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ARISTOTLE, SCIENCE AND THE DIALECTICIAN'S ACTIVITY

A DIALOGICAL APPROACH TO ARISTOTLE'S LOGIC

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Two independent events converged in Lille while I was just a third year student at the philosophy department. First, there was the *Prior Analytics* seminar in Fall 2011, co-organized by Michel Crubellier and Shahid Rahman, who was also teaching a course on dialogical logic. Then Göran Sundholm was invited to Lille in Spring 2012 to give a series of lectures on Per Martin-Löf’s Constructive Type Theory, which led me to take an Erasmus semester in Leiden the following year to study under his supervision. Ten years later, this dissertation reflects the crosspollination of these research programs and the influence of these three professors: the dialogical framework developed by Shahid Rahman, whose door is always open to students; the notation of Constructive Type Theory that Göran Sundholm brought to Lille together with his passion for the history of logical notions; and the study of Aristotle’s logical works, a subject I came to cherish by attending Michel Crubellier’s seminars and discussing the texts with him. I would like to express my most profound and heartfelt gratitude to all three professors, who have each in their own way shaped my way of thinking.

Since 2014, I have had the good fortune of participating in the STL reading seminars on the *De Anima* and the *Theaetetus*; these gave me a glimpse of the right way to study ancient texts while showing how fruitful and inspiring collaborative work can be. I would like to thank all the participants and organizers.

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Note. Being a woman, I have adopted in this dissertation the convention of using the masculine as default grammatical gender. Certain examples use the expression "white human," meaning a person who is "pale," in the sense of not tanned; this is a common example in Aristotle for referring to simple predication or to an accident of human beings (something that can be so or not so); it never had, neither today nor in Antiquity, any implied meaning. Finally, it is worth pointing out that any modification I make on a translation is explicated in a footnote, except for standardization of spelling and punctuation, such as the choice of "premise" implemented throughout the dissertation.

ARISTOTLE, SCIENCE AND THE DIALECTICIAN'S ACTIVITY
A dialogical approach to Aristotle's logic

Abstract

This dissertation develops a formal analysis of Aristotle's assertoric syllogistic that is historically and hermeneutically sensitive. It provides a modern dialogical logic that has the same *results* as Aristotle and that develops them in a way akin to Aristotle, providing an alternative to natural deduction approaches of syllogistic.

The main claim of the dissertation is that Aristotle's logic is best understood from a dialogical approach. It is backed by a historical approach of Aristotle's texts, providing a dialogical interpretation of his syllogistic and theory of scientific inquiry. This interpretation of syllogistic is then formalized in a dialogical framework, thus giving further support to the claim.

Keywords: logic, aristotle, dialectic, science, syllogistic, dialogues, dialogical logic

ARISTOTE, LA SCIENCE ET L'ACTIVITÉ DU DIALECTICIEN
Une approche dialogique de la logique d'Aristote

Résumé

Cette thèse développe une analyse formelle de la syllogistique assertorique d'Aristote selon une démarche historiquement et herméneutiquement fondée. Une logique dialogique moderne est proposée dans laquelle les résultats d'Aristote et sa manière d'y arriver sont reproduits, fournissant ainsi une alternative aux approches de la syllogistique fondées sur la déduction naturelle.

L'idée principale de cette thèse est que la logique d'Aristote se comprend au mieux avec une approche dialogique. Elle est soutenue par une démarche historique fournissant une interprétation dialogique de sa syllogistique et de sa théorie de l'enquête scientifique, à partir d'une étude de ses textes. Cette interprétation de la syllogistique est ensuite formalisée dans un cadre dialogique, lui fournissant ainsi un soutien supplémentaire.

Mots clés : logique, aristote, dialectique, science, syllogistique, dialogues, logique dialogique

RÉSUMÉ SUBSTANTIEL

Cette thèse est un travail en philosophie et en histoire de la logique. Une interprétation de la logique d'Aristote mettant l'accent sur le dialogue est présentée et justifiée à partir des textes d'Aristote, puis est formalisée dans le cadre moderne de la logique des dialogues. Il s'agit de défendre une certaine interprétation de la logique d'Aristote sans pour autant plaquer sur les textes une conception moderne de la logique, à savoir, en l'occurrence, une conception dialogique. Quatre chapitres mènent ce projet à bien. Un premier chapitre aborde le problème inhérent à l'interprétation d'une logique ancienne à partir d'un point de vue moderne et propose un mode opératoire pour réduire les biais d'interprétation susceptibles d'être introduits par une perspective moderne. Un second et un troisième chapitres développent une interprétation dialogique de la logique d'Aristote entendue au sens large, à savoir comme englobant la syllogistique, la dialectique, et la méthode d'enquête scientifique. Aucun de ces deux chapitres centraux ne fait usage de la logique moderne ; au contraire, il s'agit de soutenir l'interprétation à partir des textes et de leur contexte. Un quatrième et dernier chapitre procède à une analyse formelle de l'interprétation dialogique, afin de montrer que les principes de cette interprétation sont en accord avec les principes du cadre dialogique, et que celui-ci, par conséquent, est adapté pour formaliser la syllogistique assertorique d'Aristote. Cette formalisation dans le cadre dialogique constitue une alternative aux formalisations existantes de la syllogistique et permet de soutenir, par un appui extérieur, l'interprétation dialogique d'Aristote. Le tout forme une défense de l'approche dialogique de la logique aristotélicienne en particulier, et de la logique en général.

Chapitre 1

En ce qui concerne l'interprétation, la logique a souvent été considérée comme une discipline à part : alors que les autres disciplines devaient développer des méthodes permettant d'interpréter les textes (ou autres sources d'information) relevant de leur discipline en évitant d'introduire chemin faisant les préjugés de l'interprète dans

l'interprétation, la logique, réputée concerner la rationalité pure, atemporelle, devait avoir un accès direct à tout ce qui relevait de la logique. Aristote étant considéré comme le père de la logique, ayant produit une logique formelle notamment en ceci qu'il utilise des lettres indépendantes du contenu pouvant leur être substitué, sa logique peut, selon ce préjugé de logicien moderne, être directement comprise et évaluée à l'aune de la logique moderne, prétendument universelle et atemporelle. Le premier chapitre pointe l'importance, pour les logiciens abordant une logique ancienne, de se poser les questions d'interprétation des textes et de clarifier leurs propres présupposés logiques afin de déceler plus facilement des biais d'interprétation qu'ils introduiraient dans leur lecture des textes. Pour ce faire, différents biais introduits dans l'interprétation d'Aristote par une conception moderne de la logique sont soulignés.

La tâche des logiciens face à une logique ancienne comme celle d'Aristote consiste souvent à formaliser cette logique, c'est-à-dire à produire une logique moderne ayant les mêmes résultats que la logique ancienne. Différentes formalisations de la syllogistique assertorique d'Aristote ont été proposées, et les différences révèlent aussi différents choix interprétatifs liés aux principes mêmes de la logique moderne employée. En d'autres termes, le choix de logique moderne dans laquelle se fera la formalisation introduit des biais d'interprétation dans la lecture d'Aristote. Par exemple, la première formalisation moderne de la logique d'Aristote est celle de Jan Łukasiewicz, le premier logicien moderne (post-Frege) à considérer qu'Aristote était un bon logicien au vu de la logique moderne, qu'il avait une logique encore valable et méritant d'être étudiée. Pour montrer le mérite d'Aristote, Łukasiewicz a transposé tous les syllogismes aristotéliens dans une forme symbolique, mathématisée, utilisant la logique moderne des prédicats et des propositions. Ce faisant, il a interprété les syllogismes comme des implications, alors que la tradition les interprétait comme des inférences. Une implication est une proposition complexe, par exemple « *si* tous les cétacés respirent *et* que tous les animaux qui respirent sont vivipares, *alors* tous les cétacés sont vivipares ». Il s'agit là d'une seule phrase, qui ne dit rien des cétacés ou des vivipares, ne faisant que révéler la conséquence d'antécédents hypothétiques : *si* les cétacés sont ainsi, *alors* etc. Une inférence est tout autre : il s'agit, dans le cas des syllogismes, non pas d'une phrase mais d'au moins trois, chacune affirmant quelque chose. En prenant le même exemple, l'inférence serait « tous les cétacés respirent » à quoi on ajoute « tous les animaux qui respirent sont vivipares », permettant, à partir de ces deux affirmations, d'inférer que « tous les cétacés sont vivipares ». L'inférence nous donne des informations à chaque étape, alors que l'implication ne fait que signaler une *relation* entre les conditions de l'implication et ce qui est impliqué par ces conditions. Une des grandes caractéristiques de la formalisation de Łukasiewicz est d'interpréter les syllogismes comme implications et non comme inférences. On a par la suite rejeté un tel choix d'interprétation, mettant en évidence le fait que ce choix avait été dicté par le cadre logique axiomatique. D'autres formalisations, au contraire, ont interprété les syllogismes comme inférences, interprétation rendue possible par le choix d'une autre logique moderne. John Corcoran, par exemple, a formalisé la logique d'Aristote dans le cadre de la déduction naturelle employant plutôt des règles d'inférence que des axiomes. Les syllogismes ont alors été interprétés

comme des règles d'inférence, à savoir des règles autorisant le passage de prémisses à une conclusion. Beaucoup d'autres formalisations ont été proposées et certaines sont examinées dans le chapitre.

Le premier chapitre s'attache tout particulièrement à la distinction entre syntaxe et sémantique, qui se trouve au fondement de nombreux cadres logiques modernes, afin de montrer que le choix d'un cadre logique doit être justifié lorsqu'on aborde la logique d'Aristote : à défaut, des biais d'interprétation sont introduits, comme l'introduction dans Aristote d'une distinction syntaxe/sémantique qui lui est pourtant étrangère.

Ce premier chapitre est principalement méthodologique et négatif, il consiste à attirer l'attention sur les biais d'interprétation qui peuvent venir du fait qu'un logicien a déjà une logique en tête quand il aborde la logique d'Aristote et peut inconsciemment projeter sa propre logique dans Aristote. Ce chapitre est essentiel au projet de ma thèse, étant donné que le dernier chapitre développe une formalisation de la syllogistique dans le cadre moderne de la dialogique. Une mise en garde contre certains biais est donc de mise ; la thèse dans son ensemble vise à montrer qu'on peut faire ce travail de formalisation moderne de manière historiquement justifiée, en réduisant au maximum le genre de biais mentionné, notamment en prenant la précaution de séparer présentation et justification de l'interprétation d'Aristote (chapitres 2 à 3) de son analyse formelle dans un cadre moderne (chapitre 4).

Ainsi, les chapitres 2 à 3 sont historiques, soutenant une interprétation dialogique d'Aristote sans aucune référence à la logique moderne, n'ayant recours qu'à des arguments issus des textes et de leur contexte. Ces chapitres peuvent donc se lire sans aucune connaissance de la logique moderne. Le chapitre 4, en revanche, développe une formalisation de l'interprétation développée dans les chapitres centraux. Séparer ces deux temps, présentation et justification de l'interprétation d'une part, analyse formelle d'autre part, permet de ne pas justifier l'interprétation au moyen d'un outil extérieur à Aristote. Toutefois, l'interprétation et la formalisation sont complémentaires, au sens où les deux permettent de défendre (et illustrer, dans le cas d'Aristote) une approche dialogique de la logique en général, c'est-à-dire une conception de la logique reposant sur des fondements dialogiques.

Chapitre 2

Le chapitre 2 se concentre sur la syllogistique, généralement considérée comme ce qu'il y a de plus logique chez Aristote : elle a recours à des lettres schématiques et développe des preuves pour montrer que certaines structures d'argument sont nécessairement concluantes alors que d'autres ne le sont pas.

Les syllogismes sont des schémas d'argumentation ayant deux prémisses et une conclusion, comme dans l'exemple d'inférence donné plus haut. Ces trois propositions sont composées en tout de trois termes (« cétacé », « animal qui respire », « vivipare »), dont

un terme, le moyen terme, est commun aux deux prémisses et ne figure pas dans la conclusion (« animal qui respire »). C'est le moyen terme qui permet de justifier la nécessité de la conclusion. Chaque proposition (prémisse ou conclusion) est quantifiée selon une des quatre quantifications possibles : universelle affirmative (« tous les... sont... »), universelle négative (« aucun des... n'est... »), particulière affirmative (« certains des... sont... ») ou particulière négative (« certains des... ne sont pas... »). Les différentes positions possibles du moyen terme (sujet ou prédicat dans chacune des deux prémisses) engendrent les différentes figures du syllogisme, tandis que les quantificateurs engendrent les différents modes.

L'approche la plus répandue de la syllogistique est monologique, sans interaction visible : les syllogismes et les figures sont abordés sous l'angle d'une pure combinatoire sans lien avec la dialectique, comprise comme débat codifié entre deux partenaires, un questionneur et un répondant, qui était pratiquée à l'époque d'Aristote et qui fait l'objet des *Topiques*. La syllogistique, développée dans les chapitres 1 à 26 du premier livre des *Premiers analytiques*, et la dialectique (objet des *Topiques*) ont tendance à être séparées par les commentateurs, au point que certains ont dit que la découverte du syllogisme a rendu caduques les *Topiques*. Au contraire, ce travail soutient l'idée que la syllogistique des *Premiers analytiques* doit se lire en ayant en tête le contexte de la pratique des joutes dialectiques.

Pour établir ce lien, trois aspects de la logique d'Aristote sont étudiés et précisés ci-dessous : la signification de la quantification (*dictum de omni et de nullo*), les objections, et la détermination du contenu de ce dont on parle (*pont aux ânes*).

Au début des *Premiers analytiques*, Aristote fournit une règle, appelée *dictum de omni et de nullo*, qui stipule que la signification de la quantification universelle implique l'absence de contre-exemple. Par exemple, lorsque je dis « tous les cétacés sont vivipares », je m'engage à ce qu'on ne puisse pas apporter de contre-exemple, à savoir une instance du sujet (cétacé) qui ne serait pas en même temps une instance du prédicat (vivipare). La signification de la quantification universelle repose ainsi sur l'absence de contre-exemple, ce qui n'est pas le cas pour la quantification particulière. Lorsque je dis « certains cétacés sont des dauphins », je ne suis pas en train de dire que *tous* le sont, seulement que *certains* le sont : un cétacé qui ne serait pas un dauphin, comme une baleine, ne constitue pas une objection à cet énoncé particulier. Comme la syllogistique repose en grande partie sur la quantification, elle repose sur cette règle déterminant la signification de la quantification en terme de contre-exemples. Des travaux récents ont révélé les liens étroits unissant cette règle et une règle des joutes dialectiques énoncée dans les *Topiques*. Cette règle dialectique stipule que dans un débat, quand le questionneur a fait concéder au répondant plusieurs cas similaires, il a le droit d'exiger soit que le répondant concède l'universel, soit qu'il fournisse une objection. En d'autres termes, si le répondant accepte plusieurs cas particuliers et n'a pas de bonne raison de rejeter l'universel, il doit accepter cet universel. La parenté entre le *dictum* et cette règle dialectique est claire, et pointe vers une origine dialectique de la syllogistique.

Le *dictum de omni et de nullo* et la règle dialectique des *Topiques* reposent toutes deux sur la notion d'objection, et celle-ci implique la notion de charge de la preuve. Affirmer une proposition universelle quand on est capable de donner quelques exemples fait reposer la charge de la preuve sur l'autre, qui ne peut contester cet universel qu'en soulevant une objection, particulièrement un contre-exemple. Cette notion de charge de la preuve est constitutive de l'approche dialogique. Dans une approche monologique, soit la preuve n'est pas trouvée et la charge de la preuve repose entièrement sur qui mène l'enquête, soit la preuve est trouvée et la charge de la preuve n'existe plus du tout. En revanche, dans l'approche dialogique, impliquant toujours deux rôles antagonistes, la charge de la preuve est toujours présente : elle se trouve soit du côté d'un des interlocuteurs, soit du côté de l'autre, ou encore elle est partagée. Mais un bon argument ne fait pas disparaître, purement et simplement, la charge de la preuve : l'interlocuteur formulant l'argument se débarrasse de cette charge pour la faire reposer entièrement sur l'autre. Un bon argument est défini par l'impossibilité de produire une objection renversant de nouveau la charge de la preuve. C'est de cette manière qu'une interprétation dialogique du *sullogismos* est déterminée : le *sullogismos* est ce genre de bon argument inversant définitivement la charge de la preuve. Dans cette approche dialogique, le *sullogismos* est compris comme le moment dans un débat où un interlocuteur peut avancer une conclusion en sachant que, au vu de ce qui a déjà été posé, aucune objection levée contre cette conclusion ne tiendra. Autrement dit, c'est le moment où l'interlocuteur sait qu'il peut utiliser ce qui a déjà été posé, et cela seulement, pour détruire toute objection qui pourrait être levée contre la conclusion qu'il avance. Les « syllogismes » sont alors des formes codifiées de *sullogismos*. Ce sont des schémas de termes pour lesquels la conclusion suit nécessairement des prémisses, permettant de repérer plus facilement dans un argument ce qui suit nécessairement de ce qui a été dit ou, à l'inverse, ce qui doit être dit pour qu'une certaine conclusion s'ensuive nécessairement. Et cette nécessité se comprend comme le fait que les prémisses sont suffisantes pour rejeter toute objection pouvant être soulevée contre la conclusion, par exemple en montrant que toute personne levant une objection se trouvera en contradiction avec ce qu'elle avait déjà accepté dans les prémisses. Nécessité syllogistique et quantification s'expliquent ainsi en termes d'objection et de charge de la preuve. En défendant une approche dialogique de la logique d'Aristote, je soutiens que ces notions de charge de la preuve et d'objection permettent de mieux comprendre les *Premiers analytiques*, les *Topiques* et la *Rhétorique*. Ainsi, même dans la syllogistique, considérée comme son travail de logique pure, la notion de charge de la preuve, caractéristique de l'approche dialogique, est présente.

