Discours

Revue de linguistique, psycholinguistique et informatique. A journal of linguistics, psycholinguistics and computational linguistics

4 | 2009

Linearization and Segmentation in Discourse

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Paul A. Falzon

Electronic version

URL: <http://journals.openedition.org/discours/7241>

DOI: 10.4000/discours.7241

ISSN: 1963-1723

Publisher:

Laboratoire LATTICE, Presses universitaires de Caen

Electronic reference

Paul A. Falzon, « Discourse segmentation and the management of multiple tasks in single episodes of air traffic controller-pilot spoken radio communication », *Discours* [Online], 4 | 2009, Online since 30 June 2009, connection on 25 April 2019. URL : <http://journals.openedition.org/discours/7241> ; DOI : 10.4000/discours.7241

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Discourse segmentation and the management of multiple tasks in single episodes of air traffic controller-pilot spoken radio communication

Paul A. Falzon

Institute of Linguistics, Centre for Communication Technology,
University of Malta, Msida MSD2080, Malta
paul.falzon@um.edu.mt

Abstract

Episodes of VHF radio-mediated pilot-controller spoken communication in which multiple tasks are conducted are engendered in and through the skilful deployment and combination, by the parties to the talk, of multiple orders of discourse segmentation. These orders of segmentation are manifest at the levels of transmission design and sequential organisation. Both of these features are analysed from a Conversation Analytic standpoint in order to track their segment by segment genesis, development and completion. From the analysis it emerges that in addition to the serial type of sequential organisations described by Schegloff (1986), there exists an alternative form of organisation that enables tasks to be managed in a quasi-parallel manner, and which affords controllers and pilots a number of practical advantages in the conduct of their radio-mediated service encounters.

Keywords:

pragmatics, conversation analysis, air traffic control, technology-mediated communication, task-oriented discourse, multitasking, segmentation, turn design, sequential organisation

Résumé:

Cet article présente des extraits d'échanges oraux entre pilotes et contrôleurs du ciel via la radio VHF. On peut y voir comment le déploiement et la combinaison habile de plusieurs ordres de segmentation discursive, engageant les deux coénonciateurs de la conversation, leur permet d'accomplir des tâches multiples. Ces ordres de segmentation se manifestent aux niveaux du plan de la transmission et de l'organisation séquentielle. Ces deux niveaux sont envisagées du point de vue de l'analyse conversationnelle dans le but d'examiner, segment après segment, comment ils se mettent en place, se développent puis prennent fin. Notre étude montre que, outre le type sériel d'organisations séquentielles décrit par Schegloff (1986), il existe une forme alternative d'organisation qui permet de gérer les tâches de manière quasi parallèle, et qui fournit aux contrôleurs aériens ainsi qu'aux pilotes de nombreux avantages pratiques dans la conduite de leurs radio.

Mots-clés

pragmatique, analyse conversationnelle, contrôle de la circulation aérienne, communication médiée par la technologie, dialogue finalisé, multitâche, segmentation, construction des tours de parole, organisation séquentielle

TEXTE INTEGRAL / FULL TEXT

1. Introduction

- 1 There is a growing corpus of Conversation Analytic research into spoken discourse in institutional and organisational contexts (e.g. Arminen, 2005; Boden, Zimmerman, 1991; Drew, Heritage, 1992; Heritage, Maynard, 2006; Richards, Seedhouse, 2005; ten Have, Psathas, 1995). This body of research subsumes studies of socio-technical work settings such as emergency service despatch centres (Whalen, Zimmerman, 2005), urban railway control units (Heath, Luff, 2000; Luff, Heath, 2002), airline operations rooms (C. Goodwin, M. H. Goodwin, 1998; M. H. Goodwin, 1996) and airline cockpits (Neville, 2004, 2006, 2007). In applying Conversation Analysis (CA) to spoken radio communication in the domain of air traffic control (ATC), this article investigates a further socio-technical context and thus is intended to contribute to and complement the body of Applied CA research.
- 2 The data informing this investigation form part of a research project (Falzon, 2008) investigating spoken communication in the context of actual ATC operations. Collected on site at an international airport in southern Europe, they are drawn from a data corpus of audio recordings totalling approximately 35 hours. The data corpus contains spoken communications between 4 ATC services and 257 individual flights. These communications amount to 1003 episodes of pilot-controller talk of between 2 and 13 turns in length. The corpus comprises both air-ground and ground-ground technology-mediated communications involving Area, Approach, Aerodrome (Tower) and Apron Control units¹.
- 3 International flights departing the data airport routinely make first radio contact with Apron Control which is responsible for issuing engine start up and route clearances, and taxi clearances to specific positions short of the various runways. As they approach the runway holding-points the flights are then transferred to Aerodrome (Tower) Control for clearances to enter runways, to position for and to execute takeoff. At this stage the outbound flights are integrated into the pattern of airborne traffic operating in the immediate environment of the airport. Shortly after takeoff flights transfer to Approach Control which provides them with climb and navigational clearances and incorporates the flights into the traffic pattern in the terminal manoeuvring area (TMA), i.e. the larger airspace around the airport and its approaches. As they progress through their climbs, the departing flights are handed over to Area Control under whose direction they are cleared to their cruising flight levels, routed towards their destinations and merged into the traffic flow in the sector, i.e. sub-area of airspace, they are flying through. Area Control units also manage cross-flights, i.e. flights that neither originate from nor terminate at the data airport. Depending on their final destination, the flights are transferred from one Area Control sector to another until the whole process of transferring between ATC services is reversed when they begin to approach their destination airports as inbound flights. In addition to providing ATC services to outbound and inbound international flights, Aerodrome (Tower) and Approach Control also routinely service local flights.
- 4 Air-ground spoken ATC communication is mediated by two forms of technology: the hard technology of VHF radio and the soft technology of prescribed phraseology and operational procedure. The VHF radio network that links controllers and pilots operates as a broadcast system. Consequently, all air and ground stations whose radios are tuned to a given ATC frequency and are within signal range are able to receive transmissions. It is also a simplex communication system. Users are unable to simultaneously send and receive messages.

