

- Poser une **problématique** nouvelle à partir d'une revue de la littérature sur le sujet.
 - critères d'évaluation:
 - clarté de la présentation et adéquation des références bibliographiques
 - capacité d'analyse, maîtrise des concepts
 - positionnement du sujet par rapport à l'état de la recherche (capacité à mettre en avant la nouveauté apportée)

cf 4 questions of Tinbergen... sans les dire ?

Def prosocial behavior // motivations ?? in I or II CITE SMTG ?

III But biological explanation ? (IV history... oseb?) III to better understand IV to better understand II ??? [to ... prevent?]

=> or just better understand the ancestral conditions 5no history in models....)

=> better charac : **choose** what = fundamental in descr I.... // how to understand and even act on it... (bof pour l'application)

and even better integrate : rôle of rites emerges from...

+ III : **question de r qui change un peu avec les rep // auquel on ne repond pas**

pas dit : how important are beliefs ?? → cf mon expli sur heroism 1.1.3)

By definition (Eisenberg, Fabes & Spinrad, 2007),

ATTENTION AUX REF DISPARUES

1. 1. Self-sacrifice

1. 1. 1) Prevalence of self-sacrifice in humans

Throughout history, humans have been willing to lay down their lives for the sake of their groups (Whitehouse, 2019). Durkheim (1897, pp. 238-246) characterizes such acts as “altruistic suicides”, encompassing any behavior which will *necessarily result in death*, in which individuals engage knowingly, *in the name of a group* and/or its ideology. Throughout this paper this will be referred to as extreme *prosocial* self-sacrifice, as it involves extreme costs to the self (death) intended for the benefit of others – or simply self-sacrifice.

Early Christian martyrs (Durkheim, *ibid*), the 300 Spartans at the Battle of Thermopylae (Lazenby, 1993), kamikaze Japanese pilots during the Second World War and **Muslim** suicide terrorists in recent decades (Pape, 2005) all fall under this definition.

These examples underscore that such self-sacrificial behavior may be related to (perceived) threat to the group, perhaps notably in a context of *intergroup conflict*. Intergroup violence is a widespread and persistent feature of sapiens' environment during the Pleistocene, with potentially far-reaching impact on our mortality (Keeley, 1997), **making it likely that mechanisms to respond to such a situation would have been selected in our species.**

In contrast however, the sectarians of Amida in the early nineteenth century (Durkheim, *ibid*) appear to give up their life outside of any such context¹, in *public* displays of piety, their *memory* being held in great reverence by members of the crowd. Martyrs engaged in intergroup conflict also gain posthumous celebrity within the group (Blackwell, 2008).

1. 1. 2) Identity fusion

For Whitehouse (2019), self-sacrifice for the sake of a group is motivated by *identity fusion*, a visceral sense of oneness with the group (Swann et al., 2012). Two pathways can lead to enduring identity fusion: perceptions of *shared biology*, as well as intense collective experiences, including the horrors of frontline combat or participation in potentially extremely *painful rituals*. Highly “fused” individuals appear to take threats to the group personally, and, in extreme cases, may be motivated to lay down their life for said group. While the difficulty of evaluating actual would-be martyrs' motivations is compounded by practical and ethical issues, one can note that identity fusion is correlated with expressions of support for martyrs and even willingness to give up one's own life to defend the group (Whitehouse, 2019).

¹ Although it is hard to know (and not specified here) if they are motivated by a perceived threat to their sect.

Identity fusion can thus account for many of the characteristics of self-sacrifice as outlined above, including its relation to conflict and its stated objective (defense of the group). In addition, it allows to place willingness to lay down one's life for a group on a spectrum and connect it with two other associated social mechanisms – extreme rituals (e. g. intense initiations, Pape, 2005, p.8) and **metaphors of brotherhood (or other family-like ties) in public discourse.**

[pb : c'est 'tres' proximal ca, comme beliefs en fait je crois]

From an evolutionary standpoint however, identity fusion only begs the question. At first glance, self-sacrificial behavior and its underlying motivations, whether mediated or not by identity fusion, constitute a true biological puzzle, since dying is obviously not a good way of passing one's genes. *How can we explain the evolution and maintenance in humans of self-sacrifice for the sake of the group*, as characterized in this section?

1. 2. Existing biological explanations for self-sacrifice

Explanations for self-sacrifice usually invoke maladaptive behavior (pathology, miscalculation...), kin selection or group benefit – or, a mixture of the three.