Enfin, il s'agit de reconnaître que les objections sont liées à la signification de ce qui est rejeté : pour rejeter que « tous les cétaqués sont vivipares » il faut trouver une instance de cétaqué qui ne soit pas vivipare, ce qui suppose de connaître ce que sont les cétaqués et ce que sont les animaux vivipares. Mais c'est tout particulièrement dans le *pont aux ânes* que se trouvent des indications quant à la présence des questions de contenu au sein même du projet syllogistique des *Premiers analytiques*. La logique d'Aristote est souvent abordée au travers du début du premier livre, sans qu'on aille guère au-delà du

chapitre 26. Cette lecture tronquée donne l'impression que la syllogistique est formelle dans le sens qu'elle serait indifférente quant au contenu des termes utilisés, impression renforcée par l'utilisation de lettres pouvant être remplacées par n'importe quel terme particulier. Toutefois, dans les chapitres 26–31, Aristote se demande comment effectivement trouver le moyen terme approprié à une conclusion, conclusion qui fait alors office de problème à résoudre. Par exemple, si le problème est de savoir si « tous les cétacés sont vivipares » ou non, ce problème sera résolu lorsqu'on aura trouvé un moyen terme en relation avec « cétacé » et avec « vivipare » selon un des modes syllogistiques repérés dans les chapitres précédents des *Premiers analytiques*. Pour ce faire, Aristote préconise dans le *pont aux ânes* d'établir des listes de termes. Ces listes sont de trois sortes : pour chaque terme de la conclusion (sujet ou prédicat), il s'agit de faire la liste des termes universellement prédiqués du sujet ou du prédicat, des termes desquels le sujet ou le prédicat sont universellement prédiqués, et des termes incompatibles avec le sujet ou le prédicat. Les trois listes de termes concernant le sujet sont alors comparées à celles concernant le prédicat, et s'il y a un terme commun, c'est un bon candidat pour le moyen terme. Toutefois, n'importe quel terme commun ne fera pas l'affaire : un terme qui se prédique universellement du prédicat et du sujet ne sera d'aucune utilité, comme « animal » pour « cétacé » et « vivipare », qui ne permettra pas de déduire la conclusion souhaitée, les prémisses étant trop générales. Affirmer que « tous les cétacés sont des animaux » et que « tous les vivipares sont des animaux » ne dit rien de nécessaire quant aux relations des vivipares et des cétacés. De même, un terme commun dans les deux listes d'incompatibilité ne sera d'aucune utilité : si « aucun cétacé n'est un insecte » et « aucun vivipare n'est un insecte », cela ne produira pas de conclusion nécessaire concernant les cétacés et les vivipares. En revanche, un terme commun se trouvant dans la liste des termes se prédiquant universellement du sujet et dont le prédicat se prédique universellement produira la conclusion voulue (et sera donc la solution du problème) : « tous les cétacés respirent de l'air » et « tous les animaux respirant de l'air sont vivipares », donc, nécessairement, « tous les cétacés sont vivipares ». Cet argument est le mode *Barbara* de la première figure du syllogisme : connaître la syllogistique permet de faire le tri dans les listes de termes pour ne repérer que les termes communs produisant une conclusion nécessaire. De cette manière, la syllogistique est un outil pour trouver et produire des arguments nécessaires concernant un problème donné (la conclusion à obtenir), et les listes du *pont aux ânes* indiquent que cette recherche d'argument passe par une étude précise de la signification des termes du problème afin de dégager les prédications universelles.

De nouveau, l'outil argumentatif décrit par Aristote repose sur la quantification universelle (ce qui se dit de tout ou d'aucun), qui elle-même est définie par la règle du *dictum de omni et de nullo* reposant sur la présence ou l'absence d'objections, posées comme caractéristiques de l'approche dialogique. Puisque la recherche d'objection et l'établissement de listes de prédication concernent le contenu spécifique de ce dont on parle, la syllogistique n'est pas détachée du contenu (aspect matériel). Ainsi, l'important n'est pas tant de trouver la position d'un moyen terme, c'est-à-dire le mode et la figure d'un argument, mais de trouver effectivement le moyen terme qui convient à tel problème

donné. Cette recherche ne va pas de soi, et demande une enquête quant à la nature du sujet en question.

Le *pont aux ânes* met l'accent sur l'analyse plutôt que la déduction : il s'agit de commencer à partir de la conclusion (qui est le problème à résoudre) pour, de là, trouver le moyen terme qui permettra de rendre la conclusion nécessaire une fois les prémisses posées. Cette analyse est tout à fait applicable dans le contexte de débats dialectiques : grâce à l'analyse, le questionneur peut anticiper ce qu'il faut demander pour amener le répondant à se contredire ou à soutenir une absurdité, puisqu'il partira de ce qui est opposé à la thèse du répondant et cherchera des moyens termes successifs permettant d'arriver nécessairement à cette position une fois les prémisses acceptées. La déduction est aussi applicable dans un contexte dialectique, puisque le sens déductif, allant des prémisses à la conclusion, permet de récapituler un argument lors d'un débat afin de bien montrer la nécessité de la conclusion à partir des prémisses déjà concédées. La syllogistique et le *pont aux ânes* sont deux outils dont la maîtrise contribue à l'excellence dans la pratique des débats dialectiques. En effet, les *Topiques* présentent, entre autres, des techniques pour faire admettre des prémisses plus facilement à son interlocuteur, mais encore faut-il savoir ce qu'il faut faire accepter à l'autre. C'est ce que permettent la syllogistique et le *pont aux ânes*. Ces différents éléments permettent de défendre l'idée que la logique d'Aristote doit se lire en ayant en tête le contexte des débats dialectiques.

Cette approche dialogique de la logique d'Aristote a cependant une limite, et cela concerne sa conception de la science, l'état cognitif le plus achevé, qui fait connaître ce qu'est la chose, qu'elle ne peut être autrement, et pourquoi elle est telle. En effet, la nécessité du simple *sullogismos* se trouve au niveau de l'argument, non au niveau des choses mêmes : la nécessité du *sullogismos* est définie par le fait que les prémisses qui ont été posées sont suffisantes pour rejeter toute objection contre la thèse, inversant de ce fait définitivement la charge de la preuve. Mais cette nécessité n'implique pas qu'il en aille nécessairement ainsi dans le monde, elle reste conditionnelle (nécessité de la conclusion au vu des prémisses posées) puisqu'elle concerne la conclusion *en tant que conclusion*, ce qui ne garantit pas que son contenu même soit nécessaire. Or, pour Aristote, la science est un savoir vrai et nécessaire des choses mêmes, où la pensée et son objet sont en adéquation (par opposition au simple discours, où tout peut être dit). La nécessité du *sullogismos* en général, telle qu'elle vient d'être définie, n'est pas suffisante pour garantir la nécessité ontologique de la conclusion. Pour garantir cette nécessité, Aristote dit qu'il faut procéder à une démonstration, à savoir un *sullogismos scientifique*, qui parte de prémisses vraies, premières, antérieures à la conclusion, mieux connues et causes de la conclusion. Alors que la causalité dans le simple *sullogismos* se situe au niveau du discours, celle dans le *sullogismos* scientifique va au-delà du discours, révélant la causalité des choses mêmes. Le problème pour une approche dialogique de la logique d'Aristote comprise en un sens large est qu'il distingue *sullogismos* scientifique et *sullogismos* dialectique. Le *sullogismos* dialectique part d'opinions admises, à savoir partagées par tout le monde ou un groupe, par tous les experts ou une partie d'entre eux. Ainsi, Aristote distingue argument scientifique et argument dialectique sur la base

des prémisses utilisées dans ces arguments. Une approche dialogique de la logique aristotélicienne, incluant la démarche scientifique, doit donc rendre compte de la distinction qu'Aristote fait entre arguments scientifique et dialectique. C'est l'objet du chapitre 3.

Chapitre 3

Ce chapitre propose une réponse au problème classique qui consiste à expliquer comment Aristote peut dire que la dialectique est utile à la science, alors qu'il distingue argument scientifique et argument dialectique.

Il s'agit tout d'abord de distinguer le contexte des débats concrets entre deux personnes, contexte qui est le plus ostensiblement dialectique, et la dialectique elle-même : certes, dans le cas de débats entre deux joueurs, un questionneur et un répondant, il ne fait aucun doute qu'il s'agit de dialectique ; mais la dialectique ne se réduit pas à ce contexte, et définir ce qu'elle est indépendamment de ce contexte est l'objet du chapitre.

Le contexte des joutes dialectiques ne convient pas pour mener une enquête scientifique : les arguments lors des joutes dialectiques sont orientés vers l'autre, l'interlocuteur, alors que les arguments scientifiques doivent être entièrement orientés vers le sujet en question, vers la chose même qui est à comprendre. Toutefois, l'*entraînement* aux joutes dialectiques permet de développer des capacités importantes pour l'enquête, comme la capacité à prévoir ce qui s'ensuit de certaines propositions, à repérer des petites différences, ou à faire des rapprochements, par exemple. Cet entraînement peut aussi développer un état d'esprit propice à l'enquête, puisqu'il permet de ne pas se sentir satisfait d'une opinion commune sur un problème donné, mais de toujours mettre cette opinion en question, chercher des objections ou des failles dans ce qui pourrait soutenir cette opinion, et envisager des réponses alternatives au problème. En plus de ces capacités et de cet état mental (dispositions) propices à l'enquête scientifique, la dialectique fournit tout un ensemble d'outils pouvant être décrits et donc enseignés, contrairement aux dispositions qui ne peuvent être acquises que par la pratique. Parmi ces outils se trouvent entre autres les suivants :

les catégories déterminent ce que c'est qu'être quelque chose, si c'est être en tant que substance, quantité, qualité, etc. Les catégories permettent de poser des questions à propos du sujet examiné et d'organiser sa pensée et son discours ;

la collecte des opinions permet d'établir des listes de ce qui se dit de quoi, comment, par qui ;

les prédicables déterminent comment ce qui est prédiqué est prédiqué du sujet, si c'est en tant que définition, genre, propre, accident : les chiens sont des animaux, mais que veut-on dire par là ? Prétend-on donner la définition des chiens, leur genre,

leur propre, ou simplement indiquer un accident des chiens? Les prédicables identifient des normes très générales concernant ce qui est dit;

les apories permettent de mettre différentes positions en conflit;

les lieux des *Topiques* permettent de produire des prémisses supplémentaires ou de tester des positions.

Ces outils sont maîtrisés grâce à l'entraînement dialectique et sont très utiles lors des débats, mais ils peuvent aussi être utiles dans la recherche scientifique, par exemple pour déterminer si l'infini existe et ce qu'il est (*Physique* III) ou si le lieu existe et ce qu'il est (*Physique* IV).

Les dispositions et les outils dialectiques acquis lors de l'entraînement sont utiles à l'enquête scientifique, et en cela la dialectique ne se réduit pas aux seuls débats : la dialectique est un ensemble de capacités et d'outils qui sont utiles à la fois pour les débats et pour l'enquête scientifique. Toutefois, si une telle compréhension de la dialectique peut justifier une approche dialogique de la logique aristotélicienne, il demeure que l'enquête scientifique n'est pas en elle-même dialectique : elle se sert de la dialectique sans être elle-même dialectique. Une telle position est raisonnable, et il serait tout à fait possible de conclure ainsi, auquel cas ce serait une approche dialogique de la logique d'Aristote entendue en un sens restreint, incluant seulement syllogistique et dialectique. Je propose cependant une définition de la dialectique qui permet d'identifier au sein de l'enquête scientifique une étape proprement dialectique.

La définition proposée est la suivante : la dialectique est un processus d'établissement progressif de l'extension adéquate de ce dont on parle (détermination du contenu) au moyen d'objections et de leur résolution. Cette définition de la dialectique repose sur la notion d'objection et sur la quantification universelle (déterminant des extensions), donc sur ce qui a été repéré auparavant comme étant fondamentalement dialogique. De plus, elle s'applique également aux débats dialectiques et à un certain stade de la recherche scientifique, à savoir le stade pré-causal de description précise du sujet dont on parle et des éléments qui lui sont connexes. Des exemples de ce stade pré-causal sont pris de *l'Histoire des animaux* afin de montrer qu'Aristote procède bien à ce genre d'enquête descriptive avant de procéder à un examen des causes des faits décrits. Il s'agit aussi de montrer que concevoir ce stade pré-causal comme étant dialectique permet d'expliquer l'origine des normes spécifiques à chaque science : c'est en examinant à fond le sujet étudié que des normes du champ disciplinaire émergent. On peut imaginer par exemple qu'en voyant que les cétacés vivent dans l'eau mais respirent de l'air, l'enquêteur doit reconnaître qu'il n'y a pas de lien direct entre les modes de vie des animaux (dans l'eau) et leurs organes (poumons), ce qui implique qu'en zoologie, la cause finale déterminant la fonction des organes est nécessaire : c'est pour respirer de l'air que les cétacés ont des poumons, donc on ne peut pas dire que les poissons ont des branchies parce qu'ils vivent dans l'eau.

Selon cette conception, la dialectique est nécessaire mais non suffisante à l'enquête scientifique. Elle s'applique à des contextes argumentatifs qui n'ont pas la forme ostensible de dialogues, tout en reposant sur des fondements dialogiques, à savoir la détermination du contenu de ce dont on parle au moyen d'objections et de leur résolution, comme c'est le cas aussi dans le *pont aux ânes* et la syllogistique des *Premiers analytiques*, ainsi que dans les *Topiques*. Ainsi, l'approche dialogique de la logique d'Aristote dans son ensemble (syllogistique, dialectique, et méthode scientifique) forme un tout cohérent s'appuyant sur les textes d'Aristote. Elle permet de comprendre Aristote de manière unifiée tout en répondant au problème classique de l'apparente opposition entre science et dialectique, qui, au final, n'est qu'une opposition entre un stade pré-causal de l'enquête scientifique, nécessaire mais non suffisant, et un stade causal, suffisant pour acquérir la science recherchée, mais qui requiert les résultats du stade pré-causal (il n'est donc pas auto-suffisant). Une fois cette interprétation dialogique de la logique d'Aristote présentée et justifiée, une analyse formelle de l'interprétation est menée dans le chapitre 4.

Chapitre 4

Le cadre logique adopté est celui de la logique des dialogues, une logique développée par Paul Lorenzen dans les années 1970 à Erlangen, développée et formalisée par son doctorant Kuno Lorenz, lequel a intégré des concepts de la théorie des jeux, et poursuivie par la suite dans différentes traditions plus ou moins proches du projet d'origine. Le cadre adopté est celui développé à Lille, sous la direction de Shahid Rahman, ancien étudiant de Lorenz poursuivant la logique des dialogues dans la lignée du projet d'origine, en particulier rapprochant le cadre dialogique et la théorie constructive des types de Per Martin-Löf. Le projet initial vise à établir les fondements dialogiques de l'arithmétique dans un cadre logique prenant la forme de dialogues. Ainsi, ce cadre est dialogique en deux sens : en prenant la forme de dialogues et en reposant sur des fondements dialogiques. Comme le projet d'origine visait les fondements de l'arithmétique et de la logique, les dialogues dont il s'agit sont moins des reproductions de dialogues empiriques que des outils permettant de mettre au jour les fondements en question. L'approche dialogique, dans son projet initial, visait à *fonder* les mathématiques et la logique et non à *décrire* des techniques d'argumentation ayant cours dans des discussions empiriques.