¹The term 'air-ground talk' is conventionally used to refer to radio-mediated spoken communication between air traffic controllers and aircraft pilots regardless of whether the aircraft are actually airborne or on the ground at the time the communication occurs. Ground – ground communication, i.e. communication between mobile and fixed ground stations, does not feature in this article.

They need to switch to transmission mode in order to send their messages and revert to the default reception mode in order to receive other users' messages. Prescribed phraseology, by contrast, can be conceived of as a form of soft technology. It is an example of a controlled language that is designed to enable controllers and pilots to formulate directives and reports consistently, precisely and unambiguously. Therefore, within the community of competent phraseology users it is intended to facilitate recipients' recognition of what speakers are talking about. Similarly, operational procedure may also be viewed as a form of soft technology that provides established solutions to recurrently encountered problems associated with operating flights and controlling air traffic. Mutual familiarity with such procedure enhances controllers' and pilots' ability to make sense of each other's actions and to project upcoming routine tasks with a high degree of confidence.

- 5 Radio-mediated talk between air traffic controllers and pilots is characterised by multiple orders of segmentation. At the level of overall structure, air-ground "discourses," i.e. the totality of spoken interaction obtaining between individual flights and single air traffic control (ATC) units (Falzon, 2008: 188), are recurrently segmented into series of episodes of talk that are interspersed with relatively lengthy periods of silence. Depending on the nature of the flight, prevailing traffic conditions and operational contingencies, individual discourses in the data corpus range between 2 to 15 episodes in length. These episodes consist of exchanges of radio transmissions that constitute the loci for the verbal transaction of ATC-relevant tasks. They are occasioned by the demands of safety and expedition, and by the need to coordinate what are interrelated, but distinct, work projects. In their cockpits, pilots operate flights. On the ground, air traffic controllers coordinate the actions of the pilots of individual flights in their airspace into coherent traffic flows. Coordination of the two projects is largely achieved through controller-pilot radio-mediated talk-in-interaction.
- 6 Episodes of spoken air-ground ATC communication serve two main purposes, namely the transaction of ATC instructions and the communication of ATC-relevant information. The transaction of ATC instructions is a defining ATC task. In jointly conducting this task controllers and pilots agree on a plan of action, usually involving the manoeuvring of the aircraft in the air or on the ground, prior to the action itself being executed. Typical examples are instructions to climb or descend to a specified flight level or to alter course onto an indicated heading. The execution of the instruction transaction task is intended to enable controllers and pilots to minimise the potential for misunderstanding of the plan in the course of its communication and hence to avoid the propagation of misunderstanding to the subsequent action that the instruction sanctions. It is verbally executed in the form of an Instruction – Readback – Assessment sequence, abbreviated as I – R (– A) to denote that assessment may be either explicitly stated, I – R – A, or implicit in controller action, I – R (Falzon, 2008: 117ff).
- 7 The Report – Acknowledgement sequence, represented as Rep – Ack, serves to enable controllers and pilots to exchange information of mutual relevance (Falzon, 2008: 141). The need to exchange such information arises out of asymmetrical access to information sources. From the flight deck pilots report such things as cockpit instrument readings, air turbulence conditions and whether they are in visual contact with their target runway. At their flight data system monitors and radar screens controllers inform pilots of other aircraft operating in their vicinity, of their sequence in inbound traffic streams and of significant projected traffic conditions. The kind of information that is exchanged through the Rep – Ack sequence is thus intended to accomplish the task of updating or enhancing controllers' and pilots' situation awareness. At the level of episode structure, ATC-relevant tasks are conducted in and through the concerted deployment by the parties to the episodes of specific sequences of segments of talk.
- 8 The sequences themselves are segmented into what Sacks *et al.* (1974) describe as turn-constructional units that, in the ATC context, wholly or in part make up single radio transmissions. The I – R – A sequence, for example, is routinely enacted across three radio

transmissions. The controller initiates the sequence by making a transmission in which an instruction is issued; the relevant pilot then makes a second transmission to read back the instruction, i.e. repeat their hearing of the controller's directive; and the controller subsequently assesses the pilot's readback in a third transmission.