1. 2. 1) Self-sacrifice does not need (more) explaining

For some authors, self-sacrifice (particularly in the modern form of suicide terrorism) is caused by extreme religious views and/or pathology (Pape, 2005, p. 16). This does not square however with the extent of such behavior, which is also displayed by individuals one would more intuitively link to patriotic or nationalist beliefs (Spartans at Thermopylae, kamikaze).

More importantly, the persistence of self-sacrifice throughout our history suggests that pathology may not be a sufficient explanation: if self-sacrifice is maladaptive, seeing its huge costs to individual fitness, why was such behavior maintained in our species? In addition, contemporary studies of individuals who engage in such behavior suggest they have no appreciable psychopathology and are as educated and well-off as surrounding populations (Atran, 2003).

A related argument is that such behavior should not be understood as functionally self-sacrificial. **The biological function of a behavior is an effect of that trait that causally explains its evolution and persistence in a population (Nettle, 2009).** As outlined in **section 1.3.3**), heroism may have a social function which allows to account for the evolution of heroic behavior particularly in times of intergroup conflict. Such heroic behavior may sometimes result in death, manifestly in favor of the warring group. In such an

interpretation, self-sacrifice is thus accidental, and/or borne from miscalculation (Marie, 2019).

The distinction between risking one's life and laying it down is not always clear-cut. According to one estimate (Gambetta, 2005, p. 272), one has only a 1 in 10 chance of surviving an act worthy of a British Commonwealth Victoria Cross medal, making it hard to decide whether such acts should be characterized as heroic or self-sacrificial. For cases such as the examples given above, which involve long-term planning (e. g. suicide terrorism) and repetitive actions that can only realistically result in death (e. g. Christian martyrs), it seems hard to avoid the latter qualification – unless one factors in severe and dire miscalculation. This explanation is thus similar to the previous “pathological” one; the same objections can be made.

EN FAIT OSEF ??

1. 2. 2) Kin selection

Throughout the natural world, one example of prosocial behavior abounds: parental care. Costly behavior in favor of children (and more generally, kin) is adaptive if, from the standpoint of genes, costs are outweighed by benefits, as captured by Hamilton's rule (1964): if costs c associated with a behavior are smaller than benefits b to a kin times coefficient of genetic relationship r , then, on average, a gene that favors said behavior will leave more copies than a gene that does not. At the individual level, this is captured by the concept of *inclusive fitness*.

[FIG 1 Formule math : Hamilton]

Hamilton's rule leaves the door open to even self-sacrificial behavior in favor of kin. Thus, in some (rare) examples, such as certain spiders (Kim, Roland & Horel, 2001), mothers are systematically eaten by their offspring (and let them do it) at the end of their incubation period, a behavior which is sufficiently beneficial to the long-term prospects of the (tens of) individuals in the clutch to have evolved. Beneficiaries need not be restricted to immediate offspring: certain aphids and other social insects may “self-explode”, in order to plaster over gaps in the nest (gall) with their body fluid, to the benefit of the entire colony (Kutsukake et al., 2019).

FIG 2: photo de la video??

Whitehouse and Lanman (2014) argue that kin selection can similarly explain the evolution and maintenance of identity fusion – and self-sacrifice, in extreme cases of intergroup conflict. In such an interpretation, both pathways leading to fusion (perceived biological relatedness and shared experiences) and their corresponding social mechanisms (evoking “brotherhood”, rituals...) come down to the same fundamental issue: detecting your genetic kin, and motivating potentially extreme behavior in their favor, when the situation demands it (conflict).

This rests on the assumption that ancestral warring groups were composed of

close genetic relatives. Of course, Whitehouse and Lanman do not anticipate that such genetic proximity should be comparable to that in an aphid gall, **which would be absurd**. Contrary to us, social insects reproduce via eusocial division of labor (a colony descends from one or a small number of “kings” or “queens”) or cloning. Two random individuals taken in a colony may thus be closely related (tentatively, r measurable in tens of percentage points) – considerably more so than two random hunter-gatherers taken in a typical unit of over 100 individuals (Dunbar, 1996).

Following this perspective, the evolution of human self-sacrifice is much less likely than that of social insects, although it remains a theoretical possibility. Studies of current hunter-gatherer groups (Hill et al., 2011) and of fossils (Sikora et al., 2017) suggest however that ancestral human groups were highly fluid and not closely related.