Le cadre dialogique repose ainsi sur des fondements de la logique par eux-mêmes dialogiques. La logique, selon cette approche, obéit à des principes pragmatistes en ce que, d'une part, toute proposition est énoncée par quelqu'un et n'existe pas indépendamment d'un locuteur, et, d'autre part, la signification de ce qui est dit ne peut être séparée de ce qui est fait en le disant, à savoir en s'engageant d'une certaine manière vis-à-vis de l'interlocuteur. Par exemple, en affirmant une proposition universelle, le locuteur s'engage à soutenir que le prédicat s'applique à l'instance du sujet choisi par tout interlocuteur. La signification est ainsi déterminée au travers de règles d'interac-

tion, et c'est cette interaction qui définit ce qui est signifié. Le niveau de signification visé est assez formel, puisque ce sont généralement les connecteurs logiques qui sont ainsi définis, et non les termes eux-mêmes. Il est aussi possible d'envisager des règles définissant la signification des termes, mais cela dépasse le cadre du présent travail.

Dans le cadre dialogique, les règles d'interaction définissent à la fois la signification des propositions ayant un connecteur logique (propositions complexes) et les coups permis au cours d'un dialogue. Des règles dites structurelles régissent les dialogues : comment ils commencent, se déroulent et s'arrêtent. Chaque dialogue commence par un joueur affirmant une thèse ; ce joueur est le proposant, tandis que l'autre joueur est l'opposant. Chaque joueur, à tour de rôle, lance un défi à l'autre ou répond à un défi, selon les règles d'interaction déterminées pour chaque connecteur logique. Progressivement, les possibilités d'action pour chaque joueur s'amenuisent, jusqu'à ce qu'un joueur ne puisse plus rien jouer à son tour. Ce joueur a perdu, tandis que l'autre a gagné. Dans la tradition de Lorenzen et Lorenz, les dialogues sont intentionnellement finis, et cela reflète le projet fondationnel de la dialogique : c'est grâce à ces dialogues, menés uniquement en suivant les règles pré-déterminées du jeu, que la notion de proposition est définie : une proposition est un énoncé qui engendre un dialogue qui se termine au bout d'un nombre fini de coups du fait qu'un joueur n'a plus de coups permis. La notion de proposition est ainsi fondée par la notion de dialogue (ou jeu), elle-même construite par un ensemble de règles d'interaction définissant ces dialogues et les coups permis au sein de ces dialogues. La signification des propositions, n'étant rien d'autre que les coups permis au sein des dialogues, trouve de cette manière, elle aussi, un fondement dialogique. Enfin, la notion de validité trouve un fondement dialogique en étant définie au travers de la notion de stratégie de victoire : une stratégie de victoire, pour le proposant, est sa capacité à gagner un dialogue quels que soient les choix de l'opposant. Une proposition est ainsi valide, dans le cadre dialogique, lorsque le proposant a une manière de gagner pour n'importe quel coup de l'opposant. Les grandes notions de la logique, proposition, signification, validité, ont ainsi un fondement dialogique.

Je montre dans la thèse que ces principes fondamentaux constituant le cadre dialogique se retrouvent dans la syllogistique assertorique d'Aristote. En effet, la signification de la quantification a été repérée dans la règle du *dictum de omni et de nullo*, qui définit cette signification comme l'impossibilité d'apporter de contre-exemple. Cela peut se traduire ainsi dans le cadre dialogique : lorsqu'un joueur affirme une proposition universelle affirmative (« tous les A sont B »), l'adversaire peut choisir une instance du sujet (il affirme alors que « a est une instance de A »), mettant de ce fait le premier joueur au défi d'affirmer que cette instance, que ce premier n'aura pas choisie, est bien une instance du prédicat (« a est une instance de B »). De plus, la notion de *sullogismos*, défini plus haut comme moment où un interlocuteur peut avancer une conclusion en sachant qu'aucune objection ne pourra tenir au vu des prémisses accordées, se situe à un niveau stratégique dans le sens dialogique, puisqu'il prend en compte *toute objection possible*, c'est-à-dire toute réaction de son interlocuteur. La syllogistique d'Aristote repose, selon les principes du cadre dialogique, sur des bases stratégiques, donc déterminant la validité ou non

d'une proposition (la conclusion) conditionnée par l'acceptation d'autres propositions (les prémisses). Enfin, la notion de proposition définie au travers d'un dialogue est un apport du cadre dialogique permettant d'allier signification pragmatiste et syllogisme stratégique. Ces dialogues ne sont toutefois pas hors de propos chez Aristote puisque la syllogistique repose sur des principes dialogiques permettant de régir, entre autres, les débats dialectiques. L'analyse de l'interprétation dialogique de la logique d'Aristote proposée fait ainsi ressortir une parenté entre les principes du cadre moderne et les principes de la syllogistique.

Tous les résultats qu'Aristote obtient dans sa syllogistique assertorique sont reproduits dans ma thèse dans le cadre dialogique à partir de ces principes dialogiques qui émergent de la pensée d'Aristote même. Les dialogues utilisés comme preuve des modes syllogistiques n'ont pas vocation à représenter des dialogues réels, mais à reproduire au sein de la syllogistique les principes dialogiques fondamentaux. Différents aspects de la syllogistique assertorique sont reproduits dans le cadre dialogique selon ces mêmes principes fondamentaux : la signification de la quantification, l'ecthèse, la réduction à la première figure et la réduction à l'impossible. Ces principes permettent ainsi de rendre compte de l'unité de la syllogistique assertorique aristotélicienne. De plus, dans l'annexe, les modes non concluants sont aussi examinés au moyen de dialogues afin de montrer que tous ces modes qu'Aristote repère comme non concluants le sont également dans le cadre dialogique.

L'analyse formelle de l'interprétation dialogique de la syllogistique permet de produire une formalisation moderne de cette logique dans un cadre dialogique. Cette formalisation soutient de manière indirecte l'interprétation dialogique d'Aristote en fournissant une alternative dialogique aux formalisations modernes de la syllogistique et en montrant qu'une grande unité apparaît dans les aspects disparates de la syllogistique lorsqu'on adopte une approche dialogique.

ARISTOTLE'S TEXTS: LIST OF ABBREVIATIONS

Title of the treatise	abbr.
<i>Categories</i>	<i>Cat.</i>
<i>De Interpretatione</i>	<i>DI</i>
<i>Prior Analytics</i>	<i>APr.</i>
<i>Posterior Analytics</i>	<i>APo.</i>
<i>Topics</i>	<i>Top.</i>
<i>Sophistical Refutations</i>	<i>SE</i>
<i>Rhetoric</i>	<i>Rhet.</i>
<i>Poetics</i>	<i>Poet.</i>
<i>Physics</i>	<i>Phys.</i>
<i>De Caelo</i>	<i>DC</i>
<i>On Generation and Corruption</i>	<i>GC</i>
<i>Meteorologica</i>	<i>Meteor.</i>
<i>De Anima</i>	<i>DA</i>
<i>On Respiration</i>	<i>Resp.</i>
<i>History of Animals</i>	<i>HA</i>
<i>Parts of Animals</i>	<i>PA</i>
<i>Generation of Animals</i>	<i>GA</i>
<i>De Incessu Animalium</i>	<i>IA</i>
<i>Metaphysics</i>	<i>Met.</i>
<i>Nicomachean Ethics</i>	<i>EN</i>
<i>Eudemian Ethics</i>	<i>EE</i>

Reference to the editions of the Greek texts quoted can be found in the bibliography at the end of the dissertation.

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GENERAL INTRODUCTION

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Overview of the dissertation

The aim of this dissertation is to produce a formal analysis of Aristotle's assertoric syllogistic that is historically and hermeneutically sensitive. The point is not to simply develop a logic that has the same *results* as Aristotle (mere formalization); it is also to develop these results in a way akin to Aristotle's own way of doing (historical sensitivity). Having the same results developed in a fashion similar to Aristotle's requires first understanding what Aristotle did. The main claim of the dissertation is that Aristotle's logic is best understood from a dialogical approach. However, as stressed in chapter 1, the chosen approach to logic has an impact on how logical texts are interpreted. Thus, it needs to be justified in relation to Aristotle's texts: when adopting a dialogical approach, it must be shown that such an approach is appropriate for understanding Aristotle's logic. This is the central task of this dissertation, carried

out in chapters 2 to 3, which argues for a dialogical approach to syllogistic but also to Aristotle's scientific inquiry, identifying a pre-causal, inherently dialectical stage in scientific inquiry. The relevance of this approach cannot be justified through modern considerations, which would risk misunderstanding Aristotle's point; it must be justified through the texts and their context alone, without imports from modern logic. Thus, no prior knowledge of modern logic is required in order to follow and assess the relevance of the dialogical interpretation of Aristotle's logic carried out in these two chapters. Once the dialogical interpretation has been unraveled and justified, it makes sense to formalize the assertoric syllogistic in a modern dialogical framework, which is done in chapter 4. This final chapter provides a unified framework based on pragmatist principles enabling a modern, formal rendering of Aristotle's syllogistic figures, their reduction to the first figure, *reductio ad absurdum*, and ecthesis, thus proving that everything Aristotle does can be done in the modern framework. In addition, in appendix A, all the cases in Aristotle's syllogistic that are not valid are shown to be invalid in the modern framework as well. In this fashion, a complete formalization of Aristotle's assertoric syllogistic is provided in a modern dialogical framework.

The idea defended in this dissertation, that Aristotle's logic is best approached from a dialogical perspective, is grounded in an interpretation of Aristotle's texts, in particular the *Analytics* in which his logic and conception of science are developed, and is supported by a modern formalization of assertoric syllogistic in a dialogical framework. As an overall consequence, the merits of the dialogical approach to logic in general will be highlighted.

Principles of the dialogical approach to logic

The conception of logic defended here is based on dialogues: reasoning is done through interaction, either outwardly when someone else is present with whom to interact through questions and answers (or challenges and defences) in order to produce an argument against or in favor of a certain idea, or inwardly when a person is not actually there to play the antagonist role, but that role is nonetheless played in one's own mind.¹ The two parties may have a common goal, for instance finding truth; nonetheless, their roles remain antagonistic during the exchange, just like using a two-man saw requires

¹This distinction between two interaction forms, outward or external dialogues and inward or internal dialogical interaction, has been discussed by Catarina Dutilh Novaes, most recently and at length in 2021.

antagonistic roles in order to cut a piece of wood. The idea is that reasoning always takes place as a form of interaction between antagonistic parties, even in one's own mind. There is empirical evidence for this, such as when trying to figure something out, one proceeds through questions and answers, or when trying to examine something, one proceeds by raising objections and trying to answer them. However, this approach is not first and foremost a description of empirical dialogues or arguments; rather, it relies mainly on considerations regarding the *foundations* of logic: logic is considered as something *built out of* interaction and not just that happens to be produced through it.² Under the dialogical conception of logic, interaction constitutes meaning and is governed by rules; these rules are norms made explicit, norms that are themselves produced through interaction – produced in a conceptual rather than an empirically generative sense. It is interaction regulated by common norms that produces meaning in language, and it is from the set of interaction rules explicating the meaning of what is said that logic emerges.

Example For instance, as will be argued in this dissertation, the meaning of universal quantification – “all of the *subject* are *predicate*,” e.g. “all of the cetacea are viviparous” – can be made explicit through the following rule: if I make a universally quantified claim in a discussion, then, for any instance of the subject that someone else may choose, I have the duty to state that this instance is also an instance of the predicate, *i.e.*, that the predicate applies to this instance. In other words, if I say in a discussion that “all cetacea are viviparous,” another participant may test this claim by bringing forth an instance of cetacean, e.g. dolphins, and I will be committed to saying that dolphins are viviparous. The meaning of universal quantification (“all of the *subject* are *predicate*”) thus resides in interaction, and is based on norms of conduct embodied in duties and rights: the others have the right to choose an instance of the subject, and I have the duty to commit to the claim that the predicate applies to the chosen instance. In this regard, logic, which emerges from the use of these meaning-defining interaction rules, rests on norms, in particular on deontic norms resulting in duties and rights. Under this dialogical approach, logic rests on ethics. What is more, meaning is constituted through interaction and the norms embedded in it which is a pragmatist “meaning as

²There are studies that focus more on the empirical side than on the foundational aspects. See for instance, in the dialogical tradition, the work of Dutilh Novaes (2013), or the pragma-dialectic project of Frans H. van Eemeren and Rob Grootendorst (1992). The dialogues in the Paul Lorenzen and Kuno Lorenz tradition are not taken straight out of the empirical world, but are a rational reconstruction of argumentation grounded in a dialogical approach to meaning and reasoning, and aim at better understanding these grounds (rather than empirical discourses).

use” conception of meaning.³

The universal quantification example is “formal” in the sense that it does not depend on the particular meaning of the subject and predicate involved: the same interaction rule holds for any subject and any predicate at all. Rules could be stipulated for the meaning of the terms themselves, such as what would count as cetacean, viviparous, uneven, or any other term.⁴ Such rules would however be specific for each term, bringing us to a material (or substantive) level of consideration which is a lower limit of logic regarding propositions⁵ – an upper limit being questions of validity, discussed below.

This dissertation adopts a dialogical approach to logic regarding two objects: ancient logic on the one hand, through a dialogical interpretation of Aristotle’s logic, and modern logic on the other, through a modern formalization of the proposed interpretation of Aristotle’s logic in a dialogical framework. Each of these two objects require specific methodological considerations. But first, a distinction between a particular logic and a logical framework must be made in order to understand the problems of method regarding the modern formalization of an ancient logic that intends to be historically sensitive: Aristotle’s assertoric syllogistic is a particular logic whose results can be equally expressed in different logical frameworks, based on different conceptions of logic; but all of the conceptions of logic are not equally close to Aristotle’s own conception of logic, so if the *results* can be equally expressed in various frameworks, the *way these results are produced* varies from one framework to another and can be closer or farther from the way Aristotle produced his own results. Since the way logical results are produced is also something that should be reproduced as best as possible in a formalization, the choice of the logical framework must be justified. What is more, since a framework imports with it a certain conception of logic, which orients the logician’s interpretation of Aristotle’s texts, it should be shown that the conception of logic imported with a framework can be grounded by an interpretation of the texts that does not make any

³Robert Brandom (1994, 2001) studies the meaning of terms in an inferentialist way, expounding on the principle of *meaning as use*; he develops the conception of meaning as “games of giving and asking for reasons,” which is close to the present dialogical approach – see Mathieu Marion (2010) for details on the link between Brandom’s inferentialism and Lorenzen and Lorenz’s dialogical framework.

⁴For rules at the material level, see for instance Shahid Rahman, Zoe McConaughy, et al. (2018, chapter 10).

⁵The passage from meaning in situations of utterance (singulars identified with the use of deictics) to meaning independent of the particular situation of utterance (individual schemas constructed out of particular tokens or actualizations) is examined by Lorenz (2010, pp. 71–79). In this paper, he argues that the other approaches to logic must take for granted two presuppositions when they deal with propositions, namely the *independence-presupposition* and the *individuation-presupposition* (Lorenz, 2010, p. 74); these two presuppositions are accounted for in the dialogical approach, providing a good reason for adopting such an approach to logic.

reference to modern logic. A unified conception of Aristotle's logic should thus emerge from the interpretation of the texts and correspond to the conception that underpins the chosen modern framework.

Chapter 1 examines the methodological difficulties of studying an ancient logic from a modern perspective and stresses the interpretation biases that a logical framework can introduce and which may go unnoticed if the choice of framework is not justified. A brief presentation of the dialogical framework will here be provided, stressing a few major differences with other frameworks.

The dialogical framework vs. other frameworks

The dialogical approach presented above stems from the work of Paul Lorenzen and Kuno Lorenz, originating in the Erlangen school whose program was developed by Wilhelm Kamlah and Lorenzen (1967).⁶ While the initial project has been pursued in various directions, Shahid Rahman and the Lille school furthered dialogical logic in the Lorenzen and Lorenz tradition, developing for instance the Immanent Reasoning framework used in this dissertation, which combines the dialogical framework with the technical notation of Per Martin-Löf's Constructive Type Theory.