- 9 Finally, segmentation also occurs at the level of single transmissions. It is not uncommon for two or more turn-constructual units to comprise a single transmission by one party to the air-ground communication. In these complex transmissions, multiple turn-constructual units often function to segment transmissions in such a way as to advance multiple sequences.
- 10 To recapitulate, then, turn-constructual units are base-level segments that contribute to the production of a single transmission. Across two or more transmissions, they constitute sequences dedicated to the execution of ATC tasks. They are thus simultaneously segments of such sequences. These sequences, in turn, comprise intermediate-level segments of episodes of talk in which multiple tasks are accomplished. Finally, the episodes themselves form higher-order segments of controller-pilot discourses. It is the aim of this article to investigate how the various orders of segmentation constitute resources in the organisation of diverse modes of managing multiple ATC tasks in single episodes of radio-mediated controller-pilot spoken communication.

2. Segmentation and task complexity

- 11 Tasks that are discharged through segments of talk at the level of action sequences can usefully be conceived of as being hierarchically organised in terms of relative complexity. Simple tasks, for instance, may be defined as tasks that are regularly executed by means of a single sequence or 'package' (Schegloff, 1986: 130). In example [1], the pilot of flight 574 reports to Area Control that the aircraft has reached and is maintaining flight level 340 (an altitude of approximately 34,000 feet). In response, the Area controller acknowledges receipt of the report.²

[1] AC250702 5.4 Simple task

1		(4.1)
2	Flight 574:	ABC five seven four now maintaining level three four zero./
3		(0.8)
4	Area:	ABC five seven four roger./
5		(1.7)

- 12 Over the course of two radio transmissions, pilot and controller jointly accomplish the task of communicating the current vertical position of the aircraft by deploying two segments of talk, each made up of a single turn-constructual segment, namely "now maintaining level three four zero" (l. 2) and "roger" (l. 4), that together form a Rep – Ack sequence.³
- 13 Complex tasks, by contrast, are readily decomposed into multiple action sequences. A routinely occurring complex ATC task is the transaction of route clearance. By way of illustration, among the several instruction transactions in example [2] there occurs a typical instance of route clearance transaction. Flight 363 is being cleared to route to its destination,

² Flight and ATC unit call signs, the names of navigational waypoints and of runway designators have been slightly altered in the interests of anonymity. All other talk has been transcribed as it occurs in the recorded data.

³ "Roger" is prescribed ATC phraseology used to acknowledge receipt of reports. It claims, but does not display, understanding of the report.

“City” (l. 3) by entering the Area Control team’s airspace via navigational waypoint “Amloz” (l. 3).

[2] AC131101: 7.1Ie Complex task

1		(1.0) ((episode in progress))
2	Area:	Air Carrier three six three Centre Control good afternoon, (1.6) cleared
3		to City (0.4) via Amloz, flight level three nine zero report, (1.2) Amloz
4		(0.3) and when released by Southeastern./
5		(0.7)
6	Flight 363:	okay sir: eh cleared to destination City via Amloz flight level three
7		niner zero, (.) call you released by Southeastern./
8		(29.8)

- 14 Established ATC protocol requires that pilots read back controller instructions. This occurs in the next transmission, part of which consists of the functionally-defined segments “cleared to destination City” (l. 6) and “via Amloz” (l. 6). Overall, the task-relevant talk is organised into two I – R sequences wherein the controller and the pilot mutually establish that the flight is cleared to continue to its destination and that it is to do so by routing via Amloz. In concert, therefore, controller and pilot deploy two I – R sequence segments to conduct the higher-order task of transacting route clearance.

3. Two modes for the management of multiple tasks

- 15 In order to jointly execute their tasks, pilots and controllers take turns to transmit segments of speech that cohere, at a higher level of organisation, to form multiple action-sequences. At a still higher organisational level, the completed sequences themselves constitute segments that structure episodes of air-ground talk-in-interaction. Where episodes are engendered by a plurality of sequences, as they regularly are, they can be segmented in a number of ways that give rise to different modes of managing multiple intra-episodic tasks.
- 16 Of particular significance is the manner in which the action sequences are positioned relative to each other. This is because in achieving particular, relative orderings of sequences, co-interactants appear to orient to such matters, among others, as turn position, turn design and sequence length. Above all, controllers and pilots engaged in the concerted production of multiple-task episodes manage ATC-relevant tasks in and through their use and relative positioning, both within single transmissions and within complete episodes, of turn-constructural segments. Indeed, as Schegloff (1986) demonstrates, turn design is intimately linked to sequential organisation.
- 17 Drawing on the nexus between turn design and sequential organisation, Schegloff (1986) employs data from technology-mediated spoken interaction to distinguish between serial and interlocking sequential organisations. While both forms of organisation feature in pilot-controller multiple task episodes, and do so to varying degrees, they are complemented by a further sequential organisation that has until recently escaped analytic scrutiny.

3.1. Segmentation and serial task management

- 18 Episodes of radio-mediated air-ground spoken communication that are entirely structured in such a manner that all intra-episodic action sequences are serially ordered occur infrequently in the data corpus on which the present research is based. A representative instance of such episodes can be seen in example [3].