[Un peu long....]

In any case, even if one accepts that self-sacrifice through fusion may evolved to favor ancestral groups of kin, the question remains: *why would such behavior be maintained?* In the historical examples given, groups who benefit from self-sacrifice (e. g. national or religious community) are too large to be genetically related. From an evolutionary standpoint, feeling fused to such a large group to the point of self-sacrifice thus constitutes an extremely costly mistake – which brings us back to the arguments developed in the previous section.

Another way of complementing – or replacing – this explanation revolves around group and/or cultural selection, as detailed in the next sections. Alternatively, Blackwell (2008) notes that, for Palestinian suicide fighters, self-sacrifice comes with material gains to the family. In certain economic situations, self-sacrifice may thus increase an individual’s inclusive fitness – although Blackwell’s model does not specify how such situations come to be; in contrast with the explanation proposed in part 1.3.

1. 2. 3) Group benefit; cultural selection

Another family of explanations starts from self-sacrifice’s stated objective: collective benefit. Groups comprising prosocial individuals should fare better than groups of egoists at the collective level – offering another perspective on insect eusociality (Nowak, Tarniat & Wilson, 2010) and human prosocial behavior (Wilson & Wilson, 2010).

Many authors object to the idea that natural selection should (also) occur at the level of the group, as, in practice, human collective dynamics seem not to verify its axioms (Williams, 1966; Pinker, 2015). In fact, the fundamental level for natural selection is genetic: what determines the evolution of a heritable behavior is, all else being equal, the number of copies that genes controlling it leave in the next generation (Dawkins, 1976). Following this view, selection at

the individual level is merely an approximation, which can be made in numerous cases because of how inter-related the fate of an individual’s genes are – a condition which does not seem to be met at the collective level². At the individual level, purely prosocial behavior (with no supplementary benefit to the individual with respect to others) is a losing strategy, as illustrated by the tragedy of the commons (Hardin, 1968) – and should therefore be counter-selected.

pas répondu au pb?

In particular, explanations for self-sacrifice in terms of collective benefit make a questionable assumption: that groups may face threat of complete annihilation. Orbell and Moriwaka (2011) argue that in such a context fusion could extend to larger coalitions comprising non-related individuals, while Whitehouse et al. (2017) provide a model for the evolution of fusion and self-sacrifice directly for groups of non-kin which includes the possibility of group death. **In their two-tier model (individual and group levels), individuals may pay a cost to contribute to a collective action problem, based on previous collective experience, leading to, in cases of strong intergroup competition – where losing groups may be replaced by the offspring of others – following negative collective experience, the possibility for individual self-sacrifice**³. Yet, from the standpoint of genes, prehistoric group extinction seems highly unlikely: even if the entirety of its (predominately male) fighting force is massacred, civilian women may survive to join other groups and/or be subject to rape, as is recurrent in such conflicts (Gottschall, 2004).

[si on veut : figure = proba mort du groupe... : proportional to S_j] // Another proposes that conditioning cooperation on past experience is sufficient to fuse groups of distantly related individuals in the face of adversity (Whitehouse et al. 2017).

Another related explanation revolves around the idea of cultural selection: that cultural objects may follow a process akin to Darwinian natural selection (Richerson et al., 2014). Thus, norms or social institutions may for instance have evolved to exploit the previously described propensity to fuse and potentially self-sacrifice for kin (Orbell & Moriwaka, 2011; Swann et al., 2012; Whitehouse, 2019). Such an explanation could be more robust to the previous criticism: it may be less debatable to suggest that norms or institutions can disappear, although this neglects the fact that such cultural elements cannot exist purely outside of individuals’ minds (Boyer, 2019). **As with group selection, many argue that cultural dynamics violate Darwinian axioms – in particular, cultural transmission is non-random and culture does not exhibit inheritance in the strict sense (Sperber & Claidière, 2006; Pinker, 2015).**

+ = mistake for individuals...

² Outcomes at the individual level (reproduction, death...) largely and equally determine the prospects of his/her genes. **By contrast, group-level outcomes’ influence on individual fitness seems much less decisive and equally distributed: an individual’s success may come at the expense of others (e. g. in a competition) and can occur even when the group fares badly (e. g. profiting from war).**

³ **Materialized by individual fitness approaching 0.**

1. 2. 4) Why explain....