Various studies have shown that the initial dialogical logic was not so much a particular logic than a logical *framework* in which a variety of logics could be developed, such as the original intuitionistic logic, classical logic, modal logic, to name but a few. Chapter 4 will develop assertoric syllogistic in this dialogical framework, thus adding one more logic that can be rendered in this framework. Among other logical frameworks are the model-theoretical and the proof-theoretical frameworks. We usually speak of proof-theoretical and model-theoretical *semantics* rather than frameworks. I will use the broader term "framework" to refer to a general way for propositions to be constituted, to have meaning, and for validity to arise. In this regard, speaking of semantics is reductive, as it does not account for the constitution of propositions, and can be misleading if it gives the idea that there is an accompanying syntax: in model-theory, the semantics presupposes a syntax that determines well-formed formulas (the semantics does not deal with the constitution of propositions); in proof-theory, the semantics is

⁶The main original texts of dialogical logic have been collected in Lorenzen and Lorenz (1978). Lorenz (2001) and Peter Schröder-Heister (2008) provide historical overviews of the beginning of dialogical logic, while Rahman and Laurent Keiff (2005) cover later developments.

also the syntax, since meaning is determined in terms of proof, which are constituted from rules that provide meaning as well as their use (speaking of a “semantics” should thus not give the impression that there is an underlying syntax).

Proof-theory has the same *meaning as use* principle as the dialogical approach, but, as we will see below, the dialogical framework separates the level of meaning from the level of proofs: meaning is determined by the rules (as in proof-theory), which determine how a game can be played; if a game about a given thesis can be played, that is, if after a finite number of moves a player has no rule-abiding option left, then the thesis is a proposition⁷; proofs, on the other hand, come from winning strategies, that is, from a birds-eye perspective on all the possible games (see below). Meaning and the constitution of propositions is fully determined at the level of individual games (*i.e.* the application of the rules), while proof is built out of all the possible applications of the rules at the level of strategies. The dialogical framework thus has affinities with proof-theory, but cannot be reduced to it.

The dialogical framework implements in a technical way the philosophical and foundational considerations presented as the “dialogical approach”. The technicalities allow logics to be fully developed in the framework, producing the same results as in other frameworks (such as the proof-theoretical or the model-theoretical frameworks) but on a different foundational basis, namely, on a dialogical and pragmatist basis. In particular, the technicalities account for the fact that the dialogical framework does not deal with empirical dialogues, though they take the form of dialogues between two players, the Proponent, referred to as *he* by convention, and the Opponent, referred to as *she*.⁸ A logical dialogue game is governed by explicit rules, such as the rules mentioned above defining the meaning of logical constants (such as universal quantification) through interaction, and rules regulating the course of the game, stipulating for instance that

⁷The finite character of dialogues is constitutive of the notion of proposition. The rules are made in such a way that their application progressively reduces the possibilities of the players until one has no possibility left (that player loses). Other traditions of dialogical logic, such as that of Walter Felscher (1985), admit infinite dialogues. This misses the fact that propositions are defined through dialogue-definiteness, to the effect that infinite dialogues would not be able to ground the notion of proposition in a dialogical setting. As stressed below, the Lorenzen and Lorenz tradition’s task is more foundational than empirical.

⁸A certain number of criticisms raised against dialogical logic in the Lorenzen and Lorenz tradition have overlooked the fact that the dialogical framework is more concerned with the foundation of logic than with a description of empirical discussions. As suggested by Rahman (n.d.), this confusion may stem from an apparent continuity between Lorenzen’s (1955) Operationist logic and his later dialogical logic, while the dialogical logic is more of a rupture with the previous work (which was indeed anchored in everyday life and actions). See for instance Wilfrid Hodges (2001) who often takes empirical implausibility as an objection against Lorenzen-style dialogues. The response of Erik C. W. Krabbe (2001, p. 37) is clear on the point that Lorenzen-style dialogues are not empirical dialogues.

the Proponent is the player who makes the first statement, that each player makes a move in turn (either challenging a previous move made by the other, or answering a challenge), and that after a finite number of moves the player who had the last word wins while the other loses. The relevant rules for syllogistic are provided in chapter 4; I will here simply outline how the dialogical framework recovers the key notion of validity through dialogical games.

The model-theoretical framework is based on the notions of model and truth, the meaning of a proposition being determined by its truth-values, with different possibilities constituting different models; in such a framework, the validity concerns propositions and is defined as truth of a proposition in all models. The proof-theoretical framework is based on the notion of proof, the meaning of a proposition being determined by what counts as a proof for it; in such a framework, validity refers to closed proofs, *i.e.*, proofs in which all the assumptions are called for by the application of the rules that allow building the proposition being proved.

As mentioned above, the dialogical framework is based on the notion of rights and duties, the meaning of a proposition being determined by what each participant in a discussion has the right or the duty to do – one party's right being also the other party's duty. In the dialogical framework, the notion of validity of a proposition is secured through the notion of winning strategy for the Proponent: the Proponent is capable of winning for any choice the Opponent may make. Being capable of winning requires a certain perspective on all the possible interaction that can take place during a game; this perspective is the strategic perspective, and it is based on individual games, in which actual choices are made, which is the perspective of games. Games are played according to the game rules, which define the interaction during the game as well as the meaning of what is being said. These games are finite, which ensures that the thesis is a proposition. Thus, after a finite number of moves following the rules of a game, it can be determined which player has won and which has lost (ensuring that the thesis is a proposition); if, for any choice the Opponent may make, the Proponent always has a way of winning a game about a given thesis, then he has a winning strategy, which is the dialogical equivalent for saying that the proposition is valid. The dialogical framework can thus produce the notion of validity out of meaning, which is determined by the rules of interaction, and dialogue-definiteness, which defines the notion of proposition. A *valid proposition*, in the dialogical framework, is a thesis that generates a game won by the Proponent (the thesis generates a dialogue and thus a *proposition*) and that can be won by the Proponent for any choice the Opponent may have (the Proponent has a

winning strategy, the proposition is thus *valid*).

Various logics can be developed in the same framework and they will share the same foundational principles (such as what meaning or validity are). The same logic (*e.g.*, intuitionistic logic) can be developed in different frameworks (*e.g.*, in a model-theoretical and a dialogical framework); in each framework, the same *results* will be obtained (the same propositions will be valid, the same invalid), but the logic will have different foundational principles: meaning will come from a truth-function in the model-theoretical framework, and from the rules of interaction in the dialogical framework; validity in the model-theoretical framework will come from truth in all models, while in the dialogical framework it will come from a winning strategy, which comes from a perspective taken on individual, meaning-providing interactive games.

As mentioned above, distinguishing a particular logic from the logical framework in which it is developed is an important preliminary for the whole project of this dissertation: since one of the key points is to provide a modern formalization of Aristotle's assertoric syllogistic that is historically sensitive, and since a particular logic like syllogistic can be developed in various logical frameworks with the same results but not the same principles, the choice of the logical framework will produce a formalization of syllogistic that has principles more or less close to the principles Aristotle himself used when developing his syllogistic. For instance, choosing a model-theoretical framework will import a distinction between syntax and semantics, a distinction which, as discussed in chapter 1, may be foreign to Aristotle's conception of language. On the other hand, as will be argued in this dissertation, choosing a dialogical framework allows staying close to the historical context of the practice of dialectical debates, a context very present in Aristotle's texts. What is more, certain features of the dialogical framework, such as the distinction between meaning and proof, can help the interpretation of Aristotle's texts, like determining what a *sullogismos* is, though this interpretation then has to be justified by resorting only to Aristotle's texts. The main claim of this dissertation is that the dialogical approach makes Aristotle's logic more understandable; as a consequence, the dialogical framework, whose foundations rest in the dialogical approach, can provide a formalization of Aristotle's assertoric syllogistic that yields the desired results, as in other frameworks, but also yields them in a way close to Aristotle's own. We will now turn to the dialogical approach in Aristotle's logic.

The dialogical approach to Aristotle's logic

Chapters 2 to 3 present and defend the idea that Aristotle's logic is best approached from a dialogical perspective. These chapters develop a dialogical interpretation of Aristotle's logic – encompassing syllogistic, dialectic, and scientific inquiry – without any reference to modern logic in order to justify this interpretation only through the texts and their contexts. Once the dialogical approach has been shown to be appropriate when dealing with Aristotle's logic, it is legitimate to choose the dialogical framework in order to formalize Aristotle's assertoric syllogistic, which is done in chapter 4.

In one sense, it is natural to adopt a dialogical approach to Aristotle's logic, since dialectical debates were common practice at the time and one of Aristotle's logical treatises, the *Topics*, explicitly deals with dialectic and constitutes a kind of handbook for the dialectician. But in another sense, this approach raises difficulties, since the syllogistic of the *Prior Analytics*, considered the most logical of his treatises, does not have a dialogical form; what is more, Aristotle himself clearly distinguishes dialectical and scientific arguments, and says that the *Prior Analytics* and the *Posterior Analytics* aim toward scientific knowledge. The traditional interpretation of Aristotle's logic thus tends to separate the context of dialectical debates from the context of syllogistic and of scientific research, adopting what can be called by contrast a monological approach in these last two domains.⁹

A dialogical approach to Aristotle's logic as a whole therefore needs to explain what is dialogical in syllogistic and in what sense scientific research can be dialogical when Aristotle distinguishes dialectical and scientific arguments. A dialogical approach to syllogistic is presented in chapter 2, while chapter 3 focuses on the relation between science and dialectic.

The monological approach to syllogistic focuses only on one aspect of syllogisms (and of the *sullogismos*), namely the premise-to-conclusion direction, and on a small portion of the *Prior Analytics* (the first twenty chapters of the first book); it is also primarily a syntactic conception of syllogistic. As shown in chapter 2, this is a restrictive interpretation of syllogistic. On the contrary, by showing how the meaning of quantified propositions, which constitute syllogisms, is determined in the *Prior Analytics* by the same rule found in dialectic and repeated several times in the *Topics*, a broader

⁹See the introduction to chapter 2 for the traditional interpretation and a distinction between monological and dialogical approaches.

conception of syllogistic is produced, including an analytic conclusion-to-premises interpretation used in particular in the *pons asinorum* (*Prior Analytics* I 26–31), in addition to the more syntactic premises-to-conclusion interpretation. The role objections have in the *Topics* and the *Prior Analytics* reveals a common basis for these two treatises, which, I argue, is what the dialogical approach is about: it puts the focus on objections and the switch of the burden of proof it produces, and stresses the recurring presence of these considerations throughout the *Prior Analytics*. Under the dialogical reading, syllogistic is intimately coupled with the rest of the *Prior Analytics*, which provides the means for actually using syllogistic, for instance in dialectical debates, but also in scientific contexts.

Chapter 3 starts by defusing a possible misunderstanding: the dialogical approach to Aristotle's logic does not mean that his logic is reduced to applications in dialectical debates. In particular, the context of dialectical debates is not suitable for scientific research. So, in what sense is Aristotle's conception of scientific research dialogical? In this chapter, I argue in favor of a scientific use of dialectic that does not take the form of debates but that mobilizes tools and capacities developed through dialectical training. Dialectic in scientific inquiry is however not limited to tools and capacities: there is a stage in scientific inquiry that is of a dialectical nature in the sense that it requires what is done in dialectic, and that doing it is doing what is done in dialectic. This supposes defining the function of dialectic independently from its application in the context of debates. A certain definition of dialectic is proposed to this end: a content-determining inquiry circumscribing the adequate extensions of the subjects under investigation and proceeding through the identification of coextensive and incompatible terms. I will argue that this is the fundamental function of dialectic, and that dialectical debates make a certain use of this function (towards victory over the opponent), while the context of scientific inquiry makes another use of it (towards an adequate description of the subject at hand), a use that involves divisions, the *pons asinorum*, syllogistic, as well as other dialectical tools. Under this reading, dialectic in science takes the form of pre-causal investigations, which aim at producing an adequate description of the subject matter at hand. The adequate description is a difficult task, as can be seen in the *History of Animals*; a comparison with Plato's *Laches* will stress the dialectical nature of the description task. This task is dialogical in the sense established in chapter 2, which is characterized by the task of raising objections and trying to reject them: finding an appropriate description requires looking for counterexamples that will progressively allow a proper definition of the subject at hand. Adequate descriptions enable causal

problems to emerge and find solutions, as in the *Parts of Animals* or *Generation of Animals*, to name but the two major biological treatises that provide causal explanations to facts identified in the *History of Animals*. The passage from description (primary and true predication) to causal explanation is a theme of *Posterior Analytics* II, as well as the *pons asinorum* of the *Prior Analytics*.

The dialogical approach to Aristotle's logic in general, that is, to syllogistic, dialectic, and scientific inquiry, provides a reading of the logical treatises unified by the dialectical context, which can take the form of debates or of (pre-causal) scientific inquiry. It puts the focus on objections and their rejection, understanding a *sullogismos* as the moment in an argument where one knows no objection against the conclusion will hold, provided was has already been posited.

The dissertation in context

Defending a dialogical approach of Aristotle's logic by putting an accent on dialectic is not new. Christian August Brandis (1835, *e.g.* p. 258) argues in favor of a priority of the *Topics* over the *Analytics* (the latter presupposing the presentation of arguments in the former); Ernst Kapp (1942, pp. 83–86) recapitulates his idea that syllogisms and induction in the *Organon* are considered as ways of teaching and learning, which introduces a conversational context between two persons (questioner and respondent, or teacher and disciple) and gives the *Topics* an important role; Eric Weil (1951) considers syllogistic to be but a pre-requisite for dialectic. The role of the *Topics* in Aristotle's scientific work has been re-evaluated since the "biological turn" of the 1970s (see *e.g.* Robert Bolton, 1990, p. 186); and works such as those of G. E. L. Owen (collected in 1986) or Terence Irwin (1988) have insisted on the dialectical character of Aristotle's philosophy as a whole. More recently, Michel Crubellier (2011, 2014b) has insisted on the dialectical context of the *Organon*. These are but a few landmarks in the modern defenses of Aristotle's dialectic, which include other, no less important contributions such as Jean Marie Le Blond ([1939] 1973), J. D. G. Evans (1977), Suzanne Mansion (1961a), among others. A dialogical approach to Aristotle's logic, scientific work, and philosophy has thus been proposed on many occasions, and many more than the few mentioned here.

However, these studies have not been coupled with a modern formalization endeavor. This means that the formalizations of syllogistic currently available do not stem from

a dialogical interpretation of Aristotle's logic. Though a modern formalization is not an argument in favor of this or that interpretation, it acts as an external warrant for the interpretation formalized. Thus, when facing competing interpretations, the fact that one of them can be formalized while the other cannot plays in favor of the formalizable interpretation and against the other. In providing a dialogical interpretation of Aristotle's logic and a formalization of it in a modern dialogical framework, the dialogical approach to Aristotle gains weight and can concurrence the currently accepted formalization of John Corcoran (1972) and Timothy Smiley (1973), which are not dialogical.

An overview of the history of modern formalizations of assertoric syllogistic is provided in chapter 1, together with considerations regarding the method of formalizing an ancient logic. The dialogical interpretation of Aristotle's logic is developed in chapters 2 to 3, and the formalization of assertoric syllogistic under this interpretation is provided in chapter 4 with *ecthesis*, indirect deduction, and reductions to the first figure, and is extended in appendix A by showing that the invalid moods in Aristotle's syllogistic are also invalid in the dialogical framework.

The result is a comprehensive dialogical approach to Aristotle's logic – understood as encompassing syllogistic, dialectic, and scientific inquiry – whose assertoric syllogistic can be formalized in a dialogical framework. The overall aim of this dissertation is thus to better understand Aristotle's logic and promote a dialogical approach to logic in general, including modern logic.

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CHAPTER 1

INTERPRETATION BIASES OF MODERN STANDPOINTS ON ARISTOTLE'S LOGIC

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Introduction

This dissertation develops a dialogical interpretation of Aristotle’s logic from a historical point of view (chapters 2 to 3) and from a modern logical point of view (chapter 4). The work as a whole intends to show how modern formalizations can help understand an ancient logic. However, in logic as in any other field, there is a danger of circularity when approaching ancient texts: a modern scholar may argue that Aristotle’s texts should be interpreted in a certain fashion, without noticing that this interpretation stems from the scholar’s own modern standpoint on the subject at hand. In other words, the danger consists in seeing in Aristotle what one has oneself put, and by arguing that Aristotle’s conception on the subject was so and so, give historical justification for one’s modern standpoint. This is a classical problem of hermeneutics.