[3] AC170801: 6.5 Serial task management involving serial sequential organisation

1		(5.8)
2	Area:	Golden National one four eight Centre _z /
3		(3.5)
4	Flight 148:	go ahead sir/
5		(0.8)
6	Area:	Golden National one four eight report Foluk./
7		(0.7)
8	Flight 148:	roger will call you Folu:k eh Golden National one four eight/
9		(1.16.3)

- 19 The episode is launched by the Area controller who summons flight 148 by means of its full flight call sign and self-identifies his unit as ‘Centre.’ In answer to Area Control’s transmission, the pilot invites the controller to proceed with his message (l. 4). At this juncture in the episode, the interlocutors have jointly produced a complete summons – answer (S – A) sequence (Schegloff, 1968/1972, 2002, 2007). Functionally, this sequence enables the controller to accomplish the task of establishing whether the flight deck crew is available to attend to the controller’s as yet undefined projected business, i.e. to check that the pilots are not engaged in some other more urgent operational task. Structurally, it constitutes the prefatory segment of the episode of radio talk.
- 20 Following completion of the prefatory segment, controller and pilot advance the episode to the message component where they transact the further task of scheduling the next report so that it occurs when the aircraft has reached position Foluk. Therefore, two segments, each corresponding to a distinct task, comprise the episode in example [3]. The focus of analytic interest, at this point, is the relative ordering of the first segment, i.e. the S – A sequence, relative to the second. What is important here is that the latter task is launched in the transmission (l. 6) following that which contains the sequence-terminal segment of the antecedent sequence (l. 4). By segmenting the episode in this way, then, the participants are able to manage tasks in series.
- 21 Interlocking sequential organisation provides an alternative and more frequently used means of managing tasks serially. This organisation is illustrated in excerpt [4], in which two tasks are serially executed.

[4] AP090802: 5.2 Serial task management involving interlocking sequential organisation

1		(5.5)
2	Approach:	Airline one four four report your heading _z /
3		(0.9)
4	Flight 144:	e:h z:ero zero five for the moment./
5		(3.3)
6	Approach:	roger. fly heading eh zero (0.4) two zero./
7		(0.5)
8	Flight 144:	Fly heading zero two zero Airline one four four./
9		(50.2)

- 22 The episode in example [4] is segmented into two parts at the level of task sequences. The first segment comprises the first two transmissions and the first word of the third transmission, i.e. “roger” (l. 6), and takes the form of a Report Elicit – Report – Acknowledgement sequence (Falzon, 2008: 171), abbreviated as Rep El – Rep – Ack. In uttering this sequence, the pilot and controller execute the task of establishing the aircraft’s heading as part of their “common ground” (Clark, 1996: 93). The second segment extends

through much of the third transmission to the end of the final transmission. It is engendered as an I – R sequence by means of which the interlocutors carry out the task of transacting a navigational instruction that is designed to guide the flight on its approach to its destination airport.

- 23 The design of the Approach controller's second transmission (l. 6) is of particular interest. It consists of two turn-constructive segments, each of which contributes to a different action sequence. As has been observed, the acknowledgement token "roger" completes the Rep Elicit – Rep – Ack sequence. The rest of the talk in the same transmission, namely "fly heading eh zero two zero," initiates the subsequent I - R sequence. In effect, the controller interlocks the final segment of the antecedent sequence to the first segment of the subsequent sequence within a single radio transmission.
- 24 Although two sequences are advanced in the controller's transmission, this form of interlocking sequential organisation nevertheless results in the serial management of the two tasks. This is because the launching of the second task occurs only after the first has been completed, i.e. the subsequent sequence package is initiated post delivery of the antecedent sequence-terminal segment. It should be noted that in opting to interlock the two segments in a single transmission, the Approach controller achieves a modest degree of compression in terms of the total number of transmissions that would otherwise have been necessary to conduct the same pair of tasks in a purely serial format.
- 25 In examples [3] (serial sequential organisation) and [4] (interlocking sequential organisation), and in the recurrent practices the examples instantiate, therefore, controllers and pilots collaboratively manage tasks serially. That is to say, they initiate each new task only when the previous task has been fully completed. In so doing, they are clearly orienting to the occurrence of the sequence-terminal segment of the antecedent task. The defining feature of serial task management, therefore, is that tasks follow each other in succession, i.e. each additional task is introduced following completion of some prior task.

3.2. Segmentation and multitasking

- 26 Multitasking among interlocutors participating in a single conversation or episode of talk may be defined as the progression of two or more action sequences across adjacent turns. This definition draws on the definition of multitasking in the domain of computer programming. A typical definition appears in the online version of the Hutchinson Encyclopaedia (2008): "System in which one processor appears to run several different programs (or different parts of the same program) at the same time. All the programs are held in memory together and each is allowed to run for a certain period." This is not intended to imply that human beings, be they aviation professionals or otherwise, necessarily behave like computers. Rather, it serves as a suitable analogy for human multitasking in so far as it is manifest in spoken discourse. Indeed, if technology is conceived of as a resource for the accomplishment of recurrently encountered tasks, then speech phenomena such as action sequences constitute a form of soft technology. The appropriateness of the analogy between human and computer multitasking becomes increasingly clear when actual instances of multitasking that occur in the data corpus are subjected to detailed analysis. However, prior to advancing to such an analysis, it is warranted to note that in contrast to serial task management, wherein tasks are advanced and completed discretely and successively, in multitasking multiple tasks are managed either wholly or partly contemporaneously.
- 27 In the course of conducting research into methods of measuring controller performance in the domain of ATC, Manning & Stein (2005: 285) observe that "though all acknowledge that multitasking is important, it is a complex construct to measure." While this may pose serious problems for cognitive approaches to the study of multitasking, in applying the methodology of CA to multitasking, this article seeks to demonstrate that, at least in so far

as it is manifested in segments of talk-in-interaction, multitasking can be examined in detail and in all of its complexity as it emerges in the course of actual instances of controller-pilot spoken communications. The data corpus informing the present research provides evidence for the existence of two forms of multitasking that are germane to ATC operations. The first results in a minimal degree of concurrent running of pairs of tasks and is therefore referred to as “incipient multitasking” (Falzon, 2008: 230).

