

An approach to military operations from the perspective of prospect theory.

Prof. Dr. Luiz Maurício de Andrade da Silva

Academia da Força Aérea – Estrada de Aguiá, s/n – Campo Fontenelle – Pirassununga / SP – lma28@uol.com.br

Abstract – The main objective of the present article is to analyze elements of prospect theory, investigating its pertinence to the discussion of issues of safety and defense in Latin America. The study, exploratory, presents the result of a research accomplished with 105 cadets of the Brazilian Air Force Academy, trying to verify if the central elements of the prospective theory presents validity in a sample of future military officials, future decision makers in situation of defence at this region. We believe that this discussion may be relevant, and would set some new lights, within the issues of effects based operations – EBO. As stated by EBO's authors, one of its main issues, to be deeply discussed, is the cognitive aspects of the risk and decision processes, as presented here. We do not discuss EBO at all, but the cognitive aspects of the risk and the decision making.

Key words: Command and control; Prospect theory; defense and risk analysis.

I. INTRODUCTION

The main objective of the present article is to analyze elements of prospect theory by Kahneman & Tversky [1], investigating its pertinence to the discussion of issues of safety and defense in Latin America [2].

Prospect theory is an analysis of human decisions in risk conditions. As well as other theories of decision, prospect theory presents an algebraic formula to represent the process of decision in risk conditions. The prospect term represents the "choice" among several alternative roads, and one of its most eloquent results (empirical, obtained in a controlled way) is the fact that people, in general, are contrary to risk when in favorable, or winning conditions, and prone to take risks when in loss conditions.

Latin America is a geographical area that has been under constant changes, the relationship with rich, or more developed countries, being the main focus of this permanent alternations. In a word, it is an area under imminent risk of conflicts, be them external conflicts (among nations), given the accentuated imbalance of power among nations (both warlike and economic), or internal conflicts (urban violence, drug traffic, terrorism), given the expressive level of poverty of most of the population of Latin America.

After discussing prospect theory, and its possible use as a theory to build the foundations for a discussion of questions of safety and defense, the article presents the results of a field research carried out with cadets of the Brazilian Air Force Academy, prospective officials, and future decision makers in risky situations.

The research with the cadets of the Air Force Academy attempts to gather elements to investigate if the empirical tests already applied to professionals of different areas to test the central elements of prospect theory [3]-[4]-[5]-[6] as cited in [7], also apply to people that are being formed to occupy leadership positions in the Armed Forces. We believe that this discussion may be relevant, and would set some new lights, within the issues of uncertainty and effects based operations – EBO [8].

II. THE RESEARCH PROBLEM AND OBJECTIVES OF THE RESEARCH

The research with the cadets of the Air Force Academy attempts, in general terms, to gather elements to substantiate the claims resulting from the application of empirical tests to professionals from different areas [1]-[4]-[5]-[6], and, in particular, attempts to investigate if the central elements of prospect theory also apply to people that are being formed to occupy leadership positions in the Armed Forces.

III. THEORETICAL FRAMEWORK

Two main topics are considered important for the theoretical framework of this research: (a) safety and defense in Latin America, and (b) some elements of prospect theory. For item (a), safety and defense in Latin America, we will take as the main theoretical framework the work of Kugler & Frost [2], broadening the scope of studies by Weyland [9]. As for item (b), prospect theory, we will draw on the developments of the theory by Kahneman & Tversky [3], as cited in [7].

Safety and defense in Latin America

In spite of being an area which is relatively free of conflicts, Latin America is in a state of permanent changes (economical, institutional) because of the of external relationship with richer countries, on the one hand, and of urban violence, on the other. The factors which might be said to account for this permanent tension are: (i) international terrorism, (ii) drug traffic, (iii) latent poverty, and (iv) the fragility of democratic regimes in the area [2].

International terrorism finds what could be called a "source of raw material supplies" in the area, and financial funding for their global actions. Drug traffic in Latin America provides international terrorism with funding, as a result of their export budget.