I will not tackle the hermeneutic problem in general, but I will insist on the fact that, contrary to what has long been believed, this problem does apply in the realm of logic and should be acknowledged when studying ancient logics, and all the more when trying to formalize such a logic in a modern logical framework. Thus, modern logicians who try to formalize Aristotle’s logic in a modern logical framework should proceed with caution in their endeavor, lest their modern conception of logic unconsciously influences their interpretation of Aristotle’s texts. If we take the dilemma proposed by Alasdair MacIntyre (1984, p. 31), quoted on footnote 8 on page 24, according to which philosophies of the past are either transmuted “so as to make them relevant to our contemporary problems and enterprises,” or are read so much in their own terms that they are like “museum pieces,” then it is clear that logicians who try to provide a modern

formalization of Aristotle's logic risk falling in the first horn of the dilemma: in wanting to produce a modern rendering of syllogistic, they risk inadvertently transmuting Aristotle's logic in a way that fits their needs. As we will see in section 1.2, this dilemma was already set out by Vittorio Sainati (1968) with respect to Aristotle's logic. He argued, like MacIntyre, that one *could* read ancient philosophies without necessarily falling prey to one of the two horns, and he developed an interpretation of Aristotle's logic using the genetic reconstruction methods of Jaeger, an interpretation that also used modern logical formalizations. Similarly, Kurt Ebbinghaus (1964) was aware of the problem and he developed, in line with the program of the school of Erlangen, a reconstruction of Aristotle's assertoric syllogistic in Lorenzen's (1955) operationist framework that was also historically sensitive, insisting on the heuristic aspect of such an endeavor.

Though I agree with the common idea that it is probably impossible to develop a completely faithful interpretation of an ancient text, in the sense of an interpretation absolutely free from any modern bias or preconception, this dissertation makes the wager, with Sainati, Ebbinghaus, but also Jan Łukasiewicz and Corcoran, that, if it cannot be entirely deleted, the circularity problem can at least be substantially reduced. I will follow the method that Mathieu Marion (2013, 2020) adapts from MacIntyre's (1984) work for the purpose of modern approaches to ancient logics, and which insists on the fact that one needs to be aware of the circularity problem, make one's preconceptions as explicit as possible, and justify the proposed interpretation of Aristotle's logic *in his own context*.¹ This chapter will deal with the need to acknowledge the circularity problem when formalizing ancient logics and in this regard will mostly be cautionary, pointing out various biases in the history of modern formalizations of Aristotle's assertoric syllogistic; it will also highlight important steps in this history and how logicians have struggled with this problem when propounding their own formalization. In order to make the preconceptions regarding logic as explicit as possible and justify the proposed dialogical interpretation of Aristotle's logic through his own context (and not through modern logical considerations), the exposition of the interpretation will be separated from that of the modern formalization. The dialogical interpretation of Aristotle's logic will thus first be presented in chapters 2 to 3 and defended without any recourse to modern logic in order to avoid justifying it through modern arguments and conceptions. On the contrary, special care will be taken in order to ground the interpretation in

¹See also the criticisms Ernst Kapp raises against commentators of ancient logical texts: "There is only one indispensable requirement: we must have learned to explain a given classic passage from a given classic context, instead of trying to explain it by simply substituting traditional modern notions for original old ones" (Kapp, 1942, p. 21; see also p. 74). This chapter stresses the fact that this criticism is as topical as ever.

the context of Aristotle's work and the broader intellectual context of the time. This interpretation will then be formalized in chapter 4. Separating the exposition of the interpretation from the formalization is a tool for reducing the circularity problem pointed out.

In this chapter, a brief history of the modern formalizations of Aristotle's assertoric syllogistic will first be sketched in section 1.1. Next, in section 1.2, the problem of interpreting an ancient logic from a modern logical perspective will be approached by presenting Łukasiewicz's pioneering work and the objections Sainati raised against it. Then, the problem will be taken anew in section 1.3, focusing on methodological comments made by Ebbinghaus, Corcoran and Claude Imbert. Finally, a few bias cases will be considered in section 1.4, in particular regarding the syntax-semantics distinction common in many modern frameworks.

1.1 A short history of modern formalizations of Aristotle's assertoric syllogistic

Logic has long enjoyed a privileged status in the history of philosophy: while it is common practice in other fields to be wary of one's modern preconceptions on the subject, to the effect that one should try to understand ancient authors only from their texts and their own historical context, there has been an understanding that logic was different, that there was only one universal and invariant logic, so that if Aristotle was a "good logician," his logic would have to reflect it. However, this very conception of logic as invariant rules out the possibility of various logics, be they coexisting or succeeding one another in time, so that the "correct" conception of logic (still under the hypothesis it is invariant) necessarily is the current one at the time of speech: Aristotle is then considered a "good" logician only if his logic meets the current standards of logic, whatever these may be.² Thus, with this conception of logic as invariant, modern logicians could approach Aristotle's logic with a certain preconception of what Aristotle's logic was supposed to be, since there was but one logic, namely the modern logician's own. For instance, as discussed below, Bertrand Russell considered Aristotle not to be a good logician, while Łukasiewicz considered Aristotle's logic to be

²It is the rise of a pluralist conception of logic, in which many logics coexist and can be formulated in various logical frameworks, that allows looking at Aristotle's logic as a logic among many, a logic that can thus be studied in its idiosyncrasies, rather than a logic that is to be judged according to current, supposedly universal, standards.

CHAPTER 2

SYLLOGISTIC AND DIALECTIC

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Introduction

The core of Aristotle's logic lies in the theory of the various figures of the *sullogismos* developed in *Prior Analytics* I 1–26, called syllogistic; it is often understood together with its application in the axiomatic method of demonstration (scientific *sullogismos*) of *Posterior Analytics* I. The question however remains open as to how this syllogistic relates to the rest of the *Organon*: is the syllogistic of *Prior Analytics* I 1–26 a self-standing logic, an extension of it being the theory of the scientific *sullogismos* (demonstration) of *Posterior Analytics* I? Or is syllogistic just an important step in a larger conception of logic?

The first approach, which considers syllogistic as the high point of Aristotle's *Organon* – either in its purely logical aspect in the *Prior Analytics* or in the role it plays in constituting the scientific method of demonstration in the *Posterior Analytics* – has generally been the dominant interpretation of the *Organon*.¹ Reducing logic to syllogistic is indeed common in modern approaches, which focus on the part of the *Organon* that can most easily be formalized, while reading the *Organon* as oriented towards the theory of demonstration has been institutionalized by the Neoplatonic curriculum (see below), and can be traced back at least to the edition of the Aristotelian corpus by Andronicus of Rhodes who more or less gave the *Organon* the form we now know.

The second approach, which will be defended in this dissertation, has been adopted for just as long as the first, yet without becoming predominant: it insists on the context of dialectical debates, which is the focus of the *Topics*, and understands syllogistic in this context rather than on its own, or as solely being oriented towards (a certain conception of) scientific demonstration. More recently, the work of Kapp (1942) has promoted this more dialogical approach to Aristotle's logic, influencing Ebbinghaus' approach discussed in chapter 1 and Marion and Helge Rückert's approach discussed in section 2.3.1. Even with the steady rise of interest for the *Topics* and dialectic in Aristotle's scientific work since the 1970s, Aristotle's logic is still predominated by the first approach, which can be called monological in contrast to the dialogical approach.

Reviewing the Neoplatonic curriculum, as well as the way this curriculum is based on

¹See for instance Wolfgang Detel's opening lines: "Aristotle's logic and theory of science have been handed down to us in two texts that are nowadays called *Prior Analytics* and *Posterior Analytics*, respectively" (Detel, 2006, p. 245).

Andronicus' editorial work (first century BCE²), and then comparing them both with an alternative interpretation that gives more place to the *Topics*, will provide an example of the two diverging approaches to Aristotle's *Organon* as well as an illustration of the issues at stake when adopting one approach over the other. This chapter will argue in favor of the second (dialogical) approach by insisting that it does not exclude the first (monological) approach but rather fully integrates it.

The monological and the dialogical approaches to Aristotle's logic

The Neoplatonist curriculum

The Neoplatonist school was founded by Plotinus (third century CE), in which the practice of exegesis of Aristotle's and Plato's texts took a central place (Philippe Hoffmann, 2006, p. 597). The philosophical curriculum culminated in the study of Plato (the "great mysteries"), prepared by a prior study of Aristotle (the "small mysteries") which started with the logical writings of the *Organon* in a didactic and systematic order that followed Andronicus of Rhodes' editorial work: first the *Categories*, then the *De Interpretatione*, then the *Prior Analytics* and the *Posterior Analytics* (Hoffmann, 2006, pp. 597 & 601 & 605–606 & 612). The study of logic thus culminates in the *Posterior Analytics*, the treatise dealing specifically with scientific knowledge (*episteme*), which is secured through demonstration (*apodeixis*), i.e., a scientific deduction (*sullogismos epistemonikos*). When studying philosophy, Aristotle's logic came first, and it was conceived as the studying of an instrument of thought oriented towards scientific knowledge. Since scientific knowledge requires mastering a special kind of deduction (*sullogismos*), the study of demonstrations should be preceded by the study of deduction (*sullogismos*) in general, the object of the *Prior Analytics*. Thus, the study of the *Posterior Analytics* requires the previous study of the *Prior Analytics*. In turn, the *Prior Analytics* require some previous study: deduction in general (*sullogismos*) being a combination of propositions, the study of deductions should be preceded by the study of propositions, which is the object of the *De Interpretatione*. And propositions being a combination of terms, these should be studied only after having studied terms without composition, the object of the *Categories*. The analysis of scientific deduction, the main object of the *Posterior Analytics*, thus produces a curriculum for approaching Aristotle's logic provided in table 2.1 on the following page.

²See Andrea Falcon (2017) for difficulties in giving precise dates.

Table 2.1: The order of the *Organon* as a curriculum for studying Aristotle's logic

1	Start with the <i>Categories</i> , which are concerned with terms without composition;
2	then proceed with the <i>De Interpretatione</i> , concerned with propositions, <i>i.e.</i> , terms combined together;
3	continue with the <i>Prior Analytics</i> , concerned with deductions in general (<i>sullogismos</i>), <i>i.e.</i> , propositions combined together;
4	one can then study the <i>Posterior Analytics</i> , concerned with a special kind of deduction, <i>scientific</i> deduction (<i>sullogismos</i>), <i>i.e.</i> , demonstration (<i>apodeixis</i>), whose possession secures scientific knowledge (<i>episteme</i>).

5	There exists however another kind of specialized deduction (<i>sullogismos</i>), namely, <i>dialectic</i> deduction; its possession does not provide scientific knowledge but a looser form of knowledge since it is only probable knowledge, which depends on opinions held by the many or the knowledgeable. This kind of deduction is the object of the <i>Topics</i> and the <i>Sophistical Refutations</i> , treatises that can easily be considered as a fifth wheel when approaching the <i>Organon</i> from the perspective of scientific knowledge.
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The traditional (Neoplatonist) conception of Aristotelian logic thus has two essential ingredients: 1) it is oriented towards scientific knowledge (the *Posterior Analytics*), so that logic is a tool for mastering scientific reasoning and thus securing true and necessary knowledge; 2) it is systematically organized from the study of the elementary parts of discourse to the more complex parts (from the *Categories* to the *Posterior Analytics*). These two ingredients result in casting discredit upon the dialectical kind of deduction and the corresponding treatises, to wit, the *Topics* and the *Sophistical Refutations*. The divide between the two kinds of deductions – scientific (*Posterior Analytics*) and dialectical (*Topics*) – is exacerbated by the focus of the *Organon* on scientific knowledge (first ingredient) and the systematical order (second ingredient). Such a conception of Aristotelian logic was probably shared by Andronicus of Rhodes and is still widely spread today. W. D. Ross for instance has clearly stated the resulting prejudice against the *Topics* when he said that Aristotle “has himself shown a better way, the way of science; it is his own *Analytics* that has made his *Topics* out of date” (Ross, 1995, p. 57). More recently, this view has been held for instance by Richard Bodéüs: “On s’entend aujourd’hui et depuis longtemps sur le fait que la théorie du syllogisme et de la démonstration scientifique constitue en somme le noyau dur de la « logique » aristotélicienne³ ” (Bodéüs, 2002, p. 21). However, it is not clear to what extent this

³“We agree today and since a long time on the fact that the theory of syllogism and scientific demonstration forms the core of the Aristotelian ‘logic.’”

conception was shared by Aristotle himself.

Logic as a discipline is a concept of Stoic origin

The traditional conception of Aristotelian logic built on these two ingredients (a focus on scientific knowledge and a systematic ordering of the treatises), and, for that matter, any other conception of Aristotelian logic, presuppose that there indeed exists something that can be called *Aristotle's logic*. Yet, speaking of *a logic* as a discipline is due to Stoic influence on the commentators: Aristotle himself does not refer to a “logic” that he would have developed; the closest mention to a logic as a discipline is when he speaks of his “analytics”⁴ :

parler d'une « logique » aristotélicienne expose à plusieurs malentendus. Celui qu'implique l'anachronisme est sans doute le moindre. Car c'est aux stoïciens, encore une fois, que l'on doit, comme chacun sait, l'usage du mot pour désigner la science du langage rationnel, incluant aussi bien la grammaire que l'étude du raisonnement syllogistique. On ne peut rétrospectivement prêter à Aristote cet usage.⁵ (Bodéüs, 2002, pp. 19–20)

⁴“Aristotle never uses the term ‘logic’ in the sense given by Neoplatonist commentators, that is, in the sense of a discipline that would deal with the rules of discourse and, more precisely, as said in the passage from Ammonius quoted above, of scientific discourse. The designation ‘logic’ comes from the commentators. [...] Of course, the adjective *logikos* is not unknown to Aristotle; but he uses it, under its adjectival form or its adverbial form *logikôs*, in order to indicate an approach that is formal in the sense that it does not restrict itself to the perspective of a science, but grounds itself on the analysis of terms and ways of speaking. We can thus often translate *logikôs* by ‘dialectically,’ this adverb taking sometimes a pejorative hue, as in the famous ‘*logikôs kai kenôs*’ applied to the Platonic Ideas – ‘speaking of it is speaking only in a logical and empty way’ *Eudemian Ethics* I 8, 121b21” “Aristote n’emploie jamais le terme « logique » au sens que lui donnent les commentateurs néo-platoniciens, c’est-à-dire au sens d’une discipline qui s’occuperait des règles du discours, et, plus précisément, comme le dit le passage d’Ammonius cité plus haut, du discours scientifique. L’appellation de « logique » est le fait des commentateurs. [...] L’adjectif *logikos* n’est évidemment pas inconnu d’Aristote, mais il l’emploie, sous sa forme adjectivale ou sous sa forme adverbiale *logikôs*, pour indiquer une démarche formelle en ce qu’elle ne se cantonne pas dans la perspective d’une science, mais se fonde sur l’analyse des termes et des manières de parler. Ainsi peut-on souvent traduire *logikôs* par « dialectiquement », cet adverbe prenant parfois une teinte péjorative, comme dans les fameux « *logikôs kai kenôs* » appliqué aux Idées platoniciennes – « en parler c’est parler seulement d’une manière logique et vide » *Éthique à Eudème* I, 8, 1217b21” (Pierre Pellegrin, 2007, pp. 15–16). Michel Crubellier (2014a) however argues that in *Top.* I 14 (105b14–25), the term *logikos* is used neither in a pejorative way, as in the *logikôs kai kenôs* expression, nor as a way for determining domains as the Stoics do; rather, it refers to the way in which what is talked about is approached in the discussion: the discussion can be taken as dealing with the nature of things, and the premises will be physical, or as dealing with arguments, and they will be logical, or, third possibility mentioned by Aristotle, it can be taken as dealing with the attitude people should have regarding what is being talked about, and the premise will be ethical.

⁵“[...] Speaking of an Aristotelian ‘logic’ exposes to various misunderstandings. The one that involves anachronism is probably the least of them. For it is to the Stoics, once again, that we owe, as is well known, the use of the word [‘logic’] to refer to the science of rational language, including grammar as well as the

Pierre Pellegrin (2007) argues, against Bodéüs (1995, repeated in 2002), that it is not because logic as a discipline was introduced by the Stoics that one cannot speak of an Aristotelian logic. To make his case, Pellegrin recalls the two opposite philosophical stances regarding the nature of logic: there is the stance that harks back to the Stoics and that considers logic as a part of philosophy, *i.e.*, as a science, and there is the stance, attributed to Aristotle, that considers logic as an instrument for any science, without itself being a science. Thus, the ancient scholars, even before Andronicus, would have started speaking of Aristotle’s logic under the influence of the Stoic philosophy, but would have only imported the *term*, not the Stoic conception of logic: speaking of a logic as an instrument and not as a science goes against the Stoic tripartition of philosophy into logic, physics, and ethic.⁶ The conception of logic as an instrument would be a way of distinguishing Aristotle’s logic from the prevailing Stoic logic.⁷ Thus, Pellegrin’s thesis is that by developing the doctrine of logic as an instrument, the Aristotelians could use the Stoic notion of logic as a discipline and speak of “Aristotle’s logic,” while immediately neutralizing the Stoic import by making this “logic” an instrument and not a science.

