we are able to, if somebody's having difficulty it's a balance, I want for the group to be moving steady, the idea is for nobody to be standing in one place but I want us to stay together and I don't want somebody way up ahead, I always get annoyed with those kind of people, because if the last person at the back happens to get separated from the rest then we have a problem, we have a huge problem, so from a safety perspective is why I would say I prefer a group, but I would balance that with moderation, and hey I don't like standing around in the cold, that pisses me off.

INT: So I've already slightly asked this question before we started, P-bolts in the UK are generally rated to around 30 kilonewtons where the more I guess standard bolts in the UK are expansion, and they typically can be seen as around 25 kilonewtons; what does that make you think about the kind of safety of the bolt in itself as an expansion bolt versus something that's slightly stronger?

RES: Well, and this comes from the NCRC work that I've done, well a) remember I haven't done a whole lot of bolting, b) when I look at a system I don't just think about the bolts, we're not considering the rest of the system?

INT: Yeah just the bolts.

RES: The theory says stronger bolts are better, so I guess I would like the stronger bolt. Why wouldn't I want a stronger bolt?

INT: Also in America you do a lot of natural rigging on maybe stalagmites or trees or really large stones maybe, how does your judgement affect that in terms of how do you perceive something is safe and not safe, is there a fine limit or is there a?

RES: I've done a lot of natural anchor work, in fact it's one of the things I teach, NCRC teaches that as well, I'm curious, what did I write down on the survey?

INT: You haven't commented on naturals but it's just an interesting question, because you do use a lot more naturals than what we do here in Europe.

RES: When I use a natural anchor the first thing I'm going to check. Well I've been surprised how small an anchor needs to be, you can get by with very small trees if you properly consider the tort and the structure, so long as you minimise the tort and so long as there's enough root to hold the tree you're okay. Sometimes I will even resort to back up tying a tree to make sure I have something that will be steady, stationary and satisfactory, so when we go off the top there's a half mile of rope up there and we're rigged to a tree that's maybe one foot in diameter, and then it's backed up to another tree maybe 100 feet away that's again one foot in diameter, and we rig low on the main tree and a little bit higher on the back up, so I'm okay with natural anchors but I consider tort, I consider roots and I make sure I have a tensionless hitch, do you have webbing? There should be nothing you can't do, make sure you have enough friction in the system.

INT: Okay, so there's a lot of things you actually look at?

RES: Oh yeah I'm thinking about it quite a bit and making sure I get something right.

INT: And making that right decision.

RES: Yes, once or twice I have almost been surprised, you know in Germany Valley trying to climb up on webbing, trying to use webbing to get up a slot and rigged to a rock, and it almost probably killed me, we rigged going up and the webbing was coming from the bottom of the rock, it was okay; coming back the webbing just kind of got dropped in a pile so the webbing went over the top of the rock and now the weight had increased on a 200-300lb rock that would have pulled down on us because there was something jilting on the rock, so you have to think about taut, you have to think about the heft of the anchor; all of those things, but you can do it. You need to have you can get by if you have sufficiently large friction, you can get by with two racks, you don't need three, and I've done it.

INT: Okay, and lastly do you feel a cave should be rigged in the right way for the environment that it is intended, or do you think that because this is where it is within the cave it should be rigged like this, or actually because it's slightly different we should rig it like that?

RES: I'm trying to I probably didn't have much of an answer there did I?

INT: This is just expanding on the way you would maybe perceive rigging.

RES: As much as possible, the way I like to rig?

INT: Yeah.

RES: As much as possible I want to use a natural anchor so that you do not have to permanently alter the cave. That said I know sometimes I can't and in those cases that is what ultimately is going to be necessary.

Appendix 5

Extended Results

Figure 33

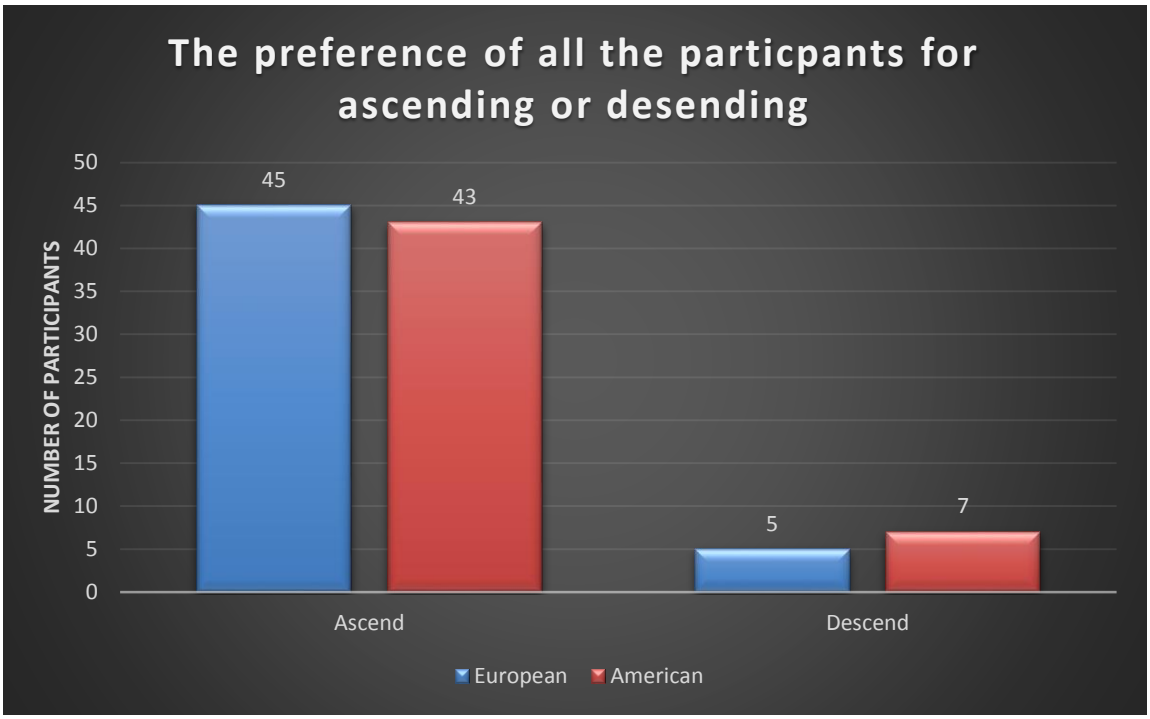

Fig. 33 shows the vast majority (N=88) of European and American cavers that took part reported that they preferred to ascend.

Table. 7 shows cavers' views on kit, interviewees were not directly asked about issues they had with their kit but throughout the interviews some points were made and have been analysed below.

Highlighted: Yellow			
Main Theme	Sub Theme	Minor Theme	Code
Kit issues	Harness	Comfortably	2:1:6:7
	Foot Jammers	Getting on the rope	2:2:6:2
		Falling off the rope	2:2:6:3
		Rebelay issues	2:2:6:5
		Extra Strength	2:2:6:7
	Chest Jammers	Wear down and sharp	1:1:4:2
		Too small	2:1:4:1
		Opening device	2:1:4:2
	P-Bolts	Placement issues	2:3:7:4
		Pull out	1:1:2:9
		Major issues	2:3:7:5
		Not up to standards	2:4:7:7
		Resin up to date	2:4:7:2
	Mitchell System	Reasonably fit	2:1:6:3
	Organisation of kit	Difficult	2:1:6:6
	Chest Roller	Pain in rebelays	3:3:1:1