3.2.1. Segmentation and incipient multitasking

- 28 Research into technology-mediated talk-in-interaction has shown that there exists a special form of interlocking organisation in which a single segment, in the form of a single turn-constructional unit, functions to both supply the last part of a sequence package and initiate the first part of the next package (Schegloff, 1986: 131). This feature, which is illustrated in example [5], also occurs in pilot-controller talk and is fundamental to incipient multitasking. For ease of reference, and in order to avoid ambiguity, this form of interlocking organisation, as opposed to the interlocking sequential organisation that supports serial task management, is referred to as *bi-functional interlocking* sequential organisation (Falzon, 2008: 231).⁴
- 29 In common with the previous data excerpt, the episode in example [5] subsumes the execution of two tasks. Controller and pilot begin by establishing the actual altitude at which inbound flight FJP is flying, and advance the interaction to transact clearance for the flight to descend to 1600 feet.

[5] AP100702: 5.7 Incipient multitasking

1		(49.9)
2	Approach:	foxtrot Juliet papa report altitude?/
3		(1.1)
4	Flight FJP:	Juliet papa:: (.) steady two thousand feet (.) one zero one
5		three/
6		(0.9)
7	Approach:	foxtrot Juliet papa, (.) descend altitude, (.) one thousand (0.7) six hundred
8		feet./
9		(2.4)
10	Flight FJP:	one thousand six hundred feet e::h (.) Juliet papa I descend./
11		(47.3)

- 30 Although the first task that is initiated is packaged as a Rep El – Rep – Ack sequence, the controller’s acknowledgement is delivered implicitly in the launching of the second task (ll. 7-8). He thus recoverably, albeit indirectly, provides pragmatic grounds on which the pilot can infer that his report has been received and understood. First, the controller does not alter, immediately following the report, the trajectory of the talk in progress by either inserting a next-turn repair initiator (Schegloff *et al.*, 1977; Schegloff, 1992) or otherwise moving to pursue provision of the report. Secondly, he formulates an instruction that follows logically from the details of the pilot’s report, i.e. he does not, for instance, direct the pilot to descend to the same altitude at which the aircraft is reportedly being flown. Consequently, the controller’s transmission in lines 7-8 simultaneously functions to complete the first task and launch the second, which comprises an I – R sequence. As such, it constitutes an instance of bi-functional interlocking sequential organisation. In this example, therefore, initiation of the subsequently launched task occurs not post, but

⁴ Schegloff (1986: 131) refers to this form of interlocking sequential organisation as a “less obtrusive interlock.”

simultaneously with, the prior-initiated task's final segment. Thus, in contrast to the serial task management associated with serial (example [3]) and interlocking (example [4]) sequential organisations, two tasks are concurrently underway in the controller's segment in lines 7-8.

- 31 Although they amount to distinct forms of executing multiple ATC-relevant tasks, incipient multitasking and serial task management, nevertheless share a feature in common. In employing both modes of task management, parties to air-ground radio talk display an orientation to the prior initiated task's sequence-final segment. An important ramification of this practice is that the distribution of serial task management and incipient multitasking appears to be tied to such segments. Therefore, the sequential distribution of the two modalities of task management analysed thus far does not extend to episode-initial transmissions and other transmissions that are positioned in advance of the loci of occurrence of sequence-terminal segments.

3.2.2. Segmentation and multitasking by batching

- 32 It is, nevertheless, a feature of pilot-controller talk-in-interaction that multitasking is also routinely and frequently initiated prior to arrival at a sequence-final segment. This gives rise to situations in which, in contrast to serial task management, there is more than a single task package in progress across adjacent turns, and wherein multitasking is more substantially developed rather than simply incipient.
- 33 By employing a number of particularly complex turn designs, both interlocutors accomplish a relatively large number of tasks in the four-transmission episode of talk in example [6]. The pilot organises his first transmission (ll. 2-4) into three distinct parts. The first provides the controller with a full unilateral opening component, i.e. addressee call sign, greeting and flight self-identification ("and Apron good afternoon again Air Carrier four zero eight"); the second takes the form of a flight status report that indicates the aircraft's position ("park nine stand eight") as well as the ATIS information⁵ ("information Juliet") with which the cockpit crew is current; and the third is made up of indirectly formulated requests for flight routing ("clearance to Capital") and engine start up clearances.