The editorial work of Andronicus of Rhodes (1st century BCE)

The Aristotelian corpus as we know it today was more or less established by Andronicus of Rhodes, the head of the Aristotelian school in the first century BCE,⁸ and found its final state around the fourth century CE (Pellegrin, 2007, pp. 25 & 37). Andronicus is credited with having organized Aristotle’s logical texts into a unity called the *Organon*,

study of syllogistic reasoning. We cannot retrospectively attribute this use to Aristotle.”

⁶It is however worth noticing that Aristotle makes a seemingly similar tripartition in *Topics* I 14, 105b20–21, when distinguishing the various kinds of premise or proposition (*protasis*); however, the *logikos* mentioned in this passage does not mean *logic* as in the Stoic conception of logic.

⁷“I am ready to accept that the first of these two facts – attributing a ‘logic’ to Aristotle – is due to a Stoic influence, but the second – making it an ‘instrument’ – then appears as a sort of corrective for this stoicisation of Aristotelianism: if the ‘logic’ is an instrument, it is not a part of philosophy, and the stoicisation we just talked about remains purely verbal.” “*Je suis tout à fait prêt à admettre que le premier de ces deux faits – attribuer une « logique » à Aristote – est dû à une influence stoïcienne, mais le second – en faire un « instrument » – apparaît alors comme une sorte de correctif à cette stoïcisation de l’aristotélisme : si la « logique » est un instrument, elle n’est pas une partie de la philosophie, et la stoïcisation dont on vient de parler reste purement verbale*” (Pellegrin, 2007, p. 30).

⁸It is not clear whether this school was located in Rome or in Athens (Myrto Hatzimichali, 2016, p. 85), and the exact date is not known, as Falcon notes: “According to one line of reasoning, [Andronicus’] activity is to be dated to the 60s (H. B. Gottschalk, 1987, pp. 1095–1096) or even to the late 70s (Paul Moraux, 1973, pp. 5–55). According to another, it should be dated after Cicero’s death (44 BCE), and most likely in the 30s (Ingemar Düring, 1957, pp. 420–425)” (Falcon, 2017, consulted in Jul. 2020).

which he placed at the very beginning of the *Corpus*.⁹

In his capacity as pinacographer, the value of Andronicus' contribution lies in presenting a holistic picture of the corpus that demonstrated Aristotle's credentials as a systematic philosopher in the face of the highly organized Stoic system. [...] His task was not to claim originality (he may have left many treatises just as he found them), but to adopt the format he judged to be closest to Aristotle's intentions and impose it consistently throughout the corpus. (Myrto Hatzimichali, 2016, p. 98)

Andronicus shared the conception of logic as instrument, which may explain why he put the *Organon* at the head of the Aristotelian corpus (Pellegrin, 2007, p. 26–27): since logic is the instrument for the sciences and other arts, it should be mastered first, and therefore naturally stands at the beginning. It thus appears that Andronicus' conception of logic – as an instrument rather than a science – has a direct influence on his editorial work.¹⁰ What is more, organizing the *Organon* into a progressive and systematical order towards scientific knowledge – *Categories*, *De Interpretatione*, *Prior Analytics*, *Posterior Analytics*, *Topics*, *Sophistical Refutations* – separates the *Categories* from the *Topics*. This is already interpretation. Other traditions consider the *Categories* to be an introduction to the *Topics*, which can more easily accommodate the last six chapters of the *Categories* (on the post-predicamenta), since these chapters link well with the *Topics* and thus with probable rather than scientific knowledge (Crubellier and Pellegrin, 2007, pp. 57–59). Andronicus' interpretative tradition separating the *Categories* from the *Topics* tends to consider these six chapters as unauthentic.¹¹ Andronicus' conception of logic has

⁹Hatzimichali thus describes Andronicus' editorial work: "What Andronicus *did not* do was to provide an authoritative text by writing out a fresh copy of the entire corpus or by entering corrections on existing copies. The absence of such a 'standard edition' led to the even-handed discussion of variants by second-century commentators and left Galen with allegedly poor copies of Aristotelian texts which he sought to improve" (Hatzimichali, 2016, pp. 98–99).

¹⁰See Javier Teixidor, who quotes Brunschwig (1991): "As is well known, the *Organon* refers to the collection of Aristotle's logical works, but we should remember that the traditional order in which the treatises are presented answer the need to systematize the philosopher's thought after his death. It is less grounded on his indications than on 'doctrinal and pedagogical considerations that translate the need to systematize the thought of the Stagirite.'" "*L'Organon désigne, comme il est bien connu, la collection des œuvres de logique d'Aristote, mais il faut se rappeler que l'ordre traditionnel dans lequel sont présentés les traités répond au souci de systématiser la pensée du philosophe après sa mort. Il est fondé moins sur ses indications que sur « les considérations doctrinales et pédagogiques qui traduisent le souci de systématiser la pensée du Stagirite »*" (Teixidor, 2002, p. 21).

¹¹"If we want to understand what the *Categories* really are, at least in their author's mind, we probably have to extract them from the *Organon's* framework in which they have been inserted, possibly by Andronicus of Rhodes. If what has later been called Aristotelian 'logic' does indeed proceed from the study of terms to that of the syllogism, scientific as well as dialectic, then the role of the *Categories* is

bearing on his editorial work.¹²

Signs that the dialogical approach has pre-Andronician origins

The importance of these choices (and the underlying conception of logic that motivated them) can be seen when comparing Andronicus' editorial work with the pre-andronician list of logical texts (Pellegrin, 2007, pp. 28–34). Before Andronicus' editing, the logic of the probable was the main focus of the logical texts and the logic of the true was only a specific part of the logic of the probable, applying certain restrictive conditions to it (Pellegrin, 2007, pp. 35–37).¹³ Andronicus' editing made the logic of the true central, and made the logic of the probable a wider, looser approach to logic.

Pour le dire en un mot, l'intervention d'Andronicos de Rhodes a avant tout consisté à réduire la part de la dialectique au profit de l'analytique. La

indeed to open this study, and their last part – the post-predicaments – is at best useless. It seems that, to restore the *Categories*' initial character, we thus have to extract them from this 'logical' environment in which they have later been inserted, and bring them closer to the *Topics*, that is, to the dialectical part of the *Organon*." "Si l'on veut comprendre ce que sont réellement les Catégories, du moins dans l'intention de leur auteur, il faut sans doute les dégager du cadre de l'*Organon* dans lequel elles ont été insérées, peut-être par Andronicos de Rhodes. Si ce que l'on a plus tard appelé la « logique » aristotélicienne va bien de l'étude des termes à celle du syllogisme, tant scientifique que dialectique, le rôle des Catégories est bien d'ouvrir cette étude, et leur dernière partie – les post-prédicaments – est au mieux inutile. Il semble que pour restaurer la figure première des Catégories, il faille donc les arracher à cet environnement « logique » dans lequel elles ont été insérées plus tard, et les rapprocher des *Topiques*, c'est-à-dire de la partie dialectique de l'*Organon*" (Crubellier and Pellegrin, 2007, p. 66).

¹²It is probably impossible to determine what comes first: a conception of logic or an interpretation of Aristotle's logic. Both probably come together, which shows how inextricable the problem of separating one's own logical convictions from the interpretation of the texts is. This is a fundamental hermeneutical problem; if it is well recognized in historical studies, it has not been taken up much in logic, and it was the purpose of chapter 1 to point out the difficulties specific to the field of logic.

¹³"We would very well imagine an Aristotelian syllogistic that would develop first and foremost on the basis of a codification of a dialectical confrontation such as we find it is in the *Topics* and the *Sophistical Refutations*. The scientific syllogism would then be a particular form of the general syllogism that would have additional constraints, at least two: having true premises, prior to the conclusion and better known than it, and provide with the middle term the cause of the conclusion. Andronicus preferred imposing on the *Organon* a principle of internal organisation that is in a way axiological: the scientific syllogism, instrument of science – that is, of philosophy in its true sense – since it is nobler than its brother dialectic – we should actually say its 'father' – becomes the pivot of Aristotelian logic." "On pourrait fort bien imaginer une syllogistique aristotélicienne qui se développerait d'abord et principalement sur la base d'une codification de l'affrontement dialectique telle que nous la trouvons dans les *Topiques* et les *Réfutations sophistiques*. Le syllogisme scientifique serait alors une forme particulière du syllogisme en général qui aurait des contraintes supplémentaires, au moins au nombre de deux : avoir des prémisses vraies, antérieures à la conclusion et plus connues qu'elle, et donner dans le moyen terme la cause de la conclusion. Andronicos a préféré imposer à l'*Organon* un principe d'organisation interne en quelque sorte axiologique : le syllogisme scientifique, instrument de la science, c'est-à-dire de la philosophie au sens vrai, comme il est plus digne que son frère – il faudrait, en fait, dire « son père » – dialectique devient le pivot de la logique aristotélicienne" (Pellegrin, 2007, p. 37).

« logique » d'Aristote, qu'il n'appelait peut-être pas ainsi mais qui reçut très rapidement ce nom sans doute sous l'influence de la division stoïcienne de la philosophie, était avant Andronicos principalement un ensemble de traités consacrés à des activités dialectiques et notamment réfutatives. Dans la conception aristotélicienne de la science, un « organon » dont le propos principal est dialectique n'est évidemment pas complètement coupé du savoir scientifique ; mais les liens entre la science et l'*Organon* sont incomparablement plus forts quand le centre de gravité de l'*Organon* devient le syllogisme scientifique. De plus cette réorganisation éditoriale aux conséquences théoriques fortes n'est nullement contraire à l'aristotélisme.¹⁴ (Pellegrin, 2007, p. 35)

The tension between the monological and the dialogical approaches mentioned above has thus accompanied the interpretation of Aristotle's logic since very early on: the editorial work of Andronicus of Rhodes and its institutionalization through the Neoplatonist curriculum have made the monological approach the standard one, while the dialogical approach stressing the importance of the dialectical context has only persisted in a marginal way.

Outline of the two chapters on Aristotle's logic

This chapter will present both approaches to Aristotle's assertoric syllogistic: first, the monological approach, which is the traditional way of approaching his logic; then the dialectical approach. This will be done by exposing the syllogistic's dialogical roots and by showing both how the syllogistic of the monological approach is but a step fully integrated in a larger dialogical approach that takes all of the *Prior Analytics* into account (rather than just the chapters 1–26 of the first book) and how the dialogical approach ties this treatise to the other treatises of the *Organon* rather than just the first book of the *Posterior Analytics*. The interpretation proposed of what a *sullogismos* is will thus be set in a dialectical context. Chapter 3 will then pursue the dialogical approach to Aristotle's logic by reconsidering a traditional problem, namely how dialectic can be

¹⁴“To put it in a nutshell, Andronicus of Rhodes' intervention has consisted above all in reducing the dialectical part in favor of the analytic. The Aristotelian 'logic,' that he may not have called thus but that received very soon this name probably under the influence of the Stoic division of philosophy, being prior to Andronicus principally a set of treatises devoted to dialectical activities and in particular refutative. In the Aristotelian conception of science, an 'organon' whose principal purpose is dialectical is evidently not completely separated from scientific knowledge; but the links between the science and the *Organon* are incomparably stronger when the *Organon's* center of gravity becomes the scientific syllogism. What is more, this editorial reorganization that has strong scientific consequences is far from being contrary to aristotelianism.”

useful in scientific inquiry. Chapter 2 will argue for a dialogical no-counterexample interpretation of the *sullogismos* that integrates the traditional monological interpretation of “syllogisms.” Chapter 3 will argue for a conception of dialectic that plays a crucial role (albeit not sufficient) in scientific inquiry, showing that both Aristotle’s syllogistic (*Prior Analytics*) and his theory of science (*Posterior Analytics*) can be understood through the dialogical approach.

2.1 The *sullogismos* from the monological and the dialogical approaches

Various passages of the *Prior Analytics* will be successively examined in order to provide an outline of the purpose of the *Prior Analytics* and of the related definition of *sullogismos* (section 2.1.1). The main lines of the monological and the dialogical approaches to syllogistic will then be presented in section 2.1.2. The monological approach will then be further developed in section 2.2, before turning to the dialogical one in section 2.3.

2.1.1 The purpose of the *Prior Analytics* and the definitions of the *sullogismos*

The opening lines of the *Prior Analytics* provide an outline of the inquiry to pursue which puts *apodeixis* (demonstration) to the fore, suggesting that the treatise will deal with this kind of *sullogismos*. Since the *Posterior Analytics* provides a theory of demonstration (see *APo.* I 2 for instance), this outline suggests that the *Prior* and the *Posterior Analytics* form a unity organized around the notion of *apodeixis* (demonstration).

We must first state what our inquiry is about and what its object is, saying that it is about demonstration and that its object is demonstrative science. Next, we must determine what a premise is, what a term is, and what a deduction is, and what sort of deduction is perfect and what sort imperfect; and after these things, what it is for something to be or not be in something as a whole, and what we mean by “to be predicated of every” or

Πρῶτον εἰπεῖν περὶ τί καὶ τίνος ἐστὶν ἡ σκέψις, ὅτι περὶ ἀπόδειξιν καὶ ἐπιστήμης ἀποδεικτικῆς· εἶτα διορίσαι τί ἐστὶ πρότασις καὶ τί ὄρος καὶ τί συλλογισμὸς, καὶ ποῖος τέλειος καὶ ποῖος ἀτελής, μετὰ δὲ ταῦτα τί τὸ ἐν ὅλῳ εἶναι ἢ μὴ εἶναι τότε τῷδε, καὶ τί λέγομεν τὸ κατὰ παντὸς ἢ μηδενὸς κατηγορεῖσθαι.

CHAPTER 3

SCIENCE AND THE DIALECTICIAN'S ACTIVITY

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Introduction

A case was made in chapter 2 for reading Aristotle's logic with the context of dialectical debates in mind. A major problem regarding this dialogical approach is however left standing: since Aristotle explicitly distinguishes dialectical and scientific arguments, how can an interpretation that insists on the dialectical roots of his logic account for science and demonstrations (scientific arguments)? Chapter 3 aims at solving this problem. First, in section 3.1, the problem itself, which is traditional (see for instance Weil, 1951), will be presented. It will be argued in particular that "one-on-one dialectical debates," *i.e.*, actual debates between two parties (the questioner and the answerer) directly discussing a thesis and ending in the victory of one over the other, are not suited for scientific inquiries. However, as developed in sections 3.2 to 3.4, dialectic should not be reduced, as it often is, to the context of one-on-one dialectical debates between a questioner and an answerer, even though that context most explicitly showcases dialectic. Another dimension of dialectic should also be considered: while one-on-one dialectical debates focus on winning against a particular adversary defending a thesis in a certain way, a broader use of dialectic considers *any possible* way an adversary can defend the thesis and tries to win against all of these possible variations. Such a broader use of dialectic is present, for instance, in Plato's dialogues when the characters start the inquiry anew, since another argumentative path is then followed, giving a richer idea of the whole problem. It is also present in Aristotle's scientific works when he strengthens some of his predecessors' arguments in order to be able to refute them even if they had argued differently: Aristotle's refutation

is not against this or that predecessor (*ad hominem* argument), but against the theses themselves, whoever the theses' champions may be (*ad argumentum* argument).

There are not two dialectics, but two different perspectives on the use of dialectic: it can be used in debates against one particular interlocutor, or it can be used in a more general context of inquiry, which focuses on the thesis and the argument rather than on how one person may happen to defend the thesis and build the argument, and thus tries to develop arguments that cannot be destroyed *at all*, regardless of the possible interlocutor. I argue in this chapter that this more general context of inquiry is scientific in the sense of searching for truth. In this regard, scientific inquiry uses dialectic in this broader perspective that does not focus on one particular opponent. The broader use of dialectic is not as explicitly dialogical as the paradigmatic context of one-on-one dialectical debates; it is however dialogical in the sense that it requires the same tools and capacities used in one-on-one debates, which are therefore called dialectical tools and capacities and are acquired through dialectical training in one-on-one debates; and it stems from the practice of individual debates in the sense that it takes into account *any possible* variation on a thesis.

Understanding the scientific use of dialectic requires focusing on the training: how dialectical training transforms the person who undergoes it; how it builds a certain disposition (*hexis*) towards opinions, a disposition necessary for scientific inquiry; how various capacities are developed, such as being able to foresee consequences of propositions; how the mind needs to be prepared for seeing the truth, and how this preparation in part requires appropriate dispositions of the mind, and in part requires tools developed in dialectical training such as collections of opinions, *aporiai*, *topoi*, predicables, categories, and divisions. Dialectical training also prepares the mind for the broader (scientific) use of dialectic, just like training with individual chess games prepares the mind for playing simultaneous games (see section 3.3.1 for this analogy). Under this reading, dialectical training is required for scientific inquiries by providing appropriate thinking habits that do not stop at a first result or difficulty, as well as tools and practices that will allow one to examine properly the subject at hand and determine *what it is*; this is a necessary albeit insufficient pre-demonstrative stage of the scientific inquiry, which ends when the causal relations are exposed in a demonstrative stage.