UNDERLYING... => all its aspects : some may be part of signal, O + W

This pushes us to try to go beyond // propose a model base on individual stuff....

=> also go beyond some of the characteristics of self-sacrifice outline throughout this section.....

Wgat = proximal + what = ?

+ HOW features are important (IG does not => group sel)

Go beyond message, purported goal = part of the signal...

- beyond the proximal ideology
- beyond collective benefit even

====> link to some of the characteristics = in context of conflict... « identification » / fusion...

====> LINK to **rites** : with cultural expla, still begs the question ====> model here = explicit more teh link, allow also the rite to emerge

[en fait eux ils partent de l'eq : oui la c'est tres couteux... mais ce qui le rend couteux = la competition justement... => sinon pas d'exclusion...]

Whitehouse : beliefs do nothing ====> just attachment to the group

====> so osef brothers as well ?

... mentionner Atran aussi donc ??

Not belief per se that motivates self-sacrifice... but attachment to a collective... // Bloom 2012 /// or Ginges + al 09

Moreover, studies in the lab and in natural settings suggest that religious beliefs lead to pro-social action because they serve as markers of group alignment. That is, it would seem to be attachment to a collective, forged through shared rituals or other identity markers, and not beliefs per se that motivate pro-group action (Bloom 2012). For example, in a series of studies (Ginges et al. 2009), frequency of participation in collective rituals has been shown to predict support for suicide attacks, whereas frequency of prayer (as a less groupish devotional act) does not.

++ see that comes in the name of lots of ideologies : not just religious...

=> give examples...

=====> point of signal : go beyond the message...

++ why do these norms exist themselves ? Begs the question... at least from an evolutionary standpoint

= from there cultural evolution...

[[Cex : Atran, sacred moral values 2010]]

Fusion, Swann et al 09

- fro, inherited bio ... Gil-White

- from shared life-defining xp : W+L 2014

both = W + al, 2017... + stats cited p. 5

+ **rites of terror** : fusion also linked to this... ==> in second-order signal = honest if of terror....

[but pb : « involuntary »???

Even though collective benefit is the displayed (moral) motivation for self-sacrifice, biological motivation will be understood in terms of benefits to the individual (Williams, 1996).

- ++ on explications from Whitehouse + al...

- ++ why:(coll benefit...

- debate not resolved : OK, let's just try to do it at the individual level ...

Abstr : The fusion mechanism has often been exploited in cultural rituals, not only by tribal societies but also in specialized cells embedded in armies, cults, and terrorist organizations. With the rise of social complexity and the spread of states and empires, fusion has also been extended to much larger groups, including doctrinal religions, ethnicities, and ideological movements.

[OK vocab = « fathers », « motherland »... mais tjs meme prob... osef meme si medie un peu les acts : give blood... mais tjs pas sacrifice]

= the message : 7

Following a closely argued discussion of these issues, Orbell and Moriwaka (2011) consider whether Blackwell's argument can shed light on the motivations of kamikaze pilots in World War II. Based, however, on extensive analysis of letters, poems, wills, and memoirs left behind by 661 Japanese pilots who perished in suicide attacks, the authors conclude that the act of self-sacrifice was not undertaken to increase the welfare of close kin. Rather, the writings of kamikaze pilots placed much greater emphasis on the desire to die for the nation or for the emperor.

[+ rituals → local fusion = cultural gadget, to mimick shared dysphoric xp]] // of terror : osef non ? Rentre pas trop dans le modele : still begs the question ====> model here = explicit more teh link, allow also the rite to emerge

The framework = signaling // + figures // + affiliations sym et asym ? ==> maths de Grafen ? // figures de JLD = ...

Trop long: couper éventuellement la partie sur reput // attention aux repetitions Go beyond message, purported goal = part of the signal...

- beyond the proximal ideology

- beyond collective benefit even

[Blackwell (2008) has argued that Palestinian suicide attackers increased their inclusive fitness outcomes by contributing, through the celebrity of their deaths, to the well-being and reproductive prospects of their close kin]

==> link to some of the characteristics = in context of conflict... « identification » / fusion...