[6] AN090802: 7.2 Multitasking by batching

1		(7.09.4)
2	Flight 408:	and Apron good afternoon again Air Carrier (.) four zero eight park
3		nine stand eight information Juliet (.) clearance to Capital we're ready
4		for the start up please/
5		(6.5)
6	Apron:	>Air Carrier four zero eight,< (.) Apron, good afternoon start up
7		appro:ved: with (.) Juliet and you are cleared to: destination via
8		waypoint two delta departure (.) squawk five two (.) seven five./
9		(3.0)
10	Flight 408:	okay >to destination waypoint two delta< five (.) two (.) seven (.) five
11		on the squawk four zero eight and (we can) start up. (0.3) thank you./
12		
13		(0.5)
14	Apron:	>Carrier four zero eight readback correct.</
15		(1.4)

⁵ ATIS (Aeronautical Terminal Information Service) reports consist of regularly updated, pre-recorded meteorological and airfield information that is automatically broadcast on a dedicated VHF radio frequency. The first broadcast of the day is assigned a code in the form of a letter in the prescribed phraseology, and each update is allocated the next letter in alphabetical order.

- 34 A similar degree of complexity marks the controller's responding transmission (ll. 6-8). First, she completes the complex task of opening the remote service encounter between the two aviation professionals by reciprocating the two call signs and returning the greeting ("Air Carrier four zero eight Apron good afternoon"). Next, she sanctions engine start ("start up approved"), acknowledges receipt of the status report ("with Juliet"), issues route clearance ("you are cleared to destination via waypoint two delta departure") and assigns a radar transponder code ("squawk five two seven five").
- 35 In the episode of radio talk in example [6], the pilot's initial transmission launches not one, but five tasks, all of which are taken up by the controller in the next transmission. Significantly, the pilot does not end his episode-initiating transmission once he has completed the segment that first launches a single task. In extending his transmission to each further task-initiating segment he is setting about another sequence package prior to arrival at the terminal segment of each previously-launched sequence package. As a result, five action sequences are in progress across the first two transmissions in the episode. Two of these sequences, namely the identification and greeting exchange sequences, form the more complex, higher-order task of opening the radio-mediated service encounter. A third sequence is engendered in the reporting and acknowledging of ATIS broadcast Juliet as current. And the indirect requests for route clearance and permission to start up occasion the Apron controller's issue of relevant clearances.
- 36 It should not escape attention that in responding to the pilot's first transmission, the Apron controller addresses every one of the tasks that she initiates without the need for prompting by the pilot in a subsequent transmission. That she does so provides clear evidence of two important features of her conduct. First, it shows that she has oriented to all of the tasks as being in progress, i.e. as having been initiated and not yet completed. Secondly, it demonstrates that she has attended to each individual task and committed it to memory. In the light of the Hutchinson Encyclopaedia (2008) definition of multitasking, particularly the subpart which states that "all the programs are held in memory together," the latter observation underscores the appropriateness of the human-computer analogy proposed in section 3.2.
- 37 A schematic representation of the episode in example [6] appears in Table 1. Each transmission (T) is depicted in terms of its constituent turn-constructive segments and the functions they carry out. The action sequences they give rise to, and which in turn segment the episode, are marked by means of arrows. Consequently, the progress of the emergent task packages that the sequences engender can be tracked across the transmissions that comprise the episode.

Table 1: Schematic representation of multitasking in example [6]

T	Source	Turn-constructual segments						
T1	Flight 408	Addee	Greet	ID	Posn Rep	ATIS Rep	Route Clr Req	Start Req
T2	Apron		↓ Greet	↓ ID		↓ Ack	↓ I	↓ SSR Code I
T3	Flight 408						↓ R	↓ R
T4	Apron						↓ A	↓ A

Note. A = assessment; Ack = acknowledgement; Addee = addressee call sign; ATIS Rep = aeronautical terminal information service report; Greet = greeting; I = instruction; ID = self-identification call sign; Posn Rep = position report; R = readback; Route Clr Req = route clearance request; SSR Code I = secondary surveillance radar code instruction; Start Req = engine start request; T = transmission.

- 38 During the course of the episode, therefore, pilot and controller have jointly carried out six base-level tasks through the collaborative production of the same number of sequence-package segments. Across pairs of turns in the episode at least two, and as many as five, discrete sequences are in progress. Of the six task packages, five are launched in a single transmission. By the end of the fourth transmission, therefore, the participants are mutually oriented to three matters. In the first instance, the five tasks launched by the pilot, and the single, additional task introduced by the controller have been successfully accomplished. Secondly, since both parties have passed up opportunity spaces in which still further tasks can be initiated, they have mutually established that there does not appear to be any further intra-episodic business to transact. And thirdly, in view of their concerted arrival at a sequence-final segment coinciding with their completion of the episode's jointly constructed agenda of tasks, a lapse in radio talk is warranted.
- 39 This type of multitasking, instanced in a dense form in example [6] and Table 1, may be referred to as "batching" (Falzon, 2008: 242). In contrast to serial task management, the relative ordering of task packages achieved by the participants' deployment of base-level segments is not successive. Instead, tasks are collaboratively discharged in batches across adjacent turns. In essence, batching involves the initiation of at least one task package prior to, and not simultaneously with, as in incipient multitasking, or following, as in serial task management, completion of some previously launched, in progress sequence that is dedicated to the accomplishment of some other task. As a result, batched sequence packages progress simultaneously across successive turns. There is a distinct sense, therefore, that in contradistinction to the essentially successive progression associated with serial task management, as they constitute the episode, the sequences in batched multitasking progress in a quasi-parallel manner across their engendering turns.
- 40 In contrast to incipient multitasking, batching is independent of the loci of occurrence of sequence-terminal segments. This independence allows for multitasking to occur at episode initiation and other pre-sequence-terminal positions. Therefore, multitasking by batching, incipient multitasking, which features solely in sequence-final positions, and serial task management, whose deployment is restricted to post sequence-final loci, occur in

complementary sequential distribution. In combination they afford pilots and controllers the potential to manage multiple tasks at any sequential position within an episode.