CHAPTER 4

SYLLOGISTIC IN THE IMMANENT REASONING FRAMEWORK

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Introduction

The modern formalizations of Aristotle's syllogistic discussed in chapter 1 take an interpretation of syllogistic in the lines of the premise-to-conclusion interpretation presented in section 2.2.1. Sections 2.3.1 to 2.3.3 argued in favor of an alternative interpretation, which understands syllogisms as the point in a discussion where a conclusion can be advanced knowing that, given what has been previously said, no objection raised against it will hold – in other words, given what has been said, the conclusion necessarily follows. This alternative interpretation reads the syllogisms of the *Prior Analytics* in the context of dialectical debates prevalent in the *Topics*. Chapter 3 argued that there is a dialectical context of inquiry in which pre-demonstrative scientific inquiries can, and must, take place; since this dialectical context was shown not to be one-on-one dialectical debates, all dialectical contexts are not reducible to opinion (as in one-on-one debates), they can also establish truth. Thus, reading syllogisms in a dialectical context is not reductive, in the sense that it would reduce syllogisms to matters of opinion; rather, it ties syllogisms to the roots of inquiries for truth, where the process of inquiry can hardly be dissociated from its content, from its substantive aspect. The no-counterexample interpretation of the *dictum de omni* – providing the explanation of the meaning of quantified statements – on the one hand and the procedure of *ecthesis*

implementing the *dictum*, *i.e.*, the rules determining this meaning, on the other allow to bridge the gap between formal syllogisms using schematic place-holders and the substantive aspect of inquiry. Indeed, through the recapitulation interpretation, the *dictum de omni*, and *ecthesis*, syllogisms are tied to objections: *the conclusion of a syllogism necessarily holds given the premises* means that no objection against the conclusion can hold provided these premises, which is ensured through the fact that the meaning of the premises is explained through objections, which are checked through the ecthetic procedure of setting out an instance and thus reasoning on an instance – *i.e.*, on a substantive case.

The interpretation of syllogisms based on the no-counterexample interpretation of the *dictum de omni* and its implementation through *ecthesis* (section 2.3.1) is thus complementary with the interpretation of syllogisms as recapitulations of a discussion (section 2.3.3) – *i.e.*, the point where one can state a conclusion knowing that from what has been said, no objection will hold. The traditional premise-to-conclusion interpretation of syllogisms (which focuses on *Prior Analytics* I 4–26, see section 2.2.1) is not incompatible with what can be called the no-counterexample dialogical interpretation of syllogisms developed in sections 2.3.1 to 2.3.3, on the condition that the premise-to-conclusion interpretation is understood as one perspective on syllogisms among other, more fundamental, perspectives, so that the premise-to-conclusion perspective has but a little scope – a preparatory scope as suggested by Crubellier (2017) quoted on page 144.

The dialogical no-counterexample interpretation of syllogistic will here be formalized using the modern dialogical framework called Immanent Reasoning; this will give weight to the claim that such an interpretation is logically sound. The Immanent Reasoning framework is a dialogical framework in the Lorenzen and Lorenz tradition that integrates the notation of Martin-Löf's Constructive Type Theory (CTT). The framework has been developed in Rahman, Zoe McConaughey, et al. (2018). Since it is a logical *framework*, various different logics can be produced in it, such as assertoric syllogistic, which will be this chapter's task. The advantages of this framework for formalizing the interpretation of syllogistic defended in chapters 2 to 3 is that it has 1) a dialogical structure, 2) a rule-based approach to meaning, 3) the means to explicit the instances implicit in subject-predicate statements, 4) an exhaustive method, and 5) a seamless structure going from validity (strategy level) to propositions (play level) and content (material level).

- 1) **The dialogical structure** The logic is carried out in plays, *i.e.*, debates between two parties who endorse the role of proponent – defending a statement called the thesis – or of opponent. This structure is parallel to the dialogical context of one-on-one dialectical debates with the answerer who must defend a thesis and the questioner who challenges it. However, the recapitulation interpretation of syllogisms entails that it is the proponent whose role is parallel to that of the questioner and the opponent whose role is parallel to that of the answerer: the dialogical plays for syllogisms start when in the dialectical debate the questioner has arrived at the point of *sullogismos* – he can bring the conclusion forward knowing that, from what has been said, no objection will hold; the answerer can then raise objections but in the end, if it was a genuine *sullogismos* (as syllogisms are), he will have to concede defeat, just like in the dialogical play the opponent can carry out all the moves she wishes (following the game rules) she will end up losing when the thesis is a syllogism. The dialogical structure of the Immanent Reasoning framework thus reflects the recapitulation interpretation of the *sullogismos* and the rooting of syllogistic in a dialectical context. It should be noted that this recapitulation interpretation separates the interaction embedded in the recapitulation of the argument from the interaction constituting the debate: during the recapitulation, the players are focusing on the argument, making sure no objection against it may hold. It is thus not the normal question and answer debate or everyday discussion, which focuses on the subject matter at hand, not on a particular argument.
- 2) **A rule-based approach** The dialogical plays are defined through game rules, specifying the interaction that can take place between the players and how the play starts, ends, and so on. The meaning of the quantified statements is defined through interaction rules (the particle rules, see section 4.2); this reflects the interpretation of the *dictum de omni* as explaining the meaning of the universal statements through a rule – namely, that for the universals no counterexample can be found.
- 3) **Expliciting instances** The Immanent Reasoning framework uses CTT which can explicit the instances hidden in the subject-predicate structure of propositions; this reflects the interpretation of the *dictum de omni* as a rule based on instances (counterexamples) and on *ecthesis* as a procedure carrying out these rules.
- 4) **An exhaustive method** The dialogical counterpart to validity in other logical frameworks is the existence of a winning strategy for the proponent (see in particular Nicolas Clerbout, 2014), which is produced through exhausting all the relevant

plays on a thesis, *i.e.*, taking into account all the plays in which the opponent can choose to play a different move and showing that in each case, the proponent has the means to win. Thus, from the level of plays (isolated debates between an opponent and a proponent ending after a finite number of moves with one player winning, the other losing) the level of strategies emerges when adopting a perspective encompassing all the possible plays on a given thesis, determining what is relevant and what is not, and making sure that the proponent is capable of winning for *every* relevant play. A play in which only the instance has changed (*e.g.* *f* instead of *d*) is not relevant, but a play in which the opponent can make a different choice is relevant. This exhaustive approach at the core of the strategy level reflects the importance of exhaustive approaches of a scientific problem in the dialectical pre-demonstrative stage of inquiry examined in section 3.3.

- 5) **A seamless structure** There is no separation between considerations on validity and considerations on meaning: validity in the Immanent Reasoning framework is provided through the existence of a winning strategy for the proponent by taking all the relevant plays into account, while it is at the level of plays that the meaning of statements is defined and that a proposition is determined. This seamless structure reflects the interpretation of syllogistic based on the no-counterexample interpretation of the *dictum de omni* and on a dialectical context dealing with content; it also reflects the continuity between the search of meaning (*ei esti* and *ti esti* questions, see section 3.3) when establishing relevant databases for a scientific inquiry and the discovery of a middle term allowing to build a demonstration (scientific *sullogismos*) – see section 3.4. The present formalization will not develop the material play level but stay at a formal play level.

What is more, section 3.2 insisted on interpreting dialectic as tools that prepare and transform the mind, endowing one with those very tools. The means for this teaching and acquisition are the one-on-one dialectical debates, which are good situations for noticing and using those tools, but which do not exhaust all the possible situations for using them, as argued in sections 3.3 to 3.4. The learning situation is important to stress as it allows to look at dialectic neither as a procedure that can be followed and that would lead one to some truths (as argued was the case in Bolton, 1990) nor as a mere psychological help (as are the interpretations of dialectic that do not make it attain truth, such as in Irwin, 1988 who needs a second type of dialectic). Two things should be noted on this “fine line” interpretation between procedure and psychology. First, the fact that it grounds dialectic in a learning situation allowing one to master

the dialectician's tools and thereby transforms that person into a dialectician makes this interpretation very compatible with the rational reconstruction of what meaning and propositions are proposed by Lorenz, one of the founders of dialogical logic in the Lorenzen tradition (Lorenzen and Lorenz, 1978), which involves interaction and teaching-learning situations (*e.g.* in the papers collected in Lorenz, 2010). Second, it preserves a tension between what can be called a subjective and an objective side of statements – which was examined in the case of *episteme* in section 3.2.2 – that is present in Frege's work, who preserved judgments while rejecting psychologism. It is Martin-Löf's (1984) work that allowed to have a formal notation marking the difference between a proposition and a judgment. This tension is also at the heart of the dialogical framework, since it keeps the two sides of statements – subjective judgment and objective proposition – while resolving the tension through interaction: the subjective component (present in judgments or in understanding) has meaning because it can be the object of some interaction – the fact that someone else reacts appropriately sanctions its common meaning or objectivity. It is thus interaction that constitutes meaning, interaction that fashions the minds of people and the concepts they use – not the other way around (Lorenz, 2010; Marion, 2010).

The formalization of this interpretation of syllogistic is not an *argument* in favor of the interpretation of Aristotle in the sense that a formalization does not help establish the interpretation was *Aristotle's* conception of syllogistic – historical arguments are required for that. Nonetheless, building a formalization can provide good incentive to the reader for adopting the proposed interpretation by furnishing an external (*i.e.*, non-historical) warrant that the interpretation is sound (without saying it was Aristotle's). Arguments defending that this interpretation was Aristotle's conception of syllogistic is the purpose of chapters 2 to 3, which invoke historical evidence and arguments without resorting to modern logical reconstructions.

Section 4.1 will develop the CTT notation for quantified statements that allows to explicit the instances underlying subject-predicate notations. Section 4.2 will then develop the basic game rules for the no-counterexample dialogical interpretation of syllogistic, rules that reflect the rules of the *dictum de omni et de nullo* and that implement *ecthesis*. Section 4.3 proves that the plays for the conversions and the three figures of the syllogism can be won by the proponent using the basic game rules for *ecthesis* presented in section 4.2. Table 4.1 on page 310 provides an overview of the types of proofs explicitly used (marked with their reference) or mentioned (marked with \diamond) in *Prior Analytics* I 2–6, the chapters in which Aristotle goes through all the

possible combinations for conversions and syllogisms in order to prove the valid ones and reject those that are not. Only the categorical syllogisms are dealt with here, the modal ones are not. From this table, it is clear that Aristotle especially uses *ecthesis* in the case of the first figure (and in *e-conversion*), where reduction to the first figure is not possible, though he also uses or mentions it in a few other cases. The core idea of the dialogical no-counterexample interpretation of syllogistic is that this *ecthesis* procedure can always be used, it is the default mode of proof.

Section 4.4 introduces rules augmenting the basic rules for *ecthesis* in order to have plays with indirect deductions, which Aristotle occasionally resorts to or mentions (see the column “indirect” in table 4.1 on the next page). The indirect plays for the conversions and three figures are then carried out, with the proponent winning.

Section 4.5 introduces another set of rules augmenting the basic *ecthesis* rules: first conversion rules allowing to convert statements during a play (and not just use conversions as the starting thesis, as what is talked about), then reduction rules for reducing second and third figure moods to first figure moods. The plays for the second and third figure moods are then reduced to first figure moods, with the proponent winning – to the exception of *Baroco* (second figure) and *Bocardo* (third figure) which cannot be reduced, a feature recognized by Aristotle as he provided indirect proofs for them (see table 4.1 on the following page).

Finally, in the appendix A, the plays for the *invalid* moods are carried out, with opponent capable of winning each time.

In this regard, the Immanent Reasoning framework is capable of formalizing the no-counterexample dialogical interpretation of syllogistic defended here by showing that all the valid moods of the syllogism are won by the proponent with the *ecthesis* rules, with the indirect rules and with the conversion and reduction rules, and that all the invalid moods are lost by the proponent with the *ecthesis* rules. What is more, when Aristotle carries out a justification of a mood (cases referenced in table 4.1 on the next page, to the exception of the *ecthesis* ones), the play and the text of the justification are put in parallel in order to see that the dialogical formalization is an explicitation of Aristotle’s way of proceeding.

Before providing the formalization of the dialogical no-counterexample interpretation of syllogistic in the Immanent Reasoning framework, the choice of this framework rather than another dialogical framework needs to be further discussed.

Table 4.1: Synoptic view of the types of proof in Aristotle's syllogistic (first line) and in the Immanent Reasoning formalization (second line, with table reference)

Type	Name	Form	Ecthesis	Indirect	Reduction
Conversion <i>APr. I 2</i>	e-conv	$AeB : BeA$	25a14–17 <i>T. 4.14 p. 357</i>	25a14–17 <i>T. 4.31 p. 377</i>	
	a-conv	$AaB : BiA$	<i>T. 4.15 p. 358</i>	25a17–19 <i>T. 4.33 p. 381</i>	
	i-conv	$AiB : BiA$	<i>T. 4.16 p. 359</i>	25a20–22 <i>T. 4.35 p. 383</i>	
First Fig. <i>APr. I 4</i>	<i>Barbara</i>	$AaB, BaC : AaC$	25b37–40 <i>T. 4.10 p. 346</i>	<i>T. 4.37 p. 385</i>	
	<i>Celarent</i>	$AeB, BaC : AeC$	25b40–26a1 <i>T. 4.12 p. 353</i>	<i>T. 4.38 p. 386</i>	
	<i>Darii</i>	$AaB, BiC : AiC$	26a23–25 <i>T. 4.13 p. 355</i>	<i>T. 4.39 p. 387</i>	
	<i>Ferio</i>	$AeB, BiC : AoC$	26a25–28 <i>T. 4.11 p. 352</i>	<i>T. 4.40 p. 389</i>	
Second Fig. <i>APr. I 5</i>	<i>Cesare</i>	$MeN, MaX : NeX$	<i>T. 4.22 p. 366</i>	<i>T. 4.41 p. 390</i>	27a5–9 <i>T. 4.58 p. 414</i>
	<i>Camestres</i>	$MaN, MeX : NeX$	<i>T. 4.21 p. 365</i>	\diamond <i>T. 4.42 p. 391</i>	27a9–14 <i>T. 4.60 p. 416</i>
	<i>Festino</i>	$MeN, MiX : NoX$	<i>T. 4.23 p. 367</i>	<i>T. 4.43 p. 392</i>	27a32–36 <i>T. 4.62 p. 419</i>
	<i>Baroco</i>	$MaN, MoX : NoX$	<i>T. 4.20 p. 364</i>	<i>T. 4.44 p. 393</i>	27a36–b1
Third Fig. <i>APr. I 6</i>	<i>Darapti</i>	$PaS, RaS : PiR$	28a22–26 <i>T. 4.24 p. 368</i>	\diamond <i>T. 4.46 p. 396</i>	28a17–22 <i>T. 4.64 p. 421</i>
	<i>Felapton</i>	$PeS, RaS : PoR$	<i>T. 4.25 p. 370</i>	\diamond <i>T. 4.47 p. 397</i>	28a26–30 <i>T. 4.66 p. 423</i>
	<i>Disamis</i>	$PiS, RaS : PiR$	<i>T. 4.27 p. 372</i>	<i>T. 4.48 p. 399</i>	28b7–11 <i>T. 4.68 p. 424</i>
	<i>Datisi</i>	$PaS, RiS : PiR$	\diamond <i>T. 4.26 p. 371</i>	\diamond <i>T. 4.49 p. 400</i>	28b12–15 <i>T. 4.70 p. 426</i>
	<i>Bocardo</i>	$PoS, RaS : PoR$	28b20–21 <i>T. 4.28 p. 373</i>	28b17–20 <i>T. 4.50 p. 401</i>	
	<i>Ferison</i>	$PeS, RiS : PoR$	<i>T. 4.29 p. 374</i>	<i>T. 4.52 p. 404</i>	28b33–35 <i>T. 4.72 p. 428</i>

Choosing the Immanent Reasoning framework over other dialogical frameworks

Aristotle's syllogistic has recently been formalized using a dialogical framework by Girle (2015), using Hamblin type dialogical frameworks – distinct from the dialogical framework of Immanent Reasoning, which is in the Lorenzen tradition.¹ Discussing this formalization will allow to present by contrast the Immanent Reasoning framework and the reasons backing this choice.