Poverty in Latin America is endemic and there has been extensive public debate on how to best tackle this problem, most of the solutions having been expressed in the form of

economic plans. Weiland [9] presents a study regarding the lessons of prospect theory to deal with the problems of economic restructuring in the area, arguing that many of the economic plans adopted by different leaders in the area were characterized as being extremely risky, exactly because their proponents saw themselves as facing imminent losses. This seems to corroborate the findings of prospect theory.

With respect to the argument of the fragility of democratic regimes in the area, it is important not to neglect the fact that different countries in Latin America have only just been introduced to democratic regimes, having only recently stepped out of authoritarian regimes.

Among the most unstable countries, Kugler & Frost [2] give special prominence to Haiti, characterized by the existence of civil conflicts, and facing external intervention today; Colombia, with its armed guerrillas; Cuba, with its long lasting dictatorship; and Venezuela and Peru, which experience democratic fragility. Today it is mandatory to include in this list Bolivia, whose government has adopted an anti-market program, which has recently led to the expropriation of the Brazilian national petroleum company, Petrobras.

In the case of Brazil, the aspect that most catches one's attention is its great territorial extension and borders, with more vulnerability assigned to the Amazon region. However, Brazil has an outstanding protection and surveillance system, known as the System of Surveillance of the Amazon region (SIVAM) and the System of Protection of the Amazon region (SIPAM), which allow for the application of modern technologies of aerial sensing for the recognition of threats, control, communication and command. This should be seen in connection with the recent developments of embarked technology, and of the manufacturing of airplanes by EMBRAER (the Brazilian state-funded aerial engineering company). One example here is the well known bi-jet ERJ145 airplane, entirely developed in Brazil.

Brazil has signed the Council of Interamerican Defense (CID), an organ sponsored by the Organization of American States (OAS). In 1995, the United States created in the area a Ministry for the Defense of America, with a calendar of biannual encounters [2]. Nowadays, many efforts have been made to create cooperation within the South America, as the common market "Mercosul" and the unified defense system "Unasul".

Among the challenges faced by Latin America countries, consolidation of the democratic regimes is the main one, but there is another common concern which has to do with the role played by the military in the region. In most countries, it seems that there is a consensus that the military should not be involved with the countries' internal matters; much on the contrary, the military should be concerned exclusively with a country's external defense.

The integration of the area is not consolidated yet, and it is considered that the United States has an important part to play in this respect: one can easily recognize the influence of the United States in the whole area, particularly in Central America and in the northern region of Latin American

countries, from Mexico (very close to the United States) to the countries of the Caribbean, which, except for Cuba, are strongly influenced by the commercial interests of the United States.

In Latin America, Brazil has slowly (and reluctantly, to some political analysts) assumed a position of leadership in the area. But, even if Latin America were already integrated and strong, there is not how to deny its inferiority, from the perspective of its warlike, economic, and technological capacity, in relation to the rich countries of the globe.

Prospect theory

The main empirical findings of prospect theory were obtained by controlled experiments, in which different individuals were tested. The results of research in this area suggest that people tend to adopt a behavior averse to risk when they are in a favorable situation, or a winning situation, for instance, but tend, on the other hand, to adopt a behavior clearly prone to risks when they are in a situation of imminent loss.

The results of these empirical tests are surprising when they suggest that people tend to be prudent in their efforts to prosper, and tend to be risk-takers in situations where they are intent on avoiding defeat.

The phenomenon of risk seeking to avoid losses had already been out pointed, long ago, by Sun Tzu, the well-known author of the classic "Art of the war", [10] as in the following fragment:

"Put your army in mortal danger and they will survive; dip them in dangerous straits and they will cross it safely. (...) Because it is precisely when a force is in danger that it is capable to struggle for victory"

Prospect theory argues that *vis-à-vis* a choice among different options of gains, people tend to select options which enable them to avoid risks, always preferring to obtain smaller gains, instead of taking risks to gain much more. However, when they are already facing losses, people tend to seek risk, avoiding safe losses of smaller magnitude, preferring to take risks in bets that, if, on the one hand, represent the promise of not having any loss at all, on the other, may lead to even greater losses.