4. Reasons for multitasking

- 41 Quintessentially, multitasking and serial task management constitute resources whereby controllers and pilots can group together verbally actionable tasks that are relevant to their respective projects and discharge them in concert in single episodes of air-ground talk. One advantage of multiple task episodes in general, therefore, obtains from the reduction in the overall number of episodes that would otherwise comprise controller-pilot discourses in their absence. In effect, this means that there are fewer occasions on which the addressed parties to the discourse are required to transfer their attention from some ongoing activity they might be occupied with, such as conducting elaborate checking procedures in the cockpit or resolving conflicting traffic situations in the ATC operations room, to verbal activity on the ATC radio frequency.
- 42 It might be argued that in its densest manifestation multitasking by batching might inhibit successful communication as a consequence of its concomitant turn complexity. While a number of quantitative studies find a significant correlation between controller message complexity, measured principally in terms of the number of items of information to be recalled, and pilot readback errors (Bürki-Cohen, 1995a, 1995b; Cardosi *et al.*, 1996; Prinzo *et al.*, 2006), it would nonetheless appear that successful ATC instruction transaction is also subject to a range of factors other than the quantity of information to be read back. Bürki-Cohen (1995b), for instance, finds that controllers' formatting of numerical data, i.e. whether numbers are spoken as sequences of single digits, in grouped form or in combinations of single and grouped formats, affects the efficacy of their instructions. Focusing on pilots' written notes of spoken ATC instructions, Rantanen and Kokayeff (2002: 149) claim that "it is apparent that the number of elements in a clearance is not a sufficient predictor of accuracy of a copy," and cite pilot familiarity with operating environment and procedures as factors contributing to successful ATC communication. More significantly, Prinzo *et al.* find that the correlation between message complexity and readback error is higher in the case of inbound flights, i.e. during the approach phase of flight, than for outbound flights. It would appear, therefore, that pilots' engagement with concurrent activities as well as the nature of such activities are also factors that have a degree of influence on the success or otherwise of air-ground communication.
- 43 Although the parties seeking to initiate episodes of radio talk can time their episode launching transmissions to fit their ongoing schedules of flight deck or control room activities, as a consequence of the lack of physical co-presence obtaining between the remotely located co-participants, they cannot be sure that their addressees are not engaged in some other task at the time they make their transmissions. When receipt of a transmission coincides with some other task-oriented activity that an addressee is engaged in, their workload is likely to increase and the safety of operations may be impacted (e.g. ASRS, 2006; TSBC, 2001). Reducing the number of episodes of talk per discourse, therefore, contemporaneously decreases the likelihood of addressee workload being increased and safety being compromised as a consequence.
- 44 Specific to multitasking is the advantage of episode compression. Although the closer packing of tasks in incipient multitasking results in episodes that are more compact than their serially organised analogues, it is multitasking by batching that produces the greatest degree of episode compression. The resulting highly compressed episodes are primarily the outcome of the dissolution of the link between the onset of task packages and sequence-terminal segments. This dissolution enables participants to achieve the quasi-parallel progression of task packages across transmissions that characterises batched multitasking. In

addition, independence from sequence-terminal segments also makes possible the launching of multiple tasks as early as the episode-initial transmission.

- 45 The practice of batching tasks, then, constitutes for controllers and pilots a resource whereby they can collaboratively achieve a significant degree of compression in episode length as measured in the total number of transmissions per episode. While the individual transmissions tend to be of longer duration as a consequence of greater transmission length resulting from the use of multiple turn-constructive segments, the controllers' practice of using addressee call signs at least when issuing instructions, and the pilots' practice of deploying flight identification call signs when reading back such directives, also add to the length of the transmissions when tasks are managed serially. In addition, each intra-episode transfer of transmitting parties extends the overall duration of the episode by as long as it takes for the current speaker to exit transmit mode and the next speaker to realise that the channel is available and switch from reception to transmit mode. As a result, the total time taken up by inter-transmission silences increases as the number of transmissions comprising each episode increases. Therefore, in reducing the total number of episodes per discourse and in compressing overall episode duration the practice of multitasking by batching constitutes a particularly effective method of minimising radio-channel occupancy.

