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 : « unvoluntary »???]

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 spraead 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 eventuellement 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 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…]

rites of terror...

revoir def prosociality si pas defini 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 phenomenons 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 bie nfixe 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 assumptions[4], 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 costly[5]. 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

[osef 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 competition[6] (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 & Andé, 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 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 so[7]. 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 to 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

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.

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.