It seems that Sun Tzu [11] had also foreseen this:

"In desperate land, announce to soldiers the impossibility of saving them their lives. The only opportunity for them is to give up any hope. Because it is characteristic of the soldier to offer an obstinate resistance when embattled, to struggle vigorously when it cannot help himself and to obey, instantly, when in danger (...) The guarantee against defeat implies defensive tactics; the capacity to defeat the enemy means taking the offensive"

As we said at the beginning, prospect theory is an analysis of human decisions in risk conditions, and as well as other theories of decision, prospect theory presents an algebraic formula to represent the process of decision in risk conditions. And the prospect term represents the "choice" among several alternative roads. According to Hastie & Dawes [7], there are two phases in the process of development of prospect theory: first, the edition (or

elaboration) of alternatives, which involves the construction of a cognitive representation of the actions, contingencies and relevant results of the decision; and second, the evaluation, in which the decision maker assesses the value of each prospect (or alternative), choosing the best. This cognitive representation of the actions and contingencies translates as, in a word, knowing the situation of decision.

It is again a surprise to read Sun Tzu [12] and how he anticipates the point just made:

"If we know the enemy as well as ourselves, we don't need to fear the result of a hundred combats. If we know ourselves, but not the enemy, for each victory we will suffer a defeat. If we know neither ourselves nor the enemy, we will succumb in all battles"

Still in relation to the elaboration of alternatives, prospect theory puts a lot of emphasis on the decision maker's background and it would be based, also, on the values and objectives that defines the decisions. This because it is the individual's background, or, in other words, what the individual brings to the moment of decision, that will define his/her sensibility to the oscillations of the alternatives presented to him/her.

An example of such a situation can be seen in Weyland [13]: *"Seen from the perspective of prospect theory, the deep economic crisis of Argentina, Brazil and Peru of the eighties put many leaders, as well as citizens, in a land of losses. Consequently, they accepted extraordinary risks in an attempt to avoid more deterioration, to recover the levels of well-being existing before the crisis and - regarding the leaders - to guarantee their political survival"*

Another important point in the phase of edition of prospect theory is the level of aspiration of the decision maker, which could be probed by questions of the type: Which are the chances that I reach my objective of 'y'? or which are the chances that I lose 'x' or more?

Besides, if we consider the level of the leaders' aspirations of most – if not all – countries in Latin America, which of them, in healthy conscience, would not have the aspiration of liberating so many of their fellow citizens from poverty?

Prospect theory suggests also that our preferences are not linear for gains and losses, once our perception of losses are approximately twice "more painful" than our perception of the "pleasure" we obtain when we gain.

Another effect of prospect theory (alarming for the purpose of this article, although with the safeguard that it was tested mainly among doctors and politicians), later revealed by researchers, is that when dealing with human lives, decision makers tend to be contrary to risk when saving lives, and prone to take risks when trying to avoid losing lives [14].

According to Hastie & Dawes [15], prospect theory is the best and more understanding description that one can give of the decision process. It summarizes several centuries of discoveries and insights concerning human behavior in dealing with decisions. This theory provides a useful apparatus for the study of behavior, by many researchers considered irrational and anomalous, concerning the human process of taking a decision.

Finally, in the present review of prospect theory, and adopting the perspective that the central objective of this article is – besides alerting to the fact that risk is a possible catalyst to the escalation of violence – to investigate the existence of the same empirical findings of prospect theory when applied to a universe of future officials of the Armed Forces, let us turn to the field research itself, proposed for the present work.

IV. METHODOLOGY OF THE RESEARCH

The central purpose of the field research presented in this article is to investigate if the same empirical findings obtained by prospect theory, applied to several types of professionals, such as doctors, managers, public leaders among others, are substantiated by findings when the same tests are applied to the cadets of the Academy of the Air Force, future decision makers in important subjects of safety and defense, in risky conditions.