==> LINK to **rites** : with cultural expla, still begs the question ==> model here = explicit more the link, allow also the rite to emerge

[en fait eux ils partent de l'eq : oui la c'est très coûteux... mais ce qui le rend coûteux = la compétition justement... => sinon pas d'exclusion...]

rites of terror...

revoir def prosociality si pas défini avant

=> self-sacrifice = examples with "extreme" costs

=> go beyond signal

Does it really make good evolutionary sense to seek the friendship of heroes?

4.1. Animal signaling

This question was studied during the internship following a signaling framework. According to the evolutionary theory of costly signaling (Zahavi, 1975), natural selection may, under certain conditions, lead to waste at the individual level (a handicap). Zahavi's handicap principle has helped explain counterintuitive phenomena across the natural world, from the brightness of male plumage in certain bird species (Zahavi, 1975), which make them more visible to predators, to stotting – whereby certain preys (e. g. gazelles) will jump up into the air upon predator encounter, apparently making them easier to catch (Maynard Smith & Harper, 2003).

~~{c'est bien fixe l'exemple du plumage??}~~

A **typical** signaling model involves senders (signalers) and an audience (receivers) and can be grounded in game theory. Senders vary in some specific unobservable *quality* of interest to the audience (note that without variation, there is no need for signals). Senders may advertise this quality to their audience, which may infer actual quality from these signals and base subsequent (unconscious or conscious) choices on these inferences (e. g. mate selection or prey pursuit – see under). Under reasonable mathematical assumptions⁴, a signaling equilibrium consisting in a pair of evolutionarily stable strategies – or ESS, as introduced by Maynard Smith (1972) – for senders and receivers, can be shown to exist (Grafen, 1990). In other words, if one assumes that the strategies followed by senders and receivers – signaling at a certain level and inferring quality from signals – are biologically encoded and heritable, then natural selection can lead to a non-trivial signaling equilibrium which is resistant to invasion by mutants (alternative strategies).

Figure : principe du signal --> cf CRI ?

Conversely, given such an ESS pair, one can deduce: that signaling should be *honest*, meaning that advertised levels should reflect actual quality; that signalers should bear a fitness *cost* (handicap); and that said cost should be higher for senders of worst quality (Grafen, 1990). This is what makes signaling theory so relevant to ethology: if one observes a situation where individual animals may be understood to be signaling a quality to an audience, then these signals should be honest and costly⁵. Honesty is key: if a signal is dishonest, then using it to infer quality would be sub-optimal – meaning that the corresponding strategy pair cannot be an ESS. This framework does not therefore apply to cases of dishonest animal communication.

Interpreting a seemingly unlikely phenotypic or behavioral outcome in such a context can thus allow to explain it. Gazelle stotting can for instance be understood as an honest signal of its ability to outrun an incoming predator: the higher it jumps, the longer it can be expected to evade a predator – and it is strategically optimal for predators to decide which prey to attack (if any) based on how high they jump. With respect to bird plumage, blue plumage in male grosbeaks (Keyser & Hill, 2000) has been interpreted as an honest signal

⁴Honesty, cost, and increasing cost for males of lesser quality – as well as more technical elements (Grafen, 1990).

⁵ If one assumes that signaling level (sender strategy) and inferring quality from signals (receiver strategy) are biologically encoded and inheritable, and therefore subject to natural selection – which converges to ESS equilibria.

directed at a female audience of potential mates, although it remains unclear which specific quality is signaled – leaving room for debate. Finding the correct underlying quality associated to a (potential) signal, as well as its audience, is not usually straightforward, as decisions such as sexual partner choices involve a variety of overlapping elements and decisions processing shaped by natural selection – potentially even including several qualities and corresponding signals (Doucet & Montgomerie, 2003).

4.2. Social signaling and human prosocial behavior

[Josef eco et prosocialite?]

The theory of costly signaling has also been used by researchers to help shape our understanding of human behavior, starting with economists. Over a century ago, Veblen (1899) thus framed higher-class luxury consumption and leisure as signals of their status and/or wealth. The underlying logic and assumptions of economic signaling theory is the same as before (Spence, 1974), with honesty emerging from competition⁶ (and differential costs), providing economists with a framework for understanding costly behavior that is not immediately followed by material benefits.