Girle (2015) adopts as starting point the Łukasiewicz (1957) thesis presented in chapter 1 according to which syllogisms are not inferences but conditionals (Girle, 2015, pp. 290–291); his aim is to formalize this interpretation of syllogisms in a dialogical framework rather than in Łukasiewicz's axiomatic proof system: "This paper is concerned to show how well syllogistic as a system of necessary conditionals or thesis conditions fits into a formal dialogue framework" (Girle, 2015, pp. 292–293). However, he does not try to interpret Aristotle's syllogisms in a dialogical way, he takes Łukasiewicz's interpretation – which is not dialogical – and puts it in a dialogical framework; neither does he try to provide a formalization of dialectic which would use syllogisms (Girle, 2015, p. 292). The rationale behind formalizing syllogistic in a dialogical framework is a suggestion by Shenefelt and White (2016) that Girle summarizes: "Aristotle's syllogistic was generated partly by Aristotle's impatience with the quality of debate and decision making in the society in which he lived and taught" (Girle, 2015, p. 294). That Aristotle may have been motivated by the context of debates for building his syllogistic does not however entail – a skeptic might object – that syllogisms are dialogical: a motivation is not a result.

In this regard, the dialogical formalization Girle provides does not seem to pass the skeptical criticism raised by Wilfrid Hodges and summarized in his abstract:

¹Eric C. W. Krabbe (2013) has provided a formalization of dialectical debates in a Hamblin-type framework, and compared this result with a formalization of the pragma-dialectical system of rules of critical discussion, a Hamblin-type system, and a Lorenzen-type system, in order to show that all these logical systems (frameworks) have topical roots. Krabbe introduces certain modifications to the Lorenzen-type framework (such as games arbitrarily limited) that will not be followed here, he does not separate real-life (one-on-one) debates from the dialogical plays (which I have argued are recapitulations of a debate), and he presupposes the validity of certain arguments (see *e.g.* p. 75); for all these reasons, I will not follow his formalization, and since Roderic A. Girle (2015) provides a formalization of syllogistic having some features very close to Krabbe's (2013) formalization of dialectic, discussing Girle's choices will serve as a discussion of Krabbe's. It is also worth mentioning that Benoît Castelnérac and Marion (2009, 2013) have used a dialogical framework to provide formal rules for dialectical games, though not for syllogistic, as will be the case here.

During the last forty or so years it has become popular to offer explanations of logical notions in terms of games. There is no doubt that many people find games helpful for understanding various logical phenomena. But we ask whether anything is really “explained” by these accounts, and we analyse Paul Lorenzen’s dialogue foundations for constructive logic as an example. The conclusion is that the value of games lies in their ability to provide helpful metaphors and representations, rather than in any true conceptual analysis. In fact, some of the standard explanations of logical notions in terms of competitive games simply don’t work. (Hodges, 2001)

The main question this paper of Hodges asks to the formalization of Girle is: why use a dialogical framework for syllogistic? What is gained through this?² The paper does not seem to offer an answer. I will contend that this formalization is not equipped for answering the main question of Hodges (what is the point of using a dialogical framework?), thus insisting on what I take to be shortcomings of the chosen dialogical framework and interpretation in order to present by contrast the assets of the Immanent Reasoning framework and the dialogical no-counterexample interpretation of syllogisms. We will have to come back to this discussion in the conclusion in order to assess the explanatory power of the formalization in the Immanent Reasoning framework in answer to Hodges.

First, in his formalization, Girle does not establish the syllogisms (that they are necessarily true³), he takes them for granted, so that his formalization is but a formalization of the *use* of syllogisms in a dialogical context, not a formalization of the *constitution* of the syllogisms, *i.e.*, of how one can establish the necessity that defines a syllogism. Aristotle however clearly distinguished establishing his syllogistic (*APr.* I 1–26) and the uses one could make of it (basically the rest of the treatise). As mentioned in section 2.2.1, syllogistic has generally been identified with *Prior Analytics* I 1–26 and reduced to it, so that when formalizing syllogistic, it is a formalization of how the necessity of the syllogisms can be shown that is expected, not a formalization of uses of syllogisms. By

²As mentioned above, Girle does not use a Lorenzen type dialogical framework, but since Hodges is explicit that his criticisms regarding Lorenzen dialogical frameworks also apply to other dialogical frameworks, his criticisms still apply to Girle’s dialogical formalization of syllogistic.

³Since Girle follows Łukasiewicz (1957) in interpreting syllogisms as conditional propositions, establishing a syllogism means establishing it is true. When interpreting syllogisms as inferences, establishing syllogisms means establishing their validity. As argued by Lorenz (2010, pp. 71–80), the dialogical framework in the Lorenzen tradition is not proof-theoretical (nor model-theoretical); in this regard, taking a syllogism such as *Barbara* as a thesis (the initial statement of the dialogue) means that syllogisms are not inferences but claims that the conclusion is unchallengeable when the premises have been said – the dialogue carries out the inference, but the syllogism itself is a claim and not an inference (nor a conditional proposition).

providing a dialogical constitution of syllogisms, the Immanent Reasoning formalization of syllogistic explains why the valid⁴ moods are valid, it shows how the necessity comes about.

Second, Girle has not chosen an appropriate predicate logic: the choice of *Monadic Predicate Logic* for the predicative relations together with propositional logic for the conditionals in the syllogisms (especially conjunction and implication) is not very expressive or accurate. For instance, he defines universal affirmative predication as $(\forall x)(Sx \supset Px)$ and particular affirmative predication as $(\exists x)(Sx \& Px)$, but type theoretical logics have shown the limitations of such expressions (see for instance Aarne Ranta, 1994, p. 33). A simple example showing their inadequacy can be seen by saying *there is a small elephant*: one is not saying that there is an x that is *an elephant* (Sx) and that it is *small* (Px), because elephants are not small things – one is rather saying that *among the things that are elephants*, there is a small one, which can be adequately expressed in the Constructive Type Theory (CTT) of Martin-Löf (1984) – see Ansten Klev (2018) for an introduction and Ranta (1994) for its capacity to express natural language.

Third, Girle's formalization does not integrate dialogical interaction into the constitution of the syllogisms (which is in part due to his presupposing syllogisms rather than his establishing their constitution), so that a skeptic like Hodges can indeed ask why syllogisms are put in a dialogical framework. In the Immanent Reasoning framework, syllogisms are produced out of dialogical interaction rules: the dialogical framework explicits the constitution of syllogisms.

Fourth, Girle's formalization identifies the dialogue games with real-life dialogues which makes many of Hodges arguments hold, since most of his objections to dialogical frameworks rest on the fact that some feature is not realistic. The recapitulation interpretation of syllogisms defended in section 2.3.3 and the interpretation of dialectic as having a broader extent than real-life one-on-one dialectical debates defended in chapter 3 allow to formalize syllogistic in dialogues that do not represent the flow of real-life debates: they rather represent the moment where *the argument* is being put to the test.

Finally, the dialogue games are presented as potentially unending⁵ (Girle, 2015, p. 306,

⁴I do not follow Łukasiewicz in interpreting syllogisms as (conditional) propositions and thus do not speak of them as *true*.

⁵Being an unending argument is presented like a desirable feature, though for some people this could be a vision of hell.

p. 311, & p. 315) which would probably make Hodges ask what the purpose of the game is, since he starts from a widespread agreement that winning or losing a game constitutes its purpose (Hodges, 2001, p. 19). In the Lorenzen tradition, on the contrary, the finiteness of dialogues is a fundamental feature that defines what a proposition is.

In this regard, Girle's paper does not seem to respond to Hodges's skepticism – it is not clear what is gained by putting the use of syllogisms in a dialogical framework – and some choices make problems mentioned by Hodges hold.⁶ What is more, his formalization does not concern the constitution of syllogisms but their use, and his choice of language seems external to Aristotle's predication relations and to any dialogical meaning constitution. The Immanent Reasoning formalization of the dialogical no-counterexample interpretation of syllogistic provides a formalization of the *dialogical constitution* of syllogisms. We will come back to this in the conclusion.

4.1 The statements for syllogistic in the Immanent Reasoning framework

I will now use the tools of the Immanent Reasoning framework to reconstruct Aristotle's assertoric syllogistic. Syllogistic in this dialogical framework is carried out in dialogues between two players who follow game rules defining appropriate interaction in the dialogue. As the Starting rule (see section 4.2.2) stipulates, the player who states the initial thesis, such as the first figure syllogism *Barbara*, will take up the role of proponent, called Proponent or **P**, while the other player will take up the role of opponent, called Opponent or **O**. By convention, Proponent is addressed as *he* and Opponent as *she*. Proponent thus states the thesis and Opponent challenges it, bringing Proponent to defend the thesis or challenge any concession Opponent might be brought to make. The interaction during the dialogue is thus a succession of challenges and answers, which can take the form of statements or of requests, all defined through the game rules. When the specific role of a player does not matter, the utterer is called **X** while the challenger is called **Y**.

Immanent Reasoning uses CTT notation that allows to render predication in an efficient way; it also allows to explicit the instance in the subject-predicate form, reflecting the no-counterexample of the *dictum de omni et de nullo* understood as providing the

⁶A problem raised by Hodges however does not hold at all, which is the asymmetry of rules between the players; this is the case in Lorenzen type frameworks, but not in Hamblin type ones.

GENERAL CONCLUSION

The dialogical approach to Aristotle's logic developed in this dissertation allows for a comprehensive and unified interpretation of syllogistic, dialectic, and scientific inquiry (chapters 2 to 3). A formal analysis of the dialogical interpretation of assertoric syllogistic is provided in chapter 4 and produces, in the dialogical framework, a modern formalization that is historically grounded. As argued for in chapter 1, this dissertation progresses using two successive methodological standards: first, it presents and justifies the proposed dialogical interpretation of Aristotle's syllogistic, dialectic, and method of scientific inquiry by focusing on Aristotle's texts, without importing modern logical considerations (chapters 2 to 3); second, it provides a full formal analysis of the dialogical interpretation using the modern dialogical framework (chapter 4 and appendix A). In this fashion, the justification of the dialogical interpretation of the *Organon* is based on historical grounds, with as little biases introduced from modern logic as possible.

While the presentation and justification of the historical interpretation is kept separate from its formal analysis in the modern dialogical framework, the upshot is a complex argument in favor of the dialogical foundation of logic in general – both in its Aristotelian roots and in its modern ramifications. Under this reading, reasoning in general – be it for everyday reasoning, for the study of arguments themselves, or for pursuing an inquiry, *e.g.* a scientific inquiry – is fundamentally dialogical in the sense that it is based on a dynamic and interactive process that constitutes the meaning of what is at stake by means of commitments and entitlements embodied principally in possible objections and their rejection. In short, what counts as an objection constitutes meaning and inserts what is said in a dynamic process of meaningful argumentation. This argumentation is called dialogical because of the interaction embedded in the

possibility of objections, which supposes a commitment to successfully defend the claim against objections or abandon the claim itself. This interactive, “dialogical” foundation of argumentation can take the form of external dialogues between parties assuming antagonist roles, but it is not limited to it since meaning itself is constituted on this interactive basis: any piece of meaningful argumentation is dialogical in this sense.

In showing that, according to Aristotle’s logical texts, both dialectical debates and contentful meaning are based on the notion of objection, their dialogical foundations are established, opening the way for a dialogical understanding 1) of syllogistic, inserting it in the broader context of dialectic, and 2) of dialectic, defining this practice in such a way that it is not limited to debates, though of course, debates are also covered by the definition. While the usual, monological approach to syllogistic focuses almost exclusively on *Prior Analytics* I 1–26, chapter 2 shows how adopting such a dialogical perspective better integrates Aristotle’s assertoric syllogistic in the context of the *Prior Analytics* as well as that of the *Organon* as a whole. Chapter 3 focuses on the use of dialectic for scientific inquiry and shows how training in dialectical debates prepares the mind of the inquirer and provides important mental tools and abilities to can help any inquiry. Dialectic in this sense cannot be reduced to the practice of dialectical debates. At this point, the study could stop, resulting in a conception of dialectic that is a useful auxiliary for scientific inquiry. A tentative definition of dialectic is however provided that makes it more than a mere auxiliary: dialectic is defined as the the process of progressively determining the extension of terms through objections and their resolution. The presence of objections captures the dialogical foundations argued for before, while the focus on extensions makes this argumentative practice intimately linked to the meaning or content of the subject at hand. Under this reading, the pre-causal stage of scientific inquiry would be dialectic, so that dialectic would be a necessary, though not sufficient, part of scientific inquiry. As mentioned below, this definition calls for further research.

In developing a dialogical interpretation of Aristotle’s logic – understood broadly as encompassing syllogistic, dialectic, and scientific inquiry – together with a modern formalization of assertoric syllogistic in a dialogical framework, this dissertation provides a comprehensive dialogical alternative to current approaches to Aristotle’s *Organon*, including Corcoran’s and Smiley’s natural deduction or Łukasiewicz’s axiomatic interpretations and formalizations of assertoric syllogistic.

The dialogical formalization provided in chapter 4 and extended in appendix A gives

a central role to Aristotle's ecthesis, which is understood as implementing the *dictum de omni* rule that determines the meaning of quantification, as defended in chapter 2. Ecthesis grounds the figures of the syllogism in a pragmatist setting capable of proving the validity of all the valid moods. Appendix A proceeds in a similar fashion regarding the invalid moods, proving them to be invalid in the dialogical framework also. Additional rules are provided for reducing second and third figure moods to first figure moods, and for proceeding to *reductio ad absurdum*. Thus, most features of Aristotle's syllogistic are integrated in a unified framework. However, Aristotle's modal syllogistic falls outside of this dissertation's scope, as it would require a full study of its own. Since modal syllogistic is a continuation of assertoric syllogistic in the sense that it adds to the four quantified propositions (universal affirmative and negative, particular affirmative and negative) two modal qualifiers, namely being necessary and being possible, yielding a total of twelve types of predication instead of four: the four quantified propositions without modal qualifiers, with the necessity qualifier, and with the possibility qualifier. The syllogistic needs to be supplemented with the syllogisms that involve modally qualified propositions. The present dissertation provides a formalization of assertoric syllogistic in the dialogical framework based on a dialogical interpretation of the *Prior Analytics* in particular, and the *Organon* in general. This approach can now be further tested by a dialogical investigation of *Prior Analytics* I 8–22 accompanied by a formal analysis of the resulting interpretation using the dialogical framework.

Various studies have examined the mathematical origins of Aristotle's syllogistic. However, the dialogical approach suggests a complementary investigation of these origins found in public debates and polemics, which include rhetoric, but also the defense of the art of medicine. For instance, a possible source of inspiration for Aristotle's notion of necessity inherent to the *sullogismos* could be found in the comparison between the force of persuasion that comes from Gorgias' exhaustive account of the possibilities in the *Encomium of Helen* or the *Defense of Palamedes* and the one produced by other pieces of rhetorical discourse. What is more, the two Hippocratical treatises *Ancient Medicine* and *Art* show that polemics were ongoing in the medical domain, in particular regarding the existence of the art of medicine and what the principles of the discipline are. We have access to these polemics through texts that argue against absent parties, in the sense that we do not have a live dialogue between the contestants, to the effect that an argued discourse held by one person and taking into consideration opposing views provides a clear example of the process of internalizing an opponent in one's own way of thinking. In such a case, the general context is dialogical by being a polemic,

but the piece of argumentation in itself is also dialogical in its way of taking real or possible objections into account in shaping both the argument and the subject matter (something all the clearer when defining the art of medicine). While this dissertation focused on the dialogical *foundations* of Aristotle's logic, further studies in the direction of its origins could reveal a dialogical *genesis* of these foundations.

Finally, as testified by the international symposium "Aristotle's Dialectic and the Sciences" organized by Luca Gili and held on August 26–27, 2021, there is currently an increased interest in determining the exact nature of the relation between Aristotle's dialectic and science. In particular, as was suggested by James Allen and Colin G. King during the symposium, the work of Paolo Fait, "*Endoxa e consenso: per la distinzione dei due concetti in Aristotele*," 1998, and its more recent ramification in the work of Tobias Reinhardt, "On 'Endoxa' in Aristotle's 'Topics'," 2015, can provide new insights on Aristotle's notion of *endoxon* and on the work of the *Topics* as providing norms of premise acceptance, an interpretative path tread by King's forthcoming book *Aristotle's Theory of Dialectical Argumentation*. The proposition of defining dialectic as a process of progressively determining the extension of terms through objections and their resolution (section 3.4), which is the most tentative part of this dissertation, will benefit from this impetus in the studies of Aristotle and opens further investigations, among others on its relation to the *topoi* of the *Topics* and to its application in various scientific treatises.

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