We understand this kind of research to be important once Latin America is an area that is in constant tension, as a result of latent conflicts of interest between this area and more developed nations, as well as a result of fractures in its social texture, from urban violence, caused by drug traffic, to poverty and democratic fragility.

And being an area in a state of latent tension, the hypothesis should be tested that, were a conflict deflagrated, either internal or external, our political leaders, military or police, acting in the face of losses, might accept extraordinary risks which would end up being catalytic factors for an escalation of violence?

The Air Force Academy prepares officials to be aviators, managers and infantrymen, in a course which takes four years, full time, in a boarding school regime. It is located in the municipal district of São Paulo, Pirassununga, where youths from almost all areas of the country are hosted, as well as some youths from neighboring countries.

The research was carried out with cadets enrolled in the third year of the course for the formation of aviators, during the month of June of 2006. A questionnaire was applied to the cadets (see Appendix), as a research instrument adapted for the objectives of this research, and 105 answers were obtained from the cadets. The research instrument was applied through the criterion (SE), or "separate evaluation tasks", such as described in González-Vallejo [16].

Tabulation of the data

The main purpose of data analysis was to investigate – through chi-square test, whose objective is to check the adjustment between observed frequencies and expected frequencies [17] – the following hypotheses:

H₀ (null hypothesis): prospect theory is not corroborated by the findings of this research, once there are no significant differences between the expected frequencies and those observed in the data. This way, the distribution of frequencies is entirely random.

H₁ (valid hypothesis): prospect theory is corroborated by this research, once there are significant differences between the

expected frequencies and those observed in the data. This way, the distribution of frequencies obtained through the experiment may be said to derive from the theoretical assumptions of prospect theory.

We adopted a 5% error level (95% of trust), with one degree of freedom, once, as can be seen in the research instrument, the respondent always had two alternative answers. Consequently, the valid hypothesis is accepted if chi-square values are above the limit of the parameters [$\chi^2(1) = 3,84$]. If they are below this limit, the null hypothesis prevails. Before we move on to the analyses of the data obtained, it

seems convenient to present the profile of the cadet-respondents (Table I) involved in this research. The profile of the sample is not probabilistic, but of an intentional character, once that are aviators who occupy, in the Air Force, important command positions.

Table I: The cadet-respondents' profile

Gender	Men: 102 (97%). Women: 03 (03%).
Academic background	3 ^o year (5 th semester) of Administration, full time.
Military formation	Enrolled in a Course for officials in aviators' formation, full time.
Age	Between 20 and 23 years.
Marital status	All single.

Chi-square test

It seems important to point out that from a sample of 105 cadets, an observation was excluded (outlier), since the

answers were not correctly understood by this cadet-respondent.

Table II introduces the frequencies that are obtained in each one of the 8 alternatives presented to the cadets, as well as the chi-square statistics.

Table II: Chi-square test

Alternatives	Frequencies observed (o)	Frequencies expected (e)	$(o-e)^2/e$
A	22	50	15,68
B	78	50	15,68
a'	64	50	3,92
b'	36	50	3,92
C	77	50	14,58
D	23	50	14,58
c'	66	50	5,12
d'	34	50	5,12
$[\chi^2(1) \geq 3,84; p < .05]$			78,60

V. DISCUSSION

It is important to call attention to the fact that the value of the chi-square test was above the minimum necessary for a level of error of 5%, leading to the valid hypothesis, and corroborating prospect theory. The results confirm the hypothesis that, within the limitations of this study, future officials, at least from what may be inferred from a sample like this, will tend to present propensity to risk in loss situations, and aversion to risk in situations of gain.

The application of chi-square test led the exploratory experiment to the confirmation of the valid hypothesis, with a margin of error of 5%, a finding that corroborates previous empirical findings in prospect theory. In other words, the experiment with 3rd year cadet aviators

confirmed the aversion to risk in moments of winning conditions and the propensity to risk in the face of losses.