Human prosocial behavior and its underlying motivations can be framed in this light. By definition, prosocial motivations push us to act towards the benefit of others, thus often paying a cost (time, money...) that is not immediately followed by benefits of the same nature. However, prosocial behavior may entail benefits of a social nature along the road, which can be captured by the concept of reputation (Sperber & Baumard, 2012). This paves the way for explaining certain prosocial behaviors and their underlying prosocial motivations, such as equitable sharing and equity (Debove, Baumard & André, 2017). Costly signals are themselves essential building-blocks in our understanding of the emergence of reputation and prosocial motivation in a specific context (Geoffroy, Baumard & André, 2019; André, 2010).

In the context of the internship, prosocial motivation was approached using costly social signals, whose purpose are to broadcast qualities which serve as bases for the establishment of social relations between individuals. Costly social signals will be evolutionarily stable if they are correlated with qualities which increase the fitness of members of the audience, who engage in social relations with signalers (Dessalles, 2014). For instance, if being acquainted with brave individuals increases one's fitness, then such individuals will be in demand, and displaying signals correlated with courage becomes a valid strategy, up to a certain cost.

4.3. Social signaling and high-cost prosocial behavior

Signaling competition can have non-linear effects, as individual decisions depend on decisions taken by all or several individuals, leading to the emergence of behavior at the collective level. Thus, unconstrained competition relations typically leads, at the collective level, to the emergence of a signaling "elite", which captures the lion's share of asymmetrical social

6 Which is a fundamental element of Darwin's (1851) theory of natural selection. Competition between signalers pushes them to signal at higher levels, up to the point where marginal gains and marginal costs cancel each other out, making their signals honest indications of their inner payoff structure – which is determined by their quality.

affiliations, and a "silent" majority (Dessalles, 2014). In such a context, individuals who are unable to attain the levels of the elite have nothing to gain from signaling and should theoretically refrain from doing so⁷. Real-world examples include the emergence of "saints" in rural Morocco (Gellner, 1969) or the emergence of individuals with thousands if not millions of followers inside each Twitter community (Kwak et al., 2010).

Competition for signaling can therefore lead to extreme costs. In some situations, bravery may even be signaled by strong risk-seeking behavior – so long as the associated costs (significantly higher death probability) are upset by even higher benefits (related to the social advantages of being a member of the "elite" in this situation). Thus, while bravery may be supported by genuine prosocial motivations (a genuine concern with the benefit of the group, to the point of risking one's life for it), prosociality and collective benefit are understood here as part of a bravery signal, not its explanation (Patton, 1996). [Thus understand underlying biological motivation to such behavior = enlightened self-interest ---> achieve higher social status]

In contrast, when social relations are constrained to be symmetrical, competition typically leads to generalized signaling, with individuals pairing up horizontally with individuals of similar quality (Chade, Jan & Smith, 2017). In such an example, one would expect benefits, and therefore signaling cost, to remain manageable. Real-world examples may include friendship, where the constraining symmetrizing factor is time spent together (Dessalles, 2014), or sexual pairing in grosbeaks and many other bird species, where care for offspring most often involves both parents (Cockburn, 2006).

Bon on meurt aussi avec le signal de grosbeak... mais bcp moins ??

4.4. Self-sacrifice: a two-tier social signaling model

In a context akin to intergroup conflict, one can imagine that commitment to the group would also be a socially in-demand quality. Betrayal by friends may for instance be a real possibility: in such a context, choosing friends who will not betray you for the enemy would be crucial (and correlate with your fitness), paving the way for costly signals intended to demonstrate such commitment, associated with achieving higher social status.

This explanation cannot hold for self-sacrifice as we have defined it, as death is assumed to be certain. Costs associated with self-sacrifice are too large; signalers would not survive to enjoy the advantages of their new status. Another hypothesis was thus added to the model studied during the internship: that social status be in part heritable for our species, as the high status of an individual can raise that of every member of his or her family (Service, 1971). More specifically, in a situation where self-sacrifice can be understood as a signal of one's commitment to the group, with high potential benefits which senders never enjoy, we hypothesize that these social benefits should (at least in part) spill over to members of their family. Seeing the

7 Somewhat similarly, gazelles or other prey who are unable to jump high enough (due to injury, their age...) should refrain from stotting, leading to segregation between signalers and non-signalers. Collective dynamics matter only however to the extent that stotting may depend on the behavior of other gazelles (as being the least fit gazelle in a group should also lead to not signaling), i. e. to the extent to which the audience should be understood as other gazelles, not the predator.

extreme nature of the costs envisioned, self-sacrifice can only be stable if it remains a low-frequency behavior (the fewer the heroes, the higher their status), pushing us to relate this hypothetical signal with unconstrained competition at a *global* level.