5. Technology, protocol and multitasking

- 46 In designing and accomplishing emergent multiple task episodes of air-ground talk-in-interaction, controllers and pilots appear to be drawing on a key affordance (Gibson, 1986; Hutchby, 2001a, 2001b) of the VHF radio technology that mediates their communications. It would appear that the simplex communication system facilitates the design and production of complex turns that are made up of pluralities of turn-constructive segments. Since it is not possible for any single user to simultaneously send and receive messages, and since contemporaneous transmissions adversely affect message intelligibility, controllers and pilots accomplish the orderly use of the channel of communication in the configuration of single serial occupancy. In contrast to fully duplex telephone-mediated talk and co-present verbal interaction, in which transmission and reception do occur simultaneously, termination of a turn-constructive segment in VHF radio-mediated air-ground talk does not regularly project speaker transition as a possible next action. It is, rather, audible exit from transmit mode that projects a possible party transition since it frees up the channel of communication and thus makes it available to the next user. Consequently, it is entirely up to the transmitting party to determine when to terminate their transmission and make the channel available to other users. In other words, the technology affords pilots and controllers, simply by staying in transmit mode, the opportunity to readily construct and deploy transmissions that are embodied by multiple turn-constructive segments, i.e. the very type of transmissions wherein multitasking by batching is initiated, advanced and completed.
- 47 Another factor that appears to facilitate multitasking is familiarity with prescribed phraseology and with organisational protocols for the sequential ordering and transacting of ATC relevant tasks. In contrast to professional-lay interaction, controller-pilot spoken interaction occurs between professionals who bilaterally bring significant degrees of expertise to their radio-mediated remote service encounters. The use of standard phraseology enables speakers to clearly signal the nature of the business they are transacting. Thus, the link between normatively phrased segments and the routine sequences they contribute to is manifestly recognisable. In turn, bilateral knowledge of operational procedure informs controllers' and pilots' situated sense-making skills. This renders translucent the relationship between talk and task and facilitates anticipation of upcoming tasks. It follows, therefore, that in employing batching in their encounters co-participants

both exploit and display their mutual familiarity with routine practices and procedures that are employed to locally manage the ATC-relevant types of business at hand.

- 48 It should be noted, however, that no claim is being made to the effect that multitasking by batching is exclusively specific to the organisational domain of ATC or solely associated with VHF radio communication technology. Indeed, Falzon (2008) demonstrates that batching features in organisational domains ranging from telephone directory assistance services to mobile emergency medical services, and occurs in both telephone and radio-mediated interaction.

6. Conclusion

- 49 It has been the primary concern of this paper to inquire into how multiple orders of segmentation are deployed by controllers and pilots as resources for the management of multiple ATC-relevant tasks in single episodes of air-ground radio-mediated spoken communication. The foregoing analysis has shown that two orders of segmentation in particular are fundamental to the management of multiple tasks in single episodes of radio talk. Parties to the air-ground talk-in-interaction deploy base-level turn-constructural segments to design transmissions that initiate, advance or complete one or more action sequences. The resulting action sequences in turn constitute intermediate-level segments through which multiple task episodes are concertedly accomplished. In combination, these orders of segmentation are adroitly configured so as to engender two principal modes of managing multiple ATC-relevant tasks. In serial task management, interlocutors collaboratively manage tasks in succession, so that only one task is open at any single point in time. Multitasking, by contrast, involves the advancement of two or more tasks at least partly simultaneously. Incipient multitasking results when a single turn-constructural segment functions to complete some task that is in progress and contemporaneously initiate a further task. Multitasking by batching enables multiple tasks to be carried out virtually in parallel. Thus, multitasking is distinct from serial task management in that two or more tasks may be open and in progress in each of a pair of adjacent turns at talk.
- 50 In the course of the analysis of multiple task management I have sought to demonstrate that in deploying serial task management and incipient multitasking, the parties to the talk-in-interaction employ sequential organisations that are oriented to sequence-terminal segments. As has been seen, this has implications for the intra-episodic application of these two modes of task management in that their deployment is restricted to loci that follow, in the case of serial task management, or are coterminous with, in the case of incipient multitasking, sequence-terminal segments. In consequence, considerable limitations are placed on the compressibility of the emergent episodes.
- 51 The analysis has also elucidated an alternative form of sequential organisation, namely batching, that is independent of such loci, and gives rise to a quasi-parallel progression of multiple tasks. This form of multitasking affords users significantly greater degrees of episode compression. Indeed, the practice of batching advances the earliest possible onset of simultaneously managing pluralities of tasks to episode-initial transmissions. Thus, while the management of multiple tasks in single episodes reduces the number of episodes per pilot-controller discourse, where each episode is potentially disruptive of other ongoing activities, and where such disruption may on occasion have safety-critical ramifications, multitasking, moreover, has the additional advantage of compacting episode length in terms of the number of transmissions per episode, and hence of minimising radio channel occupancy.

Appendix

Transcription notation

The transcription notation is based on the Jeffersonian system (e.g. Jefferson, 1989, 2004), which is the default notation system used in CA, as presented in ten Have (2007: 215-216). A small number of additions have been made to accommodate the radio-mediated data.

(1.0)	duration of silence in seconds
(1.00.0)	duration in minutes and seconds
(.)	micro-silence of less than 0.1 seconds duration
,	continuing intonation
.	stopping fall in tone
ˆ	moderately rising intonation
?	sharply rising intonation
:	prolongation of the immediately prior sound
/	audible electronic click at end of VHF radio transmission
Final	stressed elements
><	speech between these symbols is delivered more rapidly than speech that is not similarly marked
(we can)	transcriber uncertainty
((episode in progress))	transcriber's note

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To quote this paper :

e-reference:

Paul A. Falzon, Discourse segmentation and the management of multiple tasks in single episodes of air traffic controller-pilot spoken radio communication, *Discours*, 4 | 2009, [En ligne], mis en ligne le 30 juin 2009. URL : <http://discours.revues.org/index7241.html>.