VI. CONCLUSIONS

Traditionally, the applied social sciences have been concerned with an expressive range of studies of decision processes. Economy and management are areas of knowledge

considered in the forefront in the study of human decision processes, though not always from an interdisciplinary perspective.

However, these areas of knowledge have started to widen their scope, as a result of eloquent empirical findings in cognitive psychology, above all starting from studies by Kahneman & Tversky [1].

We are quite aware of the fact that a person's decision process involves several factors, some of which are predictable and others quite unpredictable. This derives from the fact that, according to Bazerman [18], we use two analytical frameworks, or types of thought, when making a decision: one of them is system 1, a more intuitive, or less structured dimension, while the other one is system 2, a more rational and structured domain.

Although some researchers have already confirmed the practical applicability of combining systems 1 and 2 in management [19]-[20], others still strongly resist the idea of an intuitive dimension to support decisions. This resistance may be partly accounted for in terms of the canonical tradition of scientific methodology, of the alienation of the researcher's subjectivity, as a way of guaranteeing the universality of scientific principles.

Something no doubt defensible from different perspectives, except for the fact that what is under discussion here is the decision process, and the psychology of human judgment. If the subjective aspects of human judgment are not taken into account, this may lead to a double mistake: (i) the first one is to underestimate human beings' perceptive capacities, and (ii) the second one is to allow less qualified people to make judgments and commit undeliberated mistakes [21].

Concerning undeliberate mistakes in human judgment, Bazerman [18] refers to the limits of conscience, to complement the concept of the "rationality boundaries" that had been originally suggested by Herbert Simon.

Klein [22], whose research is also in the area of cognitive sciences, argues that system 1, the intuitive domain, should be seen as prior to system 2, making the point that we should look for inspiration in professionals that uses the intuition very well, like doctors', firemen's, musicians' and airplane pilots' work, if we want to improve decision processes.

The objective of this article was to investigate if the already consolidated theoretical framework of prospect theory can serve as a support to the study of decision processes in military operations. The idea was never to contradict the traditional axioms of prospect theory, but just to contribute to discussions on safety and defense in Latin America, and thereby to the qualification of military personnel who occupy strategic positions in different Latin American countries.

This might be seen as a crucial element in debates about issues of public defense carried out by countries in the area, or in talks and negotiations with larger countries, with countries of a larger warlike potential, or still with multilateral organisms whose main objectives are to sponsor harmony among nations. It is strongly recommended that these results are confirmed by further studies, broadening the scope of the research in different ways.

In the interpretation of results, special care should be taken in the verification of the adaptation that was done in the research instrument to the characteristics of the present research framework. The research instrument, although quite different (because adopted for this sample) from the ones used in the seminal studies on prospect theory, elicited, nevertheless, auspicious results for the study of issues of safety and defense in Latin America.

And maybe this work shall represent one initial step to the effort of approximating the prospective theory and the EBO's, once both look for rules in the human criteria of judgment. Or still, no less important, the prospective theory maybe would be seen an indispensable element for a good work in joint operations, among the three armed forces, once their criteria of decisions and choices should be standardized.