At a more *local* level, individuals have an incentive to advertise their commitment to the group in a less costly way, in order to form more symmetrical friendship bonds, as explained above. The idea is that for such individuals, the self-sacrifice of a group “hero” may constitute an opportunity: if such behavior is understood globally as demonstrative of commitment to the group, then costly behavior associated to a hero’s self-sacrifice may also be interpreted as such by potential friends. Thus, at a local level, individuals may signal their commitment to the group by *honoring* such fallen heroes, for instance by engaging in conspicuous ceremonies in their name, in order to attract friends.

If and when honoring emerges as an honest signal of one’s commitment to the group, **emitted by all who seek friends**, this may create the conditions necessary for self-sacrifice itself to emerge. In a situation of generalized honoring, the (artificial) social benefits associated with being a (rare) hero, which spill over to relatives (translate into actual social benefits), may be enough to compensate the extreme costs of self-sacrifice.

Kin selection ==> dans 3 deja ??

The research question investigated during this internship is thus: *in a biological population where social status is heritable⁸, engaged in a context akin to intergroup conflict, self-sacrifice and honoring may emerge as first-order and second-order signals of individuals’ commitment to the group.*

The explanation investigated during this internship thus involves a two-tier signaling model. Self-sacrifice and honoring are envisioned as first-order and second-order signals of commitment to the group, which cannot exist without one another, and which take on such meaning because of one another (honoring is intended to signal commitment by referring to self-sacrifice, thus making self-sacrifice a first-order signal of commitment).

[event. Para au-dessus dans persp ? / bof...]

Both patterns are expected to be *mutually reinforcing*. With respect to first-order signaling, potential individual benefits grow with the number of individuals engaged in second-order signaling (and their average level of signaling) – although, as mentioned above, we expect self-sacrifice to remain a minority behavior. Conversely, the higher the visibility of a first-order signal, the more one stands to gain by emitting a second-order signal based on it.

As with any signaling model, honesty at equilibrium is key. While this does not appear to be a problem with respect to self-sacrifice, seeing its irremediable nature, explaining why honoring should be an honest signal is crucial (~~without which people should stop paying attention to it, leading to its disappearance and the impossibility for self-sacrifice to emerge~~).

- idea = cf le gras : **need ref for commitment → ex mafia ?** => competition over

> // mutually exclusive...

Alternatively...

IDEA = COMMITMENT to the group ==> also irremediable ... if too costly ==> so need a lot of competition.

Another way of framing this = time = more costly for individuals who are not committed to the group => ...

+ il manque quoi ?????

https://www.jstor.org/stable/23252256?seq=1#page_scan_tab_contents

= Gavin Slade, mafia

+ ex from anthropology = ?

Reports of military and insurgent behavior, past and present, indeed suggest that the more adversarial the conditions combatants are facing, the more individuals’ survival prospects are inter-related, and the costlier are the signals of commitment and the actions undertaken (Atran 2010).

mieux outline les predictions ?? ou dans la partie methodes plutot, comme dans la pre-reg?

8 This hypothesis could be relaxed if one assumes that honoring focuses on an element shared by “heroes” and their relatives – such as their last name. This seemed like unnecessary hair-splitting however, as the fact that names are shared in a family (and bear status) is probably itself a reflection of the heritability of social status in our species.

RMQ : Zahavi presente signal comme alternative a group sel et kin.....

*quality that = in demand + specific
that increases audience's fitness*

audience

honest : competition (EMERGES)

*payoff variability // link between quality and cost
Social signaling provides robust explanations for a variety of prosocial
behaviors such as
competitive helping or overt food sharing (e.g. Bliege Bird & Smith, 2005).*

*As Patton (1996) puts it: "the underlying motivation of men to undertake the
somatically risky behaviors associated with warfare is not some form of group
altruism;
rather, it is a form of enlightened self-interest in which the benefits are
measured in terms of
personal status, which on average has led to reproductive advantage in the
environments of
our evolutionary past."
Social signaling offers an elegant explanation for extreme bravery (and,
correlatively, of
cowardice avoidance), as far as it is advantageous to be friend with such a
person (rather than
with a coward). Similarly, being acquainted with someone who is committed
behto the group is
expected to be desirable in situations of intergroup conflict.*