REFERENCES

- [1] Kahneman, D. & Tversky, A. "Prospect theory: an analysis of decision under risk". *Econometrica*, 47, 1979, p. 263-291.
- [2] Kugler, R. L. & Frost, E. L.(orgs.). *The global century: globalization and national security* (VOL.II). Washington, DC: National Defense University Press, 2001.
- [3] Kahneman, D. & Tversky, A. "Choices, values and frames". *American Psychologist*, 39, 1984, p.341-350. In: Hastie, R. & Dawes, R. M. Rational choice in an uncertain world: the psychology of judgment and decision making. (p.303). Thousand Oaks, CA: Sage, 2001.
- [4] March, J.G. & Shapira, Z. "Managerial perspectives on risk and risk taking". *Management Science*, 33, 1987, p.1404-1418. In: Hastie, R. & Dawes, R. M. op.cit. p.293.
- [5] Kahneman, D., Knetsch, J. L. & Thaler, R. H. "Anomalies: the endowment effect, loss aversion, and the status quo bias". *Journal of Economic Perspectives*, 5, 1991, p.193-206. In: Hastie, R. & Dawes, R. M. op.cit. p.308.
- [6] Lamont, E. B. & Christakis, N.A. "Physician's preferences for prognostic disclosure to cancer patients near the end of life". Paper presented at the annual meeting of the *American Society Clinical Oncology*, New Orleans, 2000. In: Hastie, R. & Dawes, R. M., op.cit. p.302-303
- [7] Hastie, R. & Dawes, R. M. *Rational choice in an uncertain world: the psychology of judgment and decision making*. Thousand Oaks, CA: Sage, 2001.
- [8] Hunerwadel, J. P. "O tratamento das operações como baseadas em efeitos". *Air & Space Power Journal em Português*, 2^o trimestre, 2006, p.21-31.
- [9]Weyland, K. "Os riscos na reestruturação econômica da América Latina: lições da teoria prospectiva". *Revista Opinião Pública*, Campinas, SP Vol.VI, 1, 2000, p.76-108.
- [10] Clavell, J. *A arte da guerra: Sun Tzu*. Rio de Janeiro, RJ: Record, 1983, p.93/97.
- [11] *Ibid*, p.29/90.
- [12] *Ibid*, p.28.
- [13] Weyland, K., op.cit., p.83.
- [14] Hastie, R. & Dawes, R.M., op.cit., p.304
- [15] *Ibid*, p.310.
- [16]González-Vallejo, C. "Making trade-offs: a probabilistic and context-sensitive model of choice behavior". *Psychological Review*, 1, 137-155, 2002: p.139.
- [17] Stevenson, W. J. *Estatística aplicada à administração*. São Paulo, SP: Harbra, 1981.
- [18]Bazerman, M. H. *Judgment in managerial decision making*. 6th Edition. Hoboken, NJ: John Wiley & Sons, 2006.
- [19] Vianna, N. W. H. *A subjetividade no processo de previsão*. Tese de doutoramento, FEA/USP, SP, 154p, 1989.
- [20] Silva, L. M. A. *Instrumentalização do planejamento estratégico: aplicação no setor aeroviário comercial brasileiro*. Tese de doutoramento, FEA/USP, SP, 182p, 2000.
- [21] Bazerman, op.cit., p.167.
- [22] Klein, G. *Sources of power: how people make decisions*. Cambridge, MA: MIT Press, 2000.

APPENDIX: Research forms

BRAZILIAN AIR FORCE ACADEMY

You are commanding, in the area of the Amazonian border, an aerial military operation of strategic importance to guarantee the defense of Brazil. Suppose that the supply of fuel is the most important tactics in your decisions, and, the more fuel in stock, the better. It is necessary that you take some decisions regarding the supply of fuel available in the headquarters where the military operations are being monitored. The decisions should be made always keeping in mind this hypothetical description.

On the basis of the situation previously described, choose one of the alternatives presented below, based on your preferences:

- (a) To receive 4.000 liters of fuel with probability of 80%.
- (b) To receive 3.000 right liters of fuel.

Still on the basis of the situation described initially, choose one of the alternatives presented below, based on your preferences:

- (a') To lose 4.000 liters of fuel with probability of 80%.
- (b') To lose 3.000 right liters of fuel.

Still on the basis of the situation described initially, imagine that you have just received an extra supply of 1.000 liters of fuel.

In this case, which of the alternatives would you prefer below?

- (c) To receive 500 more right liters.
- (d) A coin is thrown: if it shows "head", you receive 1. 000 liters more; if it is "crown", you don't receive anything else.

Finally, and still on the basis of the situation described initially, imagine that you have just received an extra supply of 2.000 liters of fuel.

In this case, which of the alternatives below would you prefer?

- (c') To lose 500 right liters.
- (d') A coin is thrown: if it shows "head", you don't lose anything; if "crown", you lose 1.000 liters.

Thank you very much for your participation in